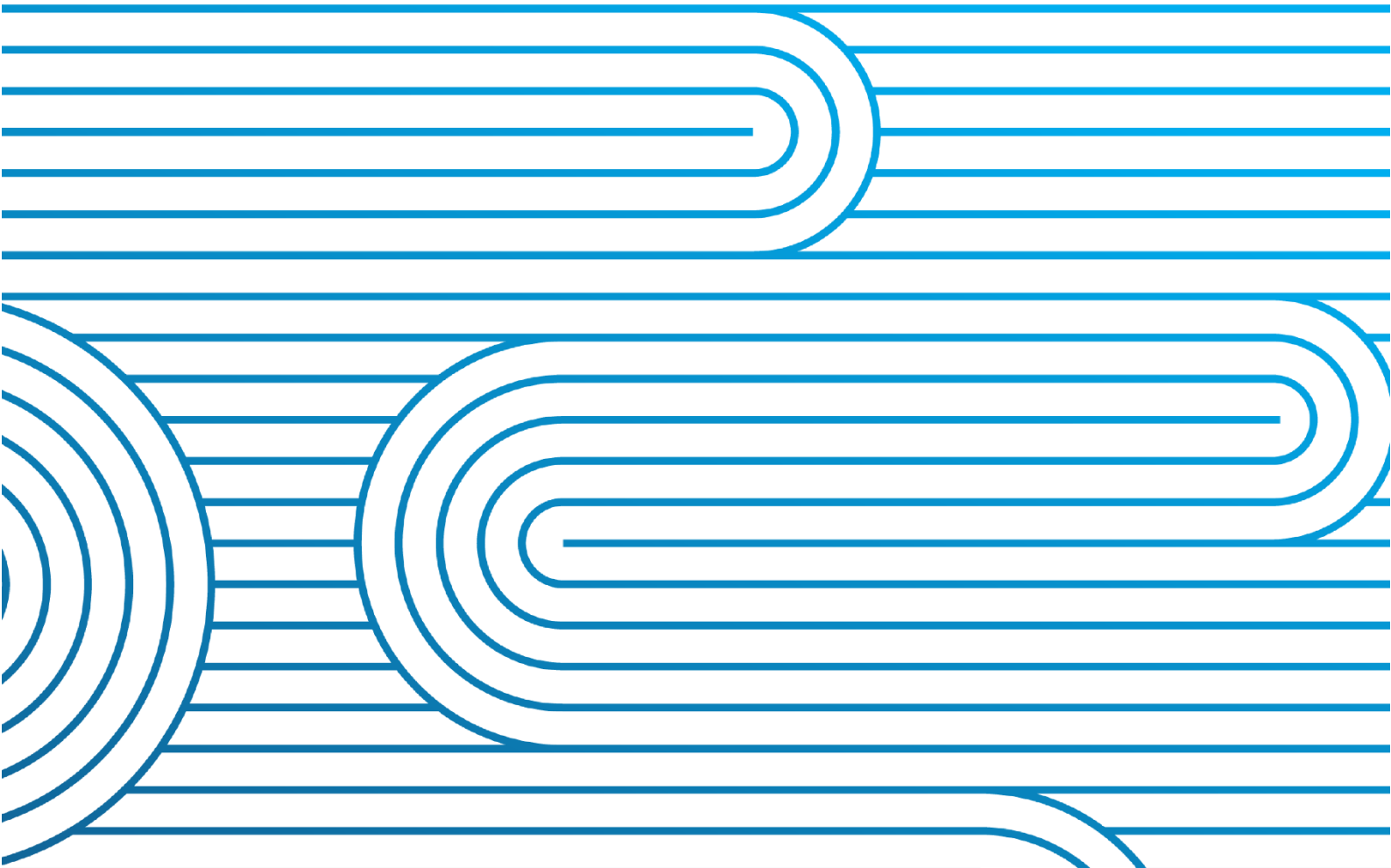
TRANSPOWER

Causation Report
23 October 2025 17:42:53
Under-Frequency Event

System Operator Event 4636

13 February 2025



IMPORTANT

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CONTENTS

1 PURPOSE

On 23 October 2025 at 17:42:53, a reduction of electricity into the power system caused the system frequency in the North Island to fall below 49.25 Hz, resulting in an under-frequency event (**UFE**).

Pursuant to clause 8.60 of the Electricity Industry Participation Code 2010 (**Code**), the System Operator investigated the event to assist the Electricity Authority (**Authority**) in determining the causer of the UFE.

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 UFE.
- The System Operator's reasons for forming its view.
- The information considered in reaching this view.

2 EXECUTIVE SUMMARY

At 17:42:50 Contact Energy's Te Huka 3 generator tripped, closely followed by Contact Energy's Tauhara generator. The disconnection of these two generators caused the frequency to drop to 49.2Hz. The North Island frequency falling below 49.25 Hz constitutes a UFE, as defined in the Code.

Investigations by the System Operator have identified the root cause of this UFE was the operation of Contact's protection for the two generators.

2.1 RECOMMENDATION OF UFE CAUSER

In accordance with clause (a) of the definition of "causer" in Part 1 of the Code, the System Operator recommends that Contact Energy as the owner of the Tauhara and Te Huka 3 generators be found as the causer of the UFE.

2.2 OTHER RECOMMENDATIONS

This investigation involved reviewing information provided by both Transpower as Grid Owner and Contact Energy. Contact Energy believed that an 'out of sync' manual closing of the Tauhara B-Wairakei circuit by the Grid Owner caused the two generators to trip. Contact raised concerns about the transients caused by closing of the circuit.

The System Operator's investigation concluded that the transients, in this case, were lower than would have been expected from a nearby fault and not expected to be sufficient to directly cause a trip of the generators. However Contact raised issues which suggest there is a need to consider concerns around voltage angle difference in some circumstances.

The System Operator's engineering investigation sets out wider recommendations for the Grid Owner, System Operator, Contact Energy specifically and other asset owners.

The System Operator does not believe that the matters raised by Contact and/or any recommendations in the System Operator's engineering report are relevant to the assessment of who the causer of the UFE is under the Code.

3 SYSTEM EVENT – 23RD OCTOBER 2025

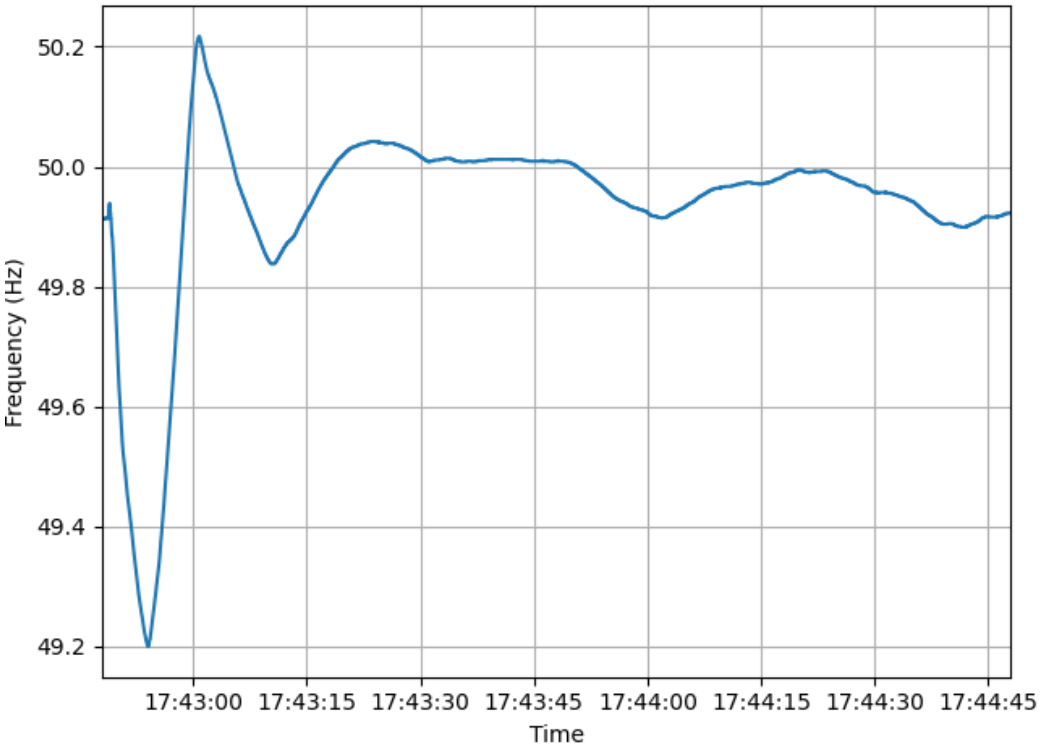
3.1 SITUATION PRIOR TO THE UNDER-FREQUENCY EVENT

Prior to the event, the Tauhara-Wairakei-1 (TAB-WRK-1) circuit was out of service on planned outage. Tauhara (TAB G1) was generating approximately 171MW and Te Huka 3 (TAC) G1 was generating approximately 52MW. At approximately 17:42:48, TAB-WRK-1 was ready to be returned to service. The breaker at the WRK end (CB162) was closed, energizing the circuit, and then the breaker at the TAB end (CB662) was closed.

3.2 THE UNDER-FREQUENCY EVENT

Very shortly after CB662 was closed TAB and TAC both tripped, causing the system frequency to drop to a minimum of 49.2Hz. The frequency was restored to normal by 17:43:00.

North Island Frequency



4 EVENT INVESTIGATION

The System Operator undertook an investigation taking into account System Operator data as well as information provided by Transpower as Grid Owner, Contact Energy and Unison Networks as Te Huka 3 connects to the Unison distribution network. Correspondence with the asset owners is provided in Appendix 1.

Both Transpower as Grid Owner, and Contact as the owner of Tauhara and Te Huka 3, confirmed that the generators tripped due to Contact's protection systems. Data accessed by, or provided to, the System Operator confirmed this.

However, Contact asserted in their correspondence that a grid disturbance caused by the closing of the Grid Owner's circuit breaker (CB662) led to both Te Huka 3 and Tauhara tripping. In Contact's view, the Grid Owner and the System Operator were responsible for system studies to identify the event in advance and the resulting procedures.

The investigation covered technical details which are included in more detail in the accompanying engineering report.

4.1 ANALYSIS

Contact Energy submitted in its correspondence with the System Operator that its investigation had concluded that the "out of sync closing" of the Tauhara-Wairakei circuit caused the Tauhara and Te Huka 3 generators to trip which subsequently caused the underfrequency event. In addition, Contact stated that there had been no consideration given to the risk on their assets prior to the manual operation of the circuit breaker, noting that there are sync check conditions in place for an automatic reclose operation. Based on these two points, Contact believed it was not the causer of the event.

The investigation considered both Contact and the Grid Owner's correspondence, including relay logs where appropriate. Contact's correspondence included assertions (as mentioned above) that the Grid Owner and System Operator were responsible for system studies to identify the event in advance, but we do not consider this is relevant to the causer determination for the purposes of the Code causer provisions that apply.

4.1.1 The root cause of the event

Contact submitted the following reasons for the two generators tripping.

- For Tauhara, Contact submitted that a current surge on the Tauhara-Wairakei circuit closure due to voltage angle difference had led to Current Transformer (CT) saturation and subsequential differential protection operation.
- For Te Huka 3, Contact submitted that its Rate of Change of Frequency (RoCoF) relay operated as a result of the grid disturbance caused by the circuit closure.

The System Operator notes that the circuit closure created a system disturbance (transient). Disturbances are to be expected when circuits are closed as power flows in the grid will change. In this case the disturbance, and the resulting torque transient at the generators, was not the source of the trip signal at either site. As Contact submitted, Tauhara tripped on differential protection, due to the CT saturation, and Te Huka 3 tripped due to its RoCoF protection.

CT saturation is a complex issue for protection systems and a forensic protection analysis has not been carried out here. However, according to the Contact data, the current experienced by the generator was twice the nominal current. This is below the maximum current magnitude that might be experienced for a nearby system

fault, and CTs being used for generator protection would not be expected to saturate at twice the nominal current.

In addition, RoCoF protection tripped Te Huka 3 when there was a significant change of the voltage angle, but no significant RoCoF.

In summary, the root cause of this event was the operation of Contact's protection relays which appear not to be a direct consequence of the circuit closing, as both operations were not expected from the system conditions experienced at each site.

4.1.2 Contributing factors related to broader issues

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Contact raised issues around voltage angle differences and potential torque transients and stated that they considered the responsibility for identifying these issues, and for considering them when closing circuits, should sit with the Grid Owner and System Operator.

Whilst we disagree with Contact's assertion that the closure of the TAB-WRK circuit and resulting voltage angle difference caused the generation to trip in this instance, we considered the issues Contact raised and have responded to these in the accompanying engineering report. We have also noted recommendations concerning these issues in the engineering report.

4.2 CAUSER RECOMMENDATION

The System Operator recommends that Contact Energy Limited is the causer. In making this recommendation, we considered the following factors.

- The immediate cause of the event was the interruption of electricity supply from Tauhara and Te Huka 3, as a result of the operation of Contact Energy's protection relays.
- We disagree with Contact's assertion that the closure of the TAB-WRK circuit caused the generation to trip. The closure of the circuit created a transient, but:
    - the magnitude of current injected by the generators was lower than would be expected for a close-in fault (which the generators should be able to ride-through), and
    - the generation was tripped, in both cases, by protection operation that was not expected from the system conditions at the time but a result of either a misinterpretation of the voltage angle change (in the case of Te Huka) or a false current reading due to Current Transformer (CT) saturation (Tauhara).

      In the case of Tauhara, the transient current experienced by the generator, according to Contact data, was twice the nominal current, which is below the maximum current magnitude that might be experienced for a nearby system fault, and CTs being used for generator protection would not be expected to saturate at twice nominal current.

      In the case of Te Huka, its 'Rate of Change of Frequency' (RoCoF) protection tripped when there was a change of voltage angle but no significant change in RoCoF.
- We disagree with Contact's assertion that this was solely a grid issue and that no consideration was given to their assets. Neither the Grid Owner (nor the System Operator) could know that closing CB662 would cause the observed operation of Contact's protection relays. In this instance, the specific protection operation resulting in the generator tripping could not have been identified in Grid Owner or System Operator studies. Contact has stated that Tauhara tripped due to saturation of a protection CT – to identify this issue an EMT study using a detailed model of the exact CT would be required, however the Grid Owner and System Operator do not have this information. Similarly, Te Huka 3 tripped due to a questionable RoCoF reading – to identify this issue would require the detailed algorithm used

by the generator protection relay, which neither Grid Owner nor System Operator have access to. In both cases the protection has operated for system conditions where it would not be expected to operate.

- The System Operator connection studies are carried out on the as-built connection design. The purpose is to determine the impact of the connecting generator on the System Operator's ability to meet its Code requirements. These studies do not include detailed modelling of protection systems.
- The connection design is determined between the asset owner and the Grid Owner. At the design stage, both Grid Owner and asset owner have the opportunity to consider any potential concerns about step changes in voltage angle at the terminal busbar, in a similar way that, for example, the change in system fault level with the TAB_WRK_1 circuit open would have been studied.

Therefore, the System Operator recommends that Contact Energy is found the causer of the under-frequency event at 17:42:53 on 23 October 2025.

5 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:

$$EC = ECR \times \left(\sum_{y} INT_{y,e} - INJ_D \right)$$

where

EC is the event charge payable by the causer

ECR is $1,250 per MW

INJ_D is 60 MW

$INT_{y,e}$ 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 INJ_D values are constants the values to calculate and complete the formula are y and $INT_{y,e}$.

Using the event charge formula the calculation is as follows:

Event Charge = $1250/MW * (222.744MW – 60MW)

Event Charge = $203,425

Appendix 1: CORRESPONDENCE

1.1 CONTACT ENERGY CORRESPONDENCE

TRANSPOWER

Wellington
22 Boulcott Street
PO Box 1021, Wellington
New Zealand
Telephone: +64-4-590 7000
Facsimile: +64-4-495 7100

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17 November 2025

Gerard Demler
Contact Energy Limited
96 The Terrace Wellington 6011

Dear Gerard,

23 October 2025 (PM) Under-Frequency Event

At 17:42:53 on 23 October an under-frequency event occurred in the North Island. We are investigating the event and require the following information from you:

- **Detailed account of the event**: Could you please provide a thorough description of the sequence of events as observed from your perspective during the under-frequency event that occurred on 23 October 2025. This should include any operational anomalies, equipment behaviour, or control actions taken around the time of the event. Furthermore, we request your assessment of the potential causes that may have contributed to the under-frequency event.
- Protection relay logs for TAB and TAC, including the GCBs, the transformer circuit breakers at TAC (CB6 and CB3102), and any circuit breakers supplying auxiliary load which tripped during the event.
- We note your email to Transpower on 12/11/2025 which states that your preliminary investigation has concluded the closure of TAB-WRK resulted in a large angle difference between WRK and TAB, resulting in a large torsional stress on TAB G1. Please provide the following further details:
  - Confirmation that torsional stress is what caused TAB and TAC to trip
  - Details of the protection element and settings that caused the trips, for example was it Out of Step protection (78G), Synch Check (25P), etc. Please explain how the relevant protection settings were determined
  - Details of any studies that were completed prior to commissioning either generator which identified the angle difference when TAB-WRK was closed as a potential issue
  - Details of any correspondence with Transpower as Grid Owner prior to this event related to procedures for manually closing either the TAB-WRK or HRP-TAB circuits. Specifically, we are interested if either party has previously raised concerns about angle difference when a circuit is closed
  - Copy of your investigation report
- **Confirmation or alternative data for MW loss**: Our preliminary assessment of SCADA data indicates a loss of 170.55 MW at TAB0 and 52.11MW at TAC0 during the event. Could you please confirm this value based on your site-specific data. If your data indicates a different value for the MW loss, please provide the alternative figure and any supporting information or logs.
- **Assessment of causation under the Code**: Based on your operational data could you please provide your assessment of whether or not your actions or the behaviour of your assets could have been the causer of the under-frequency event as per the Code. Please provide a reasoned explanation for your assessment.

Please provide the above information to us in writing by **5pm 10th December.**

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,

Connor McCarthy
Power System Engineer

CC:
Samantha Naidoo
Corporate Counsel - Compliance & Impartiality

16 December 2025

Connor McCarthy
Power System Engineer
Transpower New Zealand Ltd
22 Boulcott Street
Wellington 6011

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Cc: Samantha Naidoo
Corporate Counsel - Compliance & Impartiality

Dear Connor,

Subject: 23 October 2025 (PM) Under-Frequency Event

Thank you for your letter of enquiry dated 17 November 2025. I have sought information from site on this matter regarding your information query and our response is outlined below:

1. Detailed Account of the Event

Prior to the event, the Tauhara B (TAB) and Tauhara C (TAC) generator units were exporting via the TAB-HRP circuit only as the TAB-WRK circuit was out of service - TAB and TAC were exporting circa 163 MVA and 49 MVA respectively (net).

When the TAB-WRK circuit was closed TAB tripped and TAC tripped. On closure TAB output increased from net 163 MVA to 334 MVA (sourced from our protection relay). This current surge on circuit closure was due to the voltage angle difference (23 degrees as confirmed by the Grid Owners TAB 662 event file) between the high-impedance grid connection at TAB versus the low-impedance grid connection at WRK. To note is that this event differs from a close in grid fault event as the surge period (270ms) was well in excess of any grid fault clearance times. The surge caused CT saturation of the TAB differential protection and subsequential protection 1 relay tripped on the generator differential element. To note that the unit did not trip due to a voltage variation tripping the voltage element protection(s).

TAC tripped due to the operation of the SEL-700G ROCOF relay which initiated an SIS (safety instrument system). It should be noted that there is a guard in place to prevent operation of the ROCOF relay below 50Hz. Also note that this relay operation was a result of the grid disturbance (angular disturbance) caused by the circuit closure and not an under-frequency event.

It should be noted that the out of phase closure caused a significant torsional stress on the TAB unit as this action can be likened to a poor generator-synchronising. Contact have subsequently investigated and consulted with Fuji as to the extent of any damage to the unit. It should also be noted that TAB was subjected to high levels of negative-sequence (unbalance) current loading (circa 670 A, 8.5% of generator MCR rating) for the duration of the circuit outage as observed by both generator protection relays' negative-sequence [46] elements picking up/dropping off.

2. Protection Relay Logs

Please refer to the supplied relay logs for TAB and TAC.

3. Cause of Trip and System Studies Relating to the Event

Please refer to our response in item 1 above regarding the cause of trip. Regarding system studies to identify the event in advance, this is a system related issue due to the high impedance of the Hawkes Bay transmission loop back to WRK via RDF. We believe that the responsibility for these studies, and resulted procedures involved with this grid issue, lie with both the Grid Owner (GO) and System Operator (SO). This event is due to high loading on the transmission loop pre-switching which is contributed to by both other generating and connected load parties. Contact delivered all in scope studies that were requested by the SO as part of the compliance process for both the TAB and TAC generation projects.

We have since met with the GO to mitigate the phase angle difference related to the TAB-WRK circuit outage. The outcome is that the sync check on TAB line circuit breaker has now been reduced from 20 to 10 degrees (as of Dec 15) for the auto reclose function, and any manual reclose action requires the TAB unit to be de-loaded to 0MW to manage the risk to our unit. Our review is ongoing at present, so we are still finalising our investigation report.

4. Confirmation of MW Loss

We can confirm that the values of 170.58 MW at TAB0 and 52.11MW at TAC0 prior to the event are correct.

5. Assessment of Causation under the Code

With reference to items 1 and 3 above, our investigation has concluded that the out of sync closing of the TAB-WRK circuit caused the TAB and TAC units to trip which subsequently caused the under frequency event on 23 October at 17:42:53. There was no consideration given to the risk on our assets prior to the manual operation of the circuit breaker, noting that there are sync check conditions in place for an auto reclose operation. Based on this we do not believe that Contact was the causer of the event.

If you require further information on this matter, please get in touch with me in the first instance. Our engineering team based at Wairakei are available to discuss any details of their response above.

Yours sincerely,

Gerard Demler
Transmission Manager, Contact Energy

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Gerard Demler <Gerard.Demler@contactenergy.co.nz>
To Connor McCarthy
Cc Samantha Naidoo; Christina Leong; Kiran Nanu

Reply | Reply All | Forward
Fri 16/01/2026 10:19 am

IN CONFIDENCE
This sender Gerard.Demler@contactenergy.co.nz is from outside your organization.
You forwarded this message on 16/01/2026 10:20 am.

Cyber Security Warning: This sender is from outside of the organisation. Please be cautious when opening the links or attachments.

Hi Connor,

I hope you had a good xmas break.

The 10 deg setting was a compromise between the GO and advice from our consultant who investigated the event that the torsional stresses on our ST machine would be considerably reduced.

Thanks
Gerard

Gerard Demler
Transmission Manager
Generation and Development

Mob: 021721741

contact
PO Box 10742, Wellington 6143
Level 2, Harbour City Tower
29 Brandon Street
Wellington, New Zealand
contact.co.nz

From: Connor McCarthy <Connor.McCarthy@transpower.co.nz>
Sent: Thursday, 18 December 2025 4:52 pm
To: Gerard Demler <Gerard.Demler@contactenergy.co.nz>
Cc: Samantha Naidoo <Samantha.Naidoo@transpower.co.nz>; Christina Leong <Christina.Leong@transpower.co.nz>; Kiran Nanu <kiran.nanu@contactenergy.co.nz>
Subject: RE: Request for Information Regarding UFE on 23 October 2025 17:42:53

Hi Gerard
Thank you for your response. Could you please confirm how the new synch check setting of 10 degrees was determined, and if this is the maximum angle difference TAB and TAC can tolerate?
Please provide your response by Thursday 22 January 2026
Kind Regards

CONNOR MCCARTHY (he/him)
Power Systems Engineer

Transpower New Zealand Ltd

1.2 GRID OWNER CORRESPONDENCE

TRANSPOWER

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22 Boulcott Street
PO Box 1021, Wellington
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Telephone +64-4-590 7000
Facsimile +64-4-495 7100

17 November 2025

Melanie Marr
Grid Compliance Manager
Grid Owner
Transpower
Wellington

Dear Melanie

23 October 2025 (PM) Under-Frequency Event

At 17:42:53 on 23 October an under-frequency event occurred in the North Island. We are investigating the event and require the following information from you:

- **Detailed account of the event:** Could you please provide a thorough description of the sequence of events as observed from your perspective during the under-frequency event that occurred on 23 October 2025. This should include any operational anomalies, equipment behaviour, or control actions taken around the time of the event. Furthermore, we request your assessment of the potential causes that may have contributed to the under-frequency event.
- SCADA alarm logs indicate a three-phase fault was detected by TAB CB662 at 17:42:51, whereas PMU and Power Quality data show no indication of a fault. Please explain this discrepancy, and if CB662 did detect a fault please explain why it did not operate to clear the fault.
- SER files and data logs for relays associated with the following circuit breakers:
  - TAB CB662, CB652, CB742, and CB1022
  - WRK CB162.
- Communications from Contact Energy indicate there may have been a large angle difference between WRK and TAB when the TAB-WRK circuit was closed, resulting in a trip of TAB and TAC. To assist with our investigation, please provide the following:
  - Data on the angle difference between TAB and WRK at the instant CB662 was closed
  - Details of any functionality that prevents the manual closing of CB662 if angle difference across the breaker exceeds a threshold. Please include details of how the threshold was determined
  - Details of the closing functionality of CB662, for example are all three phases closed simultaneously or separately
  - Details of any studies that were completed prior to this event which considered the expected angle difference between TAB and WRK in this scenario
  - Details of any correspondence with Contact Energy prior to this event related to procedures for manually closing either the TAB-WRK or HRP-TAB circuits. Specifically, we are interested if either party has previously raised concerns about angle difference when a circuit is closed.
- Any other information you consider relevant to this event.
- **Assessment of causation under the Code**: Based on your operational data could you please provide your assessment of whether or not your actions or the behaviour of your assets could have been the causer of the under-frequency event as per the Code. Please provide a reasoned explanation for your assessment.

Please provide the above information to us in writing by **5pm 16th December.**

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.

Yours sincerely,

Connor McCarthy
Power System Engineer

CC:
Samantha Naidoo
Corporate Counsel - Compliance & Impartiality

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16 December 2025

Connor McCarthy
Power System Engineer
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Response to Request for Information: Under-Frequency Event on 23 October 2025 at 17:42

Dear Connor,

Thank you for your request regarding the under-frequency event on 23 October 2025 at 17:42 p.m.

Please refer to Appendix A and the attached zip file for the Grid Owners detailed response to the System Operators questions regarding the under-frequency event.

Based on the information provided, the Grid Owner does not consider itself responsible for the under-frequency event on 23 October 2025 at 17:42 p.m.

I trust this clarifies the Grid Owners understanding of the event. If you require any clarification or additional information, please feel free to contact me.

Yours sincerely,

Melanie Marr
Grid Compliance Manager

CC:
Samantha Naidoo
Corporate Counsel – Compliance & Impartiality Manager
Christina Leong
Graduate Power Systems Engineer

Appendix A – Response to System Operator request for information regarding the 23 October 2025 UFE at 17:42 p.m.

Event Summary

On 23 October 2025 the WRK-TAB-1 circuit was returned to service after an outage. TAB and TAC was generating at the time at Tauhara B. When TAB662 was closed, TAB and TAC generation removed themselves from the grid shortly after. The Transpower grid remained stable with no tripping and no grid fault present.

Detailed account of the event:

Request 1 – Sequence of events

Could you please provide a thorough description of the sequence of events as observed from your perspective during the under-frequency event that occurred on 23 October 2025. This should include any operational anomalies, equipment behaviour, or control actions taken around the time of the event.

A simplified network diagram is shown in Figure 2. When considering the SCADA logs (see Figure 3) obtained from PI data and the relay event logs the sequence of events can be stated as provided in Table 1.

Table 1: Sequence of events based on the available protection records.

No	Time	Event	Comment
1	Base	• TAB-WRK-1 circuit out of service. • TAB and TAC were generating (See Figure 4 and Figure 5).	• TAB-WRK-1 was out of service • From SCADA logs the WRK162 CB was operated many occasions prior to the event. • It is assumed the required isolations were in place and disconnectors were opened as there were no other tripping's or indications of network faults related to the testing.
2	Time not relevant	WRK162 CB closed state	• WRK162 was closed. • The relay event record shows a stable line voltage at TAB662 end and at the WRK162 end. This can be seen in the event files where the voltage is available just prior to the TAB662 CB being closed. See Figure 9. • The voltage angle difference across TAB662 CB remained at approximately 23 degrees. See Figure 12.
3	17:42:48.741 (Zero time-21 ms)	TAB662 CB close pulse (OUT307) is issued to the CB.	• From the relay event record, see Figure 10. • The first phase started to close 21 ms after the close pulse was issued. • The frequency was stable at 50 Hz. • The voltage angle difference across TAB662 CB remained at approximately 23 degrees. See Figure 12.
4	17:42:48.762 (Zero time)	TAB662 CB started to close	• From the relay event record, see Figure 9. • The Y-phase started to close first followed by the B-phase and then the R-phase. • All three phases started to close within 6 ms of each other. • The frequency was stable at 50 Hz (Figure 10).

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			• The voltage angle difference across TAB662 CB remained at approximately 23 degrees. See Figure 12. • The TAB anti-island scheme registers the change in the network (Figure 6 and Figure 7).
5:	17:42:48.797 (+ 35 ms)	Line current started to pass through the TAB-WRK-1 circuit	• From the relay event record, see Figure 9. • The phase currents started to flow 35 ms after the TAB662 CB started to close. • This was a step change in current followed by a steady decay of the current. • The phase currents do have a decaying DC offset. • The phase currents are 180 degrees out of phase with similar magnitudes and shapes, indicating that there is no fault on the circuit. This is also enforced by no reasonable dip in voltage and no main protection being triggered i.e. dif. • The frequency was stable at 50 Hz (Figure 10). • The voltage angle difference across TAB662 CB is starting to change from 23 degrees. See Figure 12. • It is observed that the TAB bus voltage is moving towards the TAB-WRK-1 line voltage (grid voltage). See Figure 12.
6	17:42:48:814 (+ 52 ms)	TAB662 CBs were all closed	• The frequency was stable at 50 Hz (Figure 10). • The voltage angle difference across TAB662 CB is almost stable with no difference. See Figure 12. • The TAB anti-island scheme registers the change in the network (see Figure 6 and Figure 7). Also, there are no indication of the anti-island protection issuing asserting an output to trip a CB or providing an intertrip.
7	17:42:48:923 (+ 155 ms)	The frequency drops from 50 Hz to 49.92 Hz	• The time is referenced to Figure 10. • The slight drop in frequency cannot definitively be explained. It may be the TAB and TAC generators starting to respond to the new network state.
8	17:42:49:091 (+ 323 ms)	The frequency drops from 49.92 Hz to 49.81 Hz	• The time is referenced to Figure 10. • The decaying line current makes a step change reduction. This may possibly be where the generation (TAB and or TAC) are removed from the grid. • There are no indication of the anti-island protection issuing asserting an output to trip a CB or providing an intertrip (see Figure 6 and Figure 7).
9	17:42:49:091 (+ 373 ms)	The frequency recovers from 49.81 Hz to 49.9 Hz	• The time is referenced to Figure 10.
10	17:42:49:214 (+ 446 ms)	The frequency drops again from 49.9 Hz to 49.2 Hz	• The time is referenced to Figure 11. • This drop in frequency may be due to the TAB and TAC generation that are removed and the load being supplied at the time. This cannot be verified from this event data. • The Transpower protection remained stable through out these periods and there was no evidence of a trip or open being issued to any CB during these.

Request 2 – Potential cause

Furthermore, we request your assessment of the potential causes that may have contributed to the under-frequency event.

The under-frequency event is caused by the sudden removal of TAB and TAC generation and the resulting generation-load mismatch in that part of the grid.

Having TAB-WRK-1 removed from and then returned to service, or any of the other 220 kV circuits around the WRK-TAB-HRP-RDF-WHI loop, is considered normal operation of the grid. When TAB-WRK is removed from service and then returned, the following two points are observed which may contribute to the generator protection not being secure.

1. The angle voltage difference across the TAB662 CB was approximately 23 degrees prior to closing.

2. The change in grid impedance presented to the generators. Each of the WRK-WHI-RDF and WRK-TAB-HRP-RDF 220 kV paths has an approximate positive sequence impedance of 40 ohms at 83 degrees. See Figure 2. The TAB-WRK-1 circuit only has a 2 ohm impedance. When the circuit is out, the generators are generating into a large series impedance (78 ohms maximum to WRK) and when the TAB-WRK-1 circuit is switched back, this series impedance is drastically reduced to potentially 2 ohms to WRK (78 and 2 ohms in parallel). This may require the generators to react and change their operating point. This may also be a function of the generators operating point (how much the generator was generating) at the time and the required load demand in that part of the grid. This can only be confirmed by dynamic studies.

Request 3 – System fault

SCADA alarm logs indicate a three-phase fault was detected by TAB CB662 at 17:42:51, whereas PMU and Power Quality data show no indication of a fault. Please explain this discrepancy, and if CB662 did detect a fault please explain why it did not operate to clear the fault.

The protection records obtained do not indicate the presence of a fault on the grid during the closing of the circuit breaker. When the WRK162 end was closed, this remained in service and when TAB662 was closed, this too remained in service with no voltage dip on the protection records.

Also, there was no operation or trigger of any main protection elements such as the line differential or any buszone protection. This indicates that there was no fault on any grid equipment, i.e. circuit or busbar. With no accompanying voltage deviation, this was not a power system fault.

In summary, there was no power system fault and Transpower's protection remained secure during the switching event.

Log files

Request 4 – Provide event files

Please provide SER files and data logs for relays associated with the following circuit breakers:
TAB CB662, CB652, CB742, and CB1022 WRK CB162.

As there were no fault and no subsequent trip in the grid, there were very little fault records available for this event. The status of all available records is provided in
Table 2 and the file identification is provided in Table 3. All the relevant available records are provided with this request for information.

Table 2: The status of Transpower event records for this TAB and TAC tripping.

Location	Type				Comment
	F	U	S	O	
TAB662	X	X	X	-	SEL411L Line protection event records.
TAB652	-	-	-	-	Transpower only have a buszone protection and point on wave relay. No records available for these relays as nothing was triggered.
TAB742	-	-	X	-	TAB T11 has a dual differential scheme. The SER is provided for the SEL487 relay and the 7UT85 does not have any records available. The SEL487 relay does not have any entries for the event in question as there was no trip.
TAB1022	-	-	X	-	The SEL311C feeder relay does not have any entries for the event in question. Only the SER is provided that also show this.
TAB anti-island	-	-	X	-	The anti-islanding protection did not issue a trip and no event file was generated as a result. The SER does indicate how the grid is changing during switching.
WRK162	X	X	X	-	SEL411L Line protection event records.
TAB682	-	-	X	-	The SEL411L relay does not have any entries for the event in question. Only the SER is provided that also show this.
HRP232	-	-	X	-	The SEL411L relay does not have any entries for the event in question. Only the SER is provided that also show this.

Note: F – Filtered, U – Unfiltered, S – sequence of events (SER), O – Other

Table 3: Table of files provided for each location and identification thereof

Location	File	Comment
TAB662	LDIF1 -SEL-411L-1_10_23_2025_17_42_48_806_200.CEV	Filtered
	LDIF1 -SEL-411L-1_10_23_2025_17_42_48_806_200.CFG	Unfiltered - COMTRADE
	LDIF1 -SEL-411L-1_10_23_2025_17_42_48_806_200.DAT	Unfiltered - COMTRADE
	LDIF1 -SEL-411L-1_10_23_2025_17_42_48_806_200.HDR	Unfiltered - COMTRADE
	TAB662_SEL411L_20251125.txt	SER
TAB742	TAB1022_T11_SEL487E_20251125.txt	SER
TAB1022	TAB1022_SEL311C_20251125.txt	SER
TAB anti-island	TAB_Anti_island_SEL451_20251024.txt	SER
WRK162	LDIF1 -SEL-411L-1_10_23_2025_17_42_48_808_200.CEV	Filtered
	LDIF1 -SEL-411L-1_10_23_2025_17_42_48_808_200.CFG	Unfiltered - COMTRADE
	LDIF1 -SEL-411L-1_10_23_2025_17_42_48_808_200.DAT	Unfiltered - COMTRADE
	LDIF1 -SEL-411L-1_10_23_2025_17_42_48_808_200.HDR	Unfiltered - COMTRADE
	WRK162_SEL411L_20251125.txt	SER
TAB682	TAB682_SEL411L_20251125.txt	SER
HRP232	HRP232_SEL411L_20251125.txt	SER

Other information

Communications from Contact Energy indicate there may have been a large angle difference between WRK and TAB when the TAB-WRK circuit was closed, resulting in a trip of TAB and TAC.
To assist with our investigation, please provide the following:

Request 5 – Angle difference

Data on the angle difference between TAB and WRK at the instant CB662 was closed

- The difference in voltage angle across TAB662 was approximately 23 degrees up until the time TAB was closed. This is from the event record in Figure 12.

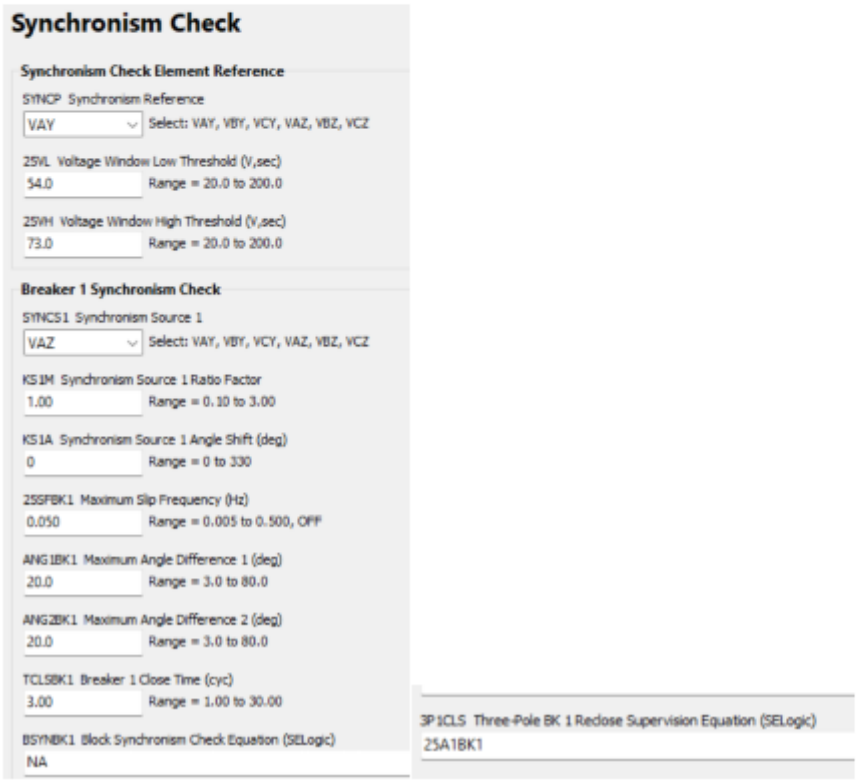
Request 6 – Manual closing

Details of any functionality that prevents the manual closing of CB662 if angle difference across the breaker exceeds a threshold. Please include details of how the threshold was determined

There is no functionality that prevents the manual closing of TAB662 on the account of a voltage angle difference across the CB. This is consistent with all parts of the grid, where there is no supervising of manual close of the circuit breaker for synchronising conditions, i.e. slip or phase angle. The synchronisation requirements for closing TAB662 are only used during auto-reclosing restorations.

During an auto-reclose event, the synchronisation settings are relevant. These are shown in Figure 1 In the synchronisation logic, the maximum angle difference used is 20 degrees (ANGiBK1). The three pole auto-reclose supervision equation is also shown in Figure 1.

Figure 1 - TAB662 Synchronisation settings and three pole auto reclose supervision equation.



Request 7 – TAB662 Closing Functionality

Details of the closing functionality of CB662, for example are all three phases closed simultaneously or separately

TAB662 is a single pole circuit breaker but no point on wave closing is applied so the circuit breaker behaves as three-pole circuit breaker when closed. The protection relays only provide a single close output the circuit breaker on OUT307. This then gets daisy chained to each phase and subsequent closing coil of the CB. In Figure 10 the close output (OUT307) can be observed, and CB open and close contacts can also be observed. The relevant part of the relay assembled form is provided in Figure 8 to interpret to binaries shown.

Request 8 – Prior studies on voltage angle difference

Details of any studies that were completed prior to this event which considered the expected angle difference between TAB and WRK in this scenario

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The Grid Owner can confirm no studies were completed prior to this event that considered the expected angle difference between TAB and WRK in this scenario or received any connection studies from Contact Energy about the expected angle difference.

Request 9 – Correspondence with Contact

Details of any correspondence with Contact Energy prior to this event related to procedures for manually closing either the TAB-WRK or HRP-TAB circuits. Specifically, we are interested if either party has previously raised concerns about angle difference when a circuit is closed.

The Grid Owner has had no prior correspondence with Contact Energy regarding procedures for manually closing either the TAB-WRK or HRP-TAB circuits. Furthermore, no concerns about angle difference when a circuit is closed have been raised with us.

Request 10 – Any other relevant information

Any other information you consider relevant to this event

The Grid Owner has no further information to add.

Assessment of causation under the Code:

Request 11 - Assessment of causation under the Code

Based on your operational data could you please provide your assessment of whether or not your actions or the behaviour of your assets could have been the causer of the under-frequency event as per the Code. Please provide a reasoned explanation for your assessment.

The definition of "causer" is set out in Part 1 of the Code. It provides, in paragraph (a) of the definition that "if the under-frequency event is caused by an interruption to or reduction of electricity supply, or an increase in electricity demand, from a single participant's asset or assets, that participant is the causer unless another participant's act or omission or property causes the interruption or reduction or increase, in which case the other participant is the causer".

The under-frequency event was triggered by a reduction in electricity supply when Tauhara generation tripped. Tauhara is Contact Energy's asset. Prima facie, that means Contact Energy is the causer, unless the proviso in paragraph (a) of the definition of causer applies. In this case, as indicated in the information we have provided in this response, there was no act or omission by, or property of, Transpower as the grid owner that caused the

1.3 UNISON CORRESPONDENCE

17 November 2025

Jason Larkin
Unison Networks Limited
1101 Omahu Road
Hastings

Dear Jason,

23 October 2025 (PM) Under-Frequency Event

23

At 17:42:53 on 23 October an under-frequency event occurred in the North Island when TAB and TAC generation tripped. We are specifically interested in the part of your network that is supplied from the TAB GXP, including the circuits which connect TAC generation. We are investigating the event and require the following information from you:

- Details of any faults that occurred in this part of your network during or up to 5 minutes prior to this event
- Protection logs for any circuit breakers in this part of your network which operated during or up to 5 minutes prior this event
- Any other information you consider relevant to this event
- **Assessment of causation under the Code**: Based on your operational data could you please provide your assessment of whether or not your actions or the behaviour of your assets could have been the causer of the under-frequency event as per the Code. Please provide a reasoned explanation for your assessment.

Please provide the above information to us in writing by **5pm 16th December.**

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,

Connor McCarthy
Power System Engineer

CC:
Samantha Naidoo
Corporate Counsel - Compliance & Impartiality

RE: Request for Information Regarding UFE on 23 October 2025 17:42:53

LV Leon Viljoen <Leon.Viljoen@unison.co.nz>
To Connor McCarthy
Cc David Bredda (Unison); Rhett Mulinder; Edward Brown; jason larkin

IN CONFIDENCE

This sender Leon.Viljoen@unison.co.nz is from outside your organization.

33kV Tauhara_Te Huka Network Diagram.pdf
687 KB

THK_THR.docx
95 KB

Cyber Security Warning: This sender is from outside of the organisation. Please be cautious when opening the links or attachments.

Hi Connor,

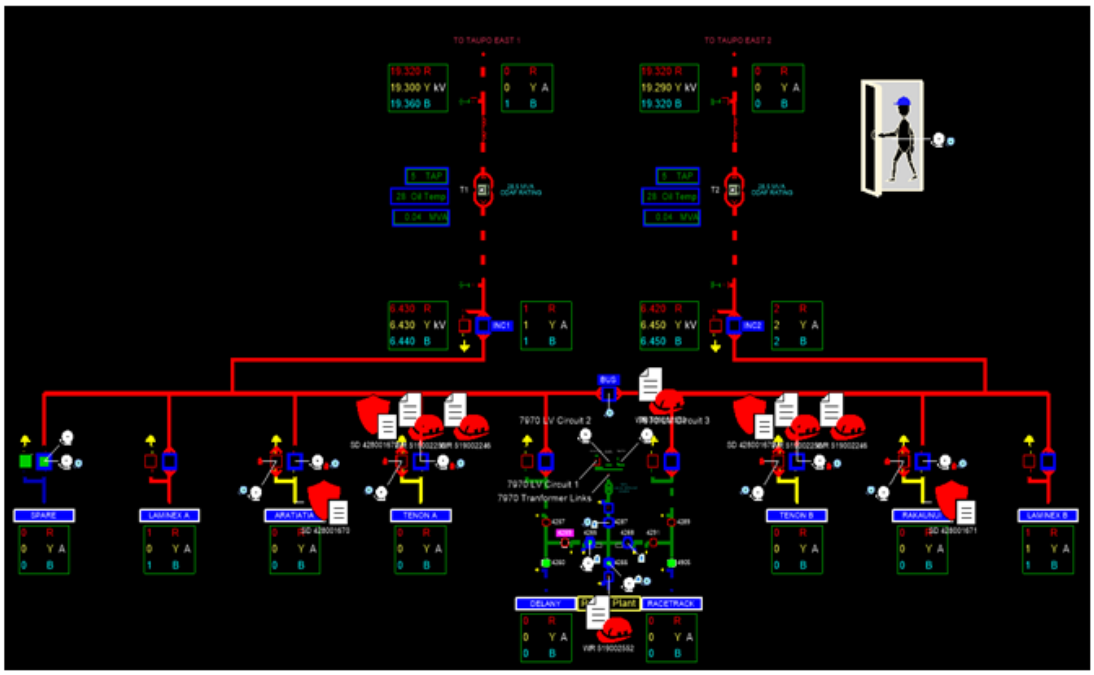
RE: Request for Information Regarding UFE on 23 October 2025 17:42:53

24

Background:
Taupo East substation is a brand new 33/11kV substation, presently in commissioning phase.
The 2x 33/11kV Tx's at Taupo East have been livened and parallelled through the 11kV bus, with no 11kV feeders presently in service/on load.
Section of network of interest has been highlighted in orange. Refer to attached 33kV Tauhara_Te Huka Network Diagram.

Feedback:
No 33kV were recorded 5min before the UFE.
Prove of no trip events (HIS & SER). Refer to THK_THR document.
No remote SCADA open commands. SER's have been checked.
No event recordings or SER's for Taupo East.

Taupo East ZS SCADA Tile to indicate no load connected:



Hope you find the above in order.

Kind Regards

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E leon.viljoen@unison.co.nz

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www.unison.co.nz

TRANSPOWER

Date: 13/032026		**SO Event No 4636**
Compiled by:	Connor McCarthy, Engineer Richard Sherry, Principal Engineer	
Reviewed by:	Katherine Moore, Head of Power Systems	
Subject:	Under-frequency Event (23/10/2025, pm)	

1 Introduction

The purpose of this report is to outline the root cause of the under-frequency event (UFE) which occurred on 23rd October 2025 at 17:42:53 and make a recommendation on the causer. This report will inform the UFE Causation Report.

1.1 Roles and responsibilities

1. **Participants**: Provide information regarding the performance of their equipment before and during the event to the system operator.
2. **System Operator**:
    a. Collect and analyse event information.
    b. Recommend the causer of the UFE, where the findings are reported to the Electricity Authority.
3. **Electricity Authority**:
    a. Make the final decision on the causer of the event.

2 Event Details

Event Summary

Prior to the event, the Tauhara-Wairakei-1 (TAB-WRK-1) circuit was out of service for a planned outage. Tauhara (TAB G1) was generating approximately 171MW and Te Huka 3 (TAC) G1 was generating approximately 52MW. At approximately 17:42:48, TAB-WRK-1 was ready to be returned to service. The breaker at the WRK end (CB162) was closed, energizing the circuit, and then the breaker at the TAB end (CB662) was closed.

Very shortly after CB662 was closed, TAC and TAB both tripped, causing the system frequency to drop to a minimum of 49.2Hz. The frequency was restored to normal by 17:43:00.

Both Transpower as Grid Owner and Contact, as the owner of TAB and TAC, have confirmed that the generators tripped due to protection actions from Contact's assets. Data accessed or provided to the System Operator confirmed this. However, both Contact and Transpower as Grid Owner submit that they are not the causer of the underfrequency event. Contact asserts that the closing of the Grid Owner's circuit breaker (CB662) led to both TAC and TAB tripping.

2.1 Event timeline

Table 1 shows the sequence of events that occurred and **Error! Reference source not found.** illustrates the frequency using PMU data.

Table 1: Event timelines

Time	Description	Source
20/10/2025 08:00	TAB-WRK-1 Removed from Service for planned outage	POCP
23/10/2025 17:42:20	TAB-WRK-1 ready for return to service, WRK CB162 Closed	Transpower SCADA
17:42:48.741	TAB CB662 close pulse issued	GO Protection Relay Log
17:42:48.8	TAB CB662 is fully closed.	GO Protection Relay Log
17:42:50.055[1]	TAC G1 Protection Relay Asserts Output to Safety Instrument System (SIS), which subsequently trips TAC G1	Contact Protection Relay (SEL 700G)
17:42:51.986	TAB G1 Trip Command Issued	Contact Protection Relay Log (ABB REG670)
17:42:53.26	Frequency drops below 49.25Hz	WRK PMU
17:43:00	Frequency restored to normal band	WRK PMU

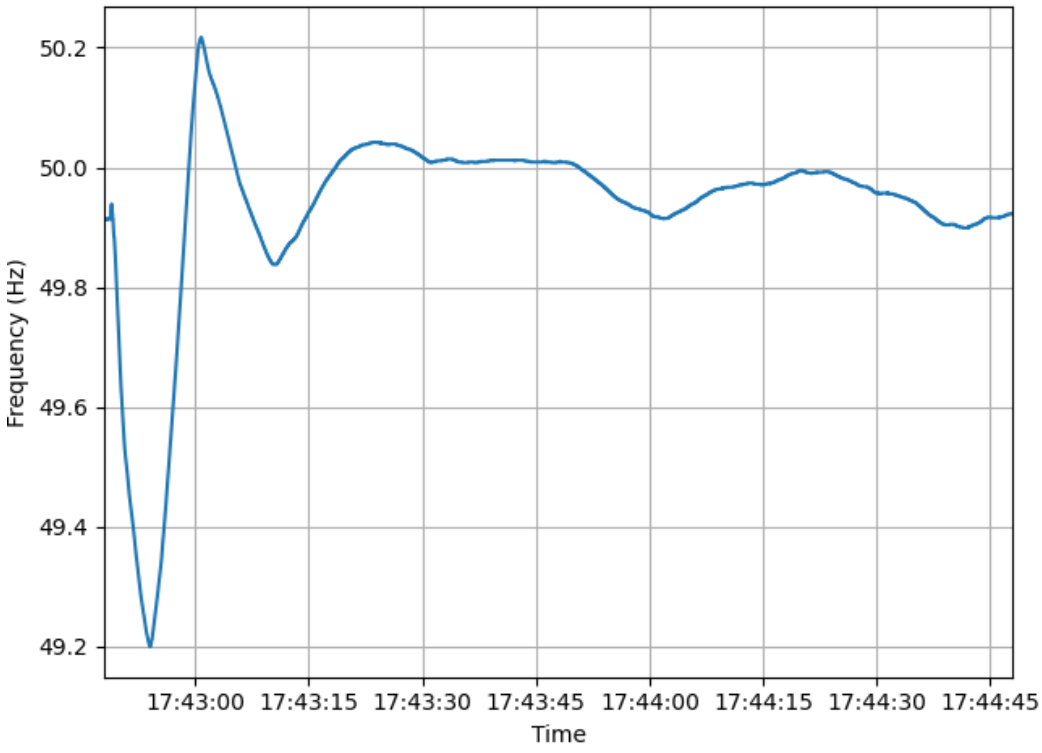

Figure 1: WRK PMU Measured Frequency

[1] The actual relay logs show the time as 16:42:50.055, however Contact provided a note explaining that the relay time is 1hr out

3 Background

This section provides background information relevant to the event:

- an overview of the TAB and TAC connection details and relevant part of the power system
- an overview of voltage angle difference as this has been raised by Contact Energy as a factor leading to the generator trippings.

3.1 Connection Details

The Tauhara (TAB) and Te Huka 3 (TAC) generators both connect to the grid at the TAB GXP. TAB is directly connected while TAC is connected via Unison's network. TAB is connected to WRK directly via the TAB-WRK-1 circuit, and indirectly through the TAB-HRP-1, HRP-RDF-1, RDF-WHI-1, and WHI-WRK-1 circuits. Figure 2 shows the single line diagram of the connection.

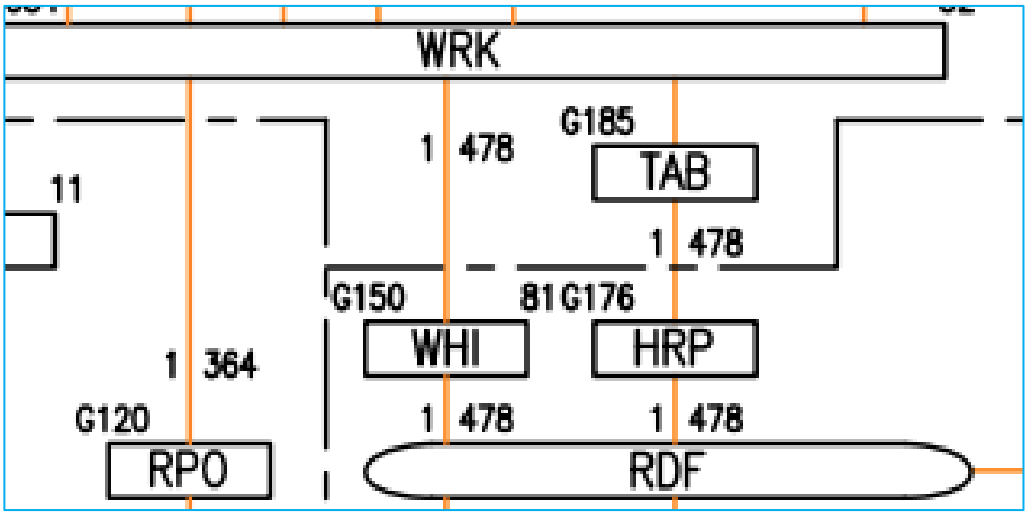

Figure 2: Hawkes Bay Single Line Diagram

TAB is significantly closer to WRK than the rest of the Hawkes Bay GXPs, resulting in the TAB-WRK-1 circuit being much lower impedance than the loop via RDF (RDF-WHI-1, and WHI-WRK-1 circuits). The TAB-WRK-1 circuit has a positive sequence impedance of approximately 2 ohms, while the impedance between TAB and WRK with TAB-WRK-1 out of service is approximately 78 ohms.

An anti-islanding scheme is installed that inter-trips TAB, TAC, and HRP generation if a fault results in the Hawkes Bay being disconnected from WRK. This did not activate during the event.

3.2 Voltage Angle

Voltage in an AC power system has both a magnitude and a phase angle which is different at different parts of the network.

Voltage angle at a given point is determined by load, generation, and impedance. For real power to flow through an impedance an angle difference must exist, and the angle difference increases for higher power transfers or for higher impedances. The high impedance between TAB and WRK when TAB-WRK-1 is out of service can result in a large voltage angle difference between the TAB busbar and the WRK busbar which would be observable across the open circuit breaker (CB662) at TAB. At the time of the event, the voltage angle difference across TAB CB662 was approximately 23 degrees.

Sudden voltage angle changes create a sudden change in electrical torque at a generator's terminals, and this can cause significant mechanical stress to the generator. The effect of the mechanical stress

depends on the specifics of the machine, eg mass, number of poles, etc. Typically, a machine with more poles can tolerate a change in electrical torque better because it has a much lower rotational speed. Sudden voltage angle changes can occur either due to network faults or switching of circuits.

Protection relays can use zero-crossings of the voltage magnitude to determine electrical frequency but they typically calculate electrical frequency based on the derivative of voltage angle with respect to time, and by extension RoCoF (rate of change of frequency) based on the double derivative of voltage angle.[2] Therefore, the algorithms used by relays apply numerical techniques and filtering to mitigate the effect of a sudden change in voltage angle – however, relay algorithms are not standardised, and sudden changes in voltage angle can still cause inaccurate readings of frequency and hence identify high RoCoF unexpectedly in some relays.

The voltage angle at a given bus for various steady state scenarios (eg circuit outages) can typically be determined by load flow studies. Such studies will identify the voltage angle difference that would exist across a presently open Circuit Breaker. Voltage angle during a fault can typically only be determined through dynamic studies.

3.3 Voltage Angle Difference Limits

The voltage angle difference across a circuit breaker as it is closed depends on many factors, including the proximity of generating units, the transmission network impedances and the system fault level at the location.

There is no international standard applied to network design for this. It is common for network relays to have a maximum value that can be applied to this parameter (which is often 60 degrees) and it also common for a default value to be applied to this parameter specifically for the *automatic* reclosing of circuit breakers – and this is typically set to 20 degrees, as it is in New Zealand. Separately, this relay parameter can be enabled for automatic and manual close operations and it is common to not enable it for manual close operations. The setting is not enabled for manual reclosing in New Zealand.

When studies are carried out on this aspect, a common assumption is that if the torque transient experienced by rotating generators is below the level that they would experience for a 3 phase terminal fault on the machine then no catastrophic damage would result, although any torque event on a machine shaft has a life-shortening effect and such events need to be rare.

4 Analysis of Participant Submissions

Following the event, the System Operator sent letters requesting information to Transpower as Grid Owner, Contact Energy Limited, and Unison Networks Limited as TAC is connected to Unison's network. Copies of this correspondence are provided in Appendix A.

This section provides a summary of each submission and the System Operator's response where relevant to the investigation.

4.1 Contact Energy

Contact Energy submitted in its correspondence with the System Operator that its investigation had concluded that the "out of sync closing" of the TAB-WRK circuit caused the TAB and TAC units to trip

[2] The exact algorithm used by a given protection relay is generally considered the IP of the relay OEM and is not available to the user

which subsequently caused the underfrequency event. The correspondence noted: "There was no consideration given to the risk on our assets prior to the manual operation of the circuit breaker, noting there are sync check conditions in place for an auto reclose operation." Based on this, and the content of its correspondence, Contact does not believe it was the causer of the event.

Contact provided protection relay logs. These relay logs confirm that:

- Both generating units were tripped after CB622 was fully closed
- TAC tripped due to the operation of the SEL-700G ROCOF relay
- TAB tripped on generator differential protection

In its submission, Contact provided the following reasons for TAB and TAC tripping following the closure CB662:

- 'On closure TAB output increased from net 163 MVA to 334 MVA (sourced from our protection relay). This current surge on circuit closure was due to the voltage angle difference (23 degrees as confirmed by the Grid Owner's TAB 662 event file) between the high impedance grid connection at TAB versus the low-impedance grid connection at WRK. To note is that this event differs from a close in grid fault event as the surge period (270ms) was well in excess of any grid fault clearance times. The surge caused CT saturation of the TAB differential protection and subsequential protection 1 relay tripped on the generator differential element'.
- 'TAC tripped due to the operation of the SEL-700G ROCOF relay which initiated an SIS (safety instrument system). It should be noted that there is a guard in place to prevent operation of the ROCOF relay below 50Hz. Also note that this relay operation was a result of the grid disturbance (angular disturbance) caused by the circuit closure and not an under-frequency event'

Contact considers that the responsibility for identifying the issues causing these trippings, and the procedures involved lies with both the Grid Owner and System Operator. In Contact's correspondence it writes: 'Regarding system studies to identify the event in advance, this is a system related issue due to the high impedance of the Hawkes Bay transmission loop back to WRK via RDF. We believe that the responsibility for these studies, and resulted [sic] procedures involved with this grid issue, lie with both the Grid Owner (GO) and System Operator (SO). This event is due to high loading on the transmission loop pre-switching which is contributed to by both other generating and connected load parties. Contact delivered all in scope studies that were requested by the SO as part of the compliance process for both the TAB and TAC generation projects.'

Contact also state in their submission that: 'It should be noted that the out of phase closure caused a significant torsional stress on the TAB unit as this action can be likened to a poor generator-synchronising. Contact have subsequently investigated and consulted with Fuji as to the extent of any damage to the unit'. The System Operator acknowledges that the closure created system transients, but the torque transient was not the source of the trip signal at either site. TAB tripped on differential protection, due to the CT saturation, and TAC tripped due to its RoCoF protection.

In the System Operator's view this is not solely a system issue. We note the following:

- Any step change in voltage angle that a rotating machine experiences at its terminals will result in a transient torque on its shaft. All such events affect the expected lifetime of the shaft and the number and magnitude of such events that a machine can tolerate depends on the specific design of the machine. Neither the GO nor SO has this level of information about the machine design. Following the event, Contact agreed with the GO to reduce the auto reclose synch check setting to 10 degrees, and stated to the SO that 'The 10 deg setting was a compromise between the GO and advice from our consultant who investigated the

event that the torsional stresses on our ST machine would be considerably reduced.' This preference for a 10-degree limitation, or any other limitation, was not identified nor communicated to either the GO or SO prior to the event.

- The transient current experienced by the generator according to the Contact data was twice nominal current. This is below the maximum current magnitude that might be experienced for a nearby system fault, and CTs being used for generator protection would not be expected to saturate at twice nominal current.
- In this instance, the specific protection operation resulting in the generator tripping could not have been identified in GO or SO studies. That is, Contact has stated that TAB tripped due to saturation of a protection CT – to identify this issue an EMT study using a detailed model of the exact CT would be required, however the GO and SO do not have this information. Similarly, TAC tripped due to a questionable RoCoF reading – to identify this issue would require the detailed algorithm used by the generator protection relay, which neither GO nor SO have access to. In both cases the protection has operated for system conditions where it would not be expected to operate. .
- The System Operator connection studies are carried out on the as-built connection design. The purpose is to determine the impact of the connecting generator on the System Operator's ability to meet our Code requirements. These studies do not include detailed modelling of protection systems..
- The connection design is determined between the asset owner and the Grid Owner. At the design stage, both Grid Owner and asset owner have the opportunity to consider any potential concerns about step changes in voltage angle at the terminal busbar, in a similar way that, for example, the change in system fault level with the TAB_WRK_1 circuit open would have been studied.

Contact also state in their submission that: 'It should also be noted that TAB was subjected to high levels of negative-sequence (unbalance) current loading (circa 670 A, 8.5% of generator MCR rating) for the duration of the circuit outage as observed by both generator protection relays' negative-sequence [46] elements picking up/dropping off'. We understand Contact's concerns about this issue and recommend they raise this separately to the UFE process. This issue needs to be investigated but we do not consider the magnitude of the pre-event negative sequence current to be relevant in determining the event causer.

4.2 Transpower as Grid Owner

The Grid Owner submitted that the under-frequency event was triggered by a reduction in electricity supply when Tauhara generation tripped. In their view, as Tauhara is Contact Energy's asset, Contact Energy is the causer. The Grid Owner considers the interruption was caused solely by the operation of Contact Energy's assets.

The Grid Owner submitted a detailed sequence of the event from their perspective, supported by protection logs. The relevant details are as follows.

- Prior to the event, the voltage angle difference across CB662 was approximately 23 degrees.
- The close pulse to CB662 was issued at 17:42:48.741, and CB662 was closed by 17:42:48:814. It appears the third phase closed approximately 2ms later than phases 1 and 2. This is within the IEC 62271-100 standard which requires a maximum difference when closing of 0.25 cycles (5ms at 50Hz).
- No other Grid Owner circuit breakers operated during the event, and the anti-islanding scheme did not assert any inter-trips.
- There was no power system fault at the time of the event.

In the System Operator's view, the 2ms delay in the third phase close may be relevant to the transients measured by Contact's protection. However, we note this delay is within the requirements of IEC 62271-100 standard.

In response to one of our questions, the Grid Owner confirmed that there is no functionality that prevents *manual* closing of CB662 on account of a voltage angle difference across the circuit breaker, and that this is consistent with other circuit breakers across the grid. There is a sync check function that is applied to *auto*-reclose attempts, which prevents *auto*-reclose if the angle difference across the breaker is greater than 20 degrees.

In the System Operator's view, the Grid Owner's protection settings regarding voltage angle difference are in line with common international practice. However, loop circuits like the WRK-RDF ring are documented to create potential issues with high voltage angles across open points and the expected conditions for TAB for grid switching operations do not appear to have been documented.

The Grid Owner confirmed that prior to the event they did not complete any studies, nor receive any connection studies from Contact, which considered the voltage angle difference between TAB and WRK when TAB-WRK-1 was out of service. The Grid Owner also stated that they had no correspondence with Contact prior to this event regarding procedures for a manual close of TAB-WRK-1 or raising any concerns about voltage angle difference in this scenario. As noted in the commentary on Contact's submission, the connection design is determined between the asset owner and the Grid Owner during design discussions.

Regarding the cause of the event, the Grid Owner submits that 'The under-frequency event is caused by the sudden removal of TAB and TAC generation and the resulting generation-load mismatch in that part of the grid. Having TAB-WRK-1 removed from and then returned to service, or any of the other 220 kV circuits around the WRK-TAB-HRP-RDF-WHI loop, is considered normal operation of the grid'.

4.3 Unison

Because TAC connects to the grid via the Unison network, we requested data from Unison relating to any tripping in the relevant part of their network at or around the time of the event. Unison confirmed there none of their assets tripped at the time of the event. Therefore, we have determined that Unison did not cause nor contribute to the cause of this event.

5 Actions Following the Event

Following the event the Contact, the Grid Owner and the System Operator have worked together on returning TAB generation to service without risk of damaging the generator. In summary:

- As a temporary measure (until 31/03/2026), the synch check setting for auto-reclose attempts has been reduced to 10 degrees
- As a temporary measure (until 31/03/2026), TAB generation will be ramped down to 0MW before TAB-WRK-1 is closed manually. The procedure is captured in a Temporary Instruction (TI-DP-1306).

Contact and Transpower's transmission business are continuing to work on a more permanent solution to this issue.

The System Operator notes that the temporary setting of 10 degrees on the auto-reclose means the security of the Hawke's Bay region is reduced as auto-reclose is significantly less likely to succeed in the event of a tripping, leaving the regional load on a single circuit. There are temporary arrangements for a managed manual reclose which provides some mitigation of the lower security. A permanent solution, ideally, will restore the load security.

6 Analysis of Event Cause

6.1 Immediate Cause

The immediate cause of the underfrequency event was the disconnection of TAB and TAC generation. This is supported by System Operator data and information from both the Grid Owner and Contact Energy.

6.2 Root Cause

The root cause of this event was the operation of Contact's protection relays which appear not to be directly related to the torque transient caused by CB662 closing and not expected from the system conditions experienced at each site. Differential protection tripped at TAB due to CT saturation and RoCoF protection tripped TAC when there was a significant change of the voltage angle, but no significant RoCoF. CT saturation in particular is a complex issue for protection systems and a forensic analysis has not been carried out here. For the purposes of the event causer determination it is our view that the saturation which has caused the trip is not expected for the current magnitudes observed during the event.

6.3 Other Contributing Factors

In this section, contributing factors related to broader issues are discussed.

6.3.1 Voltage Angle

At the time CB662 was closed, there was a voltage angle difference (of approximately 23 degrees) across the breaker. The sudden shift in voltage angle when CB662 closed caused a transient on TAB G1 which caused a large current to flow, this apparently caused a TAB protection CT to saturate, which subsequently caused TAB to trip on differential protection. The TAC protection relay appears to have interpreted the sudden shift in voltage angle as a high RoCoF and initiated a safety system which tripped the unit.

The Code does not set a standard for what voltage angle step change a generator must ride through, nor a standard on either Grid Owner or System Operator on the maximum step change in voltage angle that is acceptable for switching operations, either at the design stage or during operation.

However, the Code does expect that all participants adopt best industry practice. Internationally, this issue is documented in many networks, and solutions are typically bespoke to the specific circuits involved. It is quite common for Transmission System Operators and/or Owners to identify and mitigate these issues e.g. [1], and for manual close operations large angle differences up to 60 degrees are often tolerated.

This event has identified that assessment of step changes in voltage angle is not part of routine analysis carried out in Transpower's system studies, either in system design or in system operation. Historically, it would have been unusual to see this kind of issue in New Zealand due to the network topology and the design and location of generation connections, however going forward it is likely to be a more common issue as generation is connected to more remote parts of the grid.

6.3.2 Grid Owner Procedures

Although the Grid Owner routinely conducts load flow studies which can identify potentially large voltage angle differences, they do not routinely consider it when planning this type of connection. By creating a loop, there is potential for a large voltage angle difference across the open point when the loop is open.

A suggestion is that the Grid Owner should raise the issue if there is potential for the voltage angle difference to exceed a threshold (e.g. 20 degrees which is the standard used for auto-reclose). It would then be up to the customer to determine if this would be a problem for their equipment and to discuss any required mitigations.

6.3.3 System Operator Procedure

Similarly to the Grid Owner, the System Operator routinely conducts load flow studies (and requires Asset Owners to conduct them as part of their connection studies). However, the focus of these studies is generally thermal loading of equipment and voltage stability (i.e. the System Operator's Principal Performance Obligations (PPOs)).

A suggestion is for the System Operator to identify potential issues in the System Security Forecast, and / or to raise the issue during either the commissioning process or the outage planning process as required.

If an issue is identified, any potential mitigation (e.g. disconnecting or running back the generator before closing a circuit) would need to be discussed and agreed with the System Operator prior to generator commissioning.

6.3.4 Asset Owner Procedure

It is recognised that any transient event such as a system fault or a switching operation that creates a torque transient will impose stress on rotating machine shafts.

Contact would have known that an auto-reclose synch check setting of 20 degrees was applied to the circuits as part of the co-ordinated protection design. As far as we can determine, no concerns were raised regarding the synch-check setting not being enabled for manual reclose.

7 Recommendations

7.1 Causer Recommendation

The Code defines the causer as:
'causer, in relation to an **under-frequency event**, means—

- (a) if the **under-frequency event** is caused by an interruption to or reduction of **electricity** supply, or an increase in **electricity demand**, from a single **participant's asset** or **assets**, the **participant**, unless another **participant's** act or omission or property causes the interruption to or reduction of **electricity** supply or the increase in **electricity demand**, in which case the other **participant** is the causer; or
- (b) if the **under-frequency event** is caused by more than 1 interruption to or reduction of **electricity** supply or increase in **electricity demand**, the **participant** 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 to or reduction of **electricity** supply or increase in **electricity demand**; but

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

The System Operator recommends that Contact Energy Limited is the causer. In making this recommendation, we considered the following factors.

- The immediate cause of the event was the interruption of electricity supply from TAB and TAC, which are Contact Energy's assets.
- The root cause of the event was the operation of Contact Energy's protection relays.
- We disagree with Contact's assertion that the closure of the TAB-WRK circuit caused the generation to trip. The closure of the circuit created a transient, but the magnitude was lower than would be expected for a close-in fault, and not expected to be sufficient to directly cause a trip of the generators. The generation was tripped in both cases by protection operation that was not expected from the system conditions at the time but a result of either a misinterpretation of the voltage angle change (TAC) or a false current reading due to CT saturation (TAB).
- We agree with the Grid Owner's submission that there was no act or omission by, or property of, Transpower as the Grid Owner that caused the interruption.
- We disagree with Contact's assertion that this was solely a grid issue and that no consideration was given to their assets. The Grid Owner (or the System Operator) could not know that closing CB662 would cause the observed operation of Contact's protection relays.

7.2 Other Recommendations

We recommend that:

- Contact reviews the CT cores used for the protection relays at TAB to ensure they are suitable. Saturation at twice nominal current could result in unexpected and unwanted tripping for nearby grid system faults.
- Contact, the Grid Owner and System Operator continue to work to find a permanent solution for TAB.

7.2.1 Recommendations regarding voltage angle differences

Whilst we disagree with Contact's assertion that the closure of the TAB-WRK circuit and resulting voltage angle difference caused the generation to trip, Contact has raised issues around voltage angle differences and potential torque transients which suggest there is a need to consider this in some circumstances.

We recommend generation asset owners:

- Consider potential voltage angle differences and torque transients associated with grid system switching operations that their plant may be exposed to, particularly while the design of their connection to the Grid is being agreed.
- Raise any potential issues with the Grid Owner and the System Operator during the commissioning process.

We recommend that the Grid Owner:

- Considers updating its procedures for connecting new generation to consider potential voltage angle differences and discuss potential issues with customers.

We recommend the System Operator:

- Considers updating its guidelines for generator connection studies to include consideration of potential voltage angle differences at points of network switching, and the associated transients that the generation would be exposed to.
- Considers whether useful analysis on this issue could be included as part of the System Security Forecast.

Appendix A: Correspondence

Contact Energy Correspondence

TRANSPOWER

Waikoukou
22 Boulcott Street
PO Box 1021, Wellington
New Zealand
Telephone +64-4-590 7000
Facsimile: +64-4-495 7100

17 November 2025

Gerard Dernier
Contact Energy Limited
96 The Terrace Wellington 6011

Dear Gerard,

23 October 2025 (PM) Under-Frequency Event

At 17:42:53 on 23 October an under-frequency event occurred in the North Island. We are investigating the event and require the following information from you:

- **Detailed account of the event**: Could you please provide a thorough description of the sequence of events as observed from your perspective during the under-frequency event that occurred on 23 October 2025. This should include any operational anomalies, equipment behaviour, or control actions taken around the time of the event. Furthermore, we request your assessment of the potential causes that may have contributed to the under-frequency event.
- Protection relay logs for TAB and TAC, including the GCBs, the transformer circuit breakers at TAC (CB6 and CB3102), and any circuit breakers supplying auxiliary load which tripped during the event.
- We note your email to Transpower on 12/11/2025 which states that your preliminary investigation has concluded the closure of TAB-WRK resulted in a large angle difference between WRK and TAB, resulting in a large torsional stress on TAB G1. Please provide the following further details:
  - Confirmation that torsional stress is what caused TAB and TAC to trip
  - Details of the protection element and settings that caused the trips, for example was it Out of Step protection (78G), Synch Check (25P), etc. Please explain how the relevant protection settings were determined
  - Details of any studies that were completed prior to commissioning either generator which identified the angle difference when TAB-WRK was closed as a potential issue
  - Details of any correspondence with Transpower as Grid Owner prior to this event related to procedures for manually closing either the TAB-WRK or HRP-TAB circuits. Specifically, we are interested if either party has previously raised concerns about angle difference when a circuit is closed
  - Copy of your investigation report
- **Confirmation or alternative data for MW loss**: Our preliminary assessment of SCADA data indicates a loss of 170.55 MW at TAB0 and 52.11MW at TAC0 during the event. Could you please confirm this value based on your site-specific data. If your data indicates a different value for the MW loss, please provide the alternative figure and any supporting information or logs.
- **Assessment of causation under the Code**: Based on your operational data could you please provide your assessment of whether or not your actions or the behaviour of your assets could have been the causer of the under-frequency event as per the Code. Please provide a reasoned explanation for your assessment.

Please provide the above information to us in writing by **5pm 16th December.**

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,

Connor McCarthy
Power System Engineer

CC:
Samantha Naidoo
Corporate Counsel - Compliance & Impartiality

TRANSPOWER

contact

16 December 2025

Connor McCarthy
Power System Engineer
Transpower New Zealand Ltd
22 Boulcott Street
Wellington 6011

Cc: Samantha Naidoo
Corporate Counsel - Compliance & Impartiality

Dear Connor,

Subject: 23 October 2025 (PM) Under-Frequency Event

Thank you for your letter of enquiry dated 17 November 2025. I have sought information from site on this matter regarding your information query and our response is outlined below:

1. Detailed Account of the Event

Prior to the event, the Tauhara B (TAB) and Tauhara C (TAC) generator units were exporting via the TAB-HRP circuit only as the TAB-WRK circuit was out of service - TAB and TAC were exporting circa 163 MVA and 49 MVA respectively (net).

When the TAB-WRK circuit was closed TAB tripped and TAC tripped. On closure TAB output increased from net 163 MVA to 334 MVA (sourced from our protection relay). This current surge on circuit closure was due to the voltage angle difference (23 degrees as confirmed by the Grid Owners TAB 662 event file) between the high-impedance grid connection at TAB versus the low-impedance grid connection at WRK. To note is that this event differs from a close in grid fault event as the surge period (270ms) was well in excess of any grid fault clearance times. The surge caused CT saturation of the TAB differential protection and subsequential protection 1 relay tripped on the generator differential element. To note that the unit did not trip due to a voltage variation tripping the voltage element protection(s).

TAC tripped due to the operation of the SEL-700G ROCOF relay which initiated an SIS (safety instrument system). It should be noted that there is a guard in place to prevent operation of the ROCOF relay below 50Hz. Also note that this relay operation was a result of the grid disturbance (angular disturbance) caused by the circuit closure and not an under-frequency event.

It should be noted that the out of phase closure caused a significant torsional stress on the TAB unit as this action can be likened to a poor generator-synchronising. Contact have subsequently investigated and consulted with Fuji as to the extent of any damage to the unit. It should also be noted that TAB was subjected to high levels of negative-sequence (unbalance) current loading (circa 670 A, 8.5% of generator MCR rating) for the duration of the circuit outage as observed by both generator protection relays' negative-sequence [46] elements picking up/dropping off.

2. Protection Relay Logs

Please refer to the supplied relay logs for TAB and TAC.

3. Cause of Trip and System Studies Relating to the Event

Please refer to our response in item 1 above regarding the cause of trip. Regarding system studies to identify the event in advance, this is a system related issue due to the high impedance of the Hawkes Bay transmission loop back to WRK via RDF. We believe that the responsibility for these studies, and resulted procedures involved with this grid issue, lie with both the Grid Owner (GO) and System Operator (SO). This event is due to high loading on the transmission loop pre-switching which is contributed to by both other generating and connected load parties. Contact delivered all in scope studies that were requested by the SO as part of the compliance process for both the TAB and TAC generation projects.

We have since met with the GO to mitigate the phase angle difference related to the TAB-WRK circuit outage. The outcome is that the sync check on TAB line circuit breaker has now been reduced from 20 to 10 degrees (as of Dec 15) for the auto reclose function, and any manual reclose action requires the TAB unit to be de-loaded to 0MW to manage the risk to our unit. Our review is ongoing at present, so we are still finalising our investigation report.

4. Confirmation of MW Loss

We can confirm that the values of 170.58 MW at TAB0 and 52.11MW at TAC0 prior to the event are correct.

5. Assessment of Causation under the Code

With reference to items 1 and 3 above, our investigation has concluded that the out of sync closing of the TAB-WRK circuit caused the TAB and TAC units to trip which subsequently caused the under frequency event on 23 October at 17:42:53. There was no consideration given to the risk on our assets prior to the manual operation of the circuit breaker, noting that there are sync check conditions in place for an auto reclose operation. Based on this we do not believe that Contact was the causer of the event.

If you require further information on this matter, please get in touch with me in the first instance. Our engineering team based at Wairakei are available to discuss any details of their response above.

Yours sincerely,

Gerard Demler
Transmission Manager, Contact Energy

of the circuit breaker, noting that there are sync check conditions in place for an auto reclose operation. Based on this we do not believe that Contact was the causer of the event.

If you require further information on this matter, please get in touch with me in the first instance. Our engineering team based at Wairakei are available to discuss any details of their response above.

Yours sincerely,

Gerard Demler
Transmission Manager, Contact Energy

Reply | Reply All | Forward

GD Gerard Demler <Gerard.Demler@contactenergy.co.nz>
To Connor McCarthy
Cc Samantha Naidoo; Christina Leong; Kiran Nanu
Fri 16/01/2026 10:19 am

IN CONFIDENCE
This sender Gerard.Demler@contactenergy.co.nz is from outside your organization.
You forwarded this message on 16/01/2026 10:20 am.

Cyber Security Warning: This sender is from outside of the organisation. Please be cautious when opening the links or attachments.

Hi Connor,

I hope you had a good xmas break.

The 10 deg setting was a compromise between the GO and advice from our consultant who investigated the event that the torsional stresses on our ST machine would be considerably reduced.

Thanks
Gerard

Gerard Demler
Transmission Manager
Generation and Development

Mob: 021721741

contact
PO Box 10742, Wellington 6143
Level 2, Harbour City Tower
29 Brandon Street
Wellington, New Zealand
contact.co.nz

From: Connor McCarthy <Connor.McCarthy@transpower.co.nz>
Sent: Thursday, 18 December 2025 4:52 pm
To: Gerard Demler <Gerard.Demler@contactenergy.co.nz>
Cc: Samantha Naidoo <Samantha.Naidoo@transpower.co.nz>; Christina Leong <Christina.Leong@transpower.co.nz>; Kiran Nanu <kiran.nanu@contactenergy.co.nz>
Subject: RE: Request for Information Regarding UFE on 23 October 2025 17:42:53

Hi Gerard
Thank you for your response. Could you please confirm how the new synch check setting of 10 degrees was determined, and if this is the maximum angle difference TAB and TAC can tolerate?
Please provide your response by Thursday 22 January 2026
Kind Regards

CONNOR MCCARTHY (he/him)
Power Systems Engineer

Transpower New Zealand Ltd

Grid Owner Correspondence

TRANSPOWER

Wellington
22 Boulcott Street
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New Zealand
Telephone: +64-4-590 7000
Facsimile: +64-4-495 7100

17 November 2025

Melanie Marr
Grid Compliance Manager
Grid Owner
Transpower
Wellington

Dear Melanie

23 October 2025 (PM) Under-Frequency Event

At 17:42:53 on 23 October an under-frequency event occurred in the North Island. We are investigating the event and require the following information from you:

- **Detailed account of the event:** Could you please provide a thorough description of the sequence of events as observed from your perspective during the under-frequency event that occurred on 23 October 2025. This should include any operational anomalies, equipment behaviour, or control actions taken around the time of the event. Furthermore, we request your assessment of the potential causes that may have contributed to the under-frequency event.
- SCADA alarm logs indicate a three-phase fault was detected by TAB CB662 at 17:42:51, whereas PMU and Power Quality data show no indication of a fault. Please explain this discrepancy, and if CB662 did detect a fault please explain why it did not operate to clear the fault.
- SER files and data logs for relays associated with the following circuit breakers:
  - TAB CB662, CB652, CB742, and CB1022
  - WRK CB162.
- Communications from Contact Energy indicate there may have been a large angle difference between WRK and TAB when the TAB-WRK circuit was closed, resulting in a trip of TAB and TAC. To assist with our investigation, please provide the following:
  - Data on the angle difference between TAB and WRK at the instant CB662 was closed
  - Details of any functionality that prevents the manual closing of CB662 if angle difference across the breaker exceeds a threshold. Please include details of how the threshold was determined
  - Details of the closing functionality of CB662, for example are all three phases closed simultaneously or separately
  - Details of any studies that were completed prior to this event which considered the expected angle difference between TAB and WRK in this scenario
  - Details of any correspondence with Contact Energy prior to this event related to procedures for manually closing either the TAB-WRK or HRP-TAB circuits. Specifically, we are interested if either party has previously raised concerns about angle difference when a circuit is closed.
- Any other information you consider relevant to this event.
- **Assessment of causation under the Code**: Based on your operational data could you please provide your assessment of whether or not your actions or the behaviour of your assets could have been the causer of the under-frequency event as per the Code. Please provide a reasoned explanation for your assessment.

Please provide the above information to us in writing by **5pm 10th December.**

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.

Yours sincerely,

Connor McCarthy
Power System Engineer

CC:
Samantha Naidoo
Corporate Counsel - Compliance & Impartiality

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16 December 2025

Connor McCarthy
Power System Engineer
22 Boulcott Street
Wellington

Response to Request for Information: Under-Frequency Event on 23 October 2025 at 17:42

Dear Connor,

Thank you for your request regarding the under-frequency event on 23 October 2025 at 17:42 p.m.

Please refer to Appendix A and the attached zip file for the Grid Owners detailed response to the System Operators questions regarding the under-frequency event.

Based on the information provided, the Grid Owner does not consider itself responsible for the under-frequency event on 23 October 2025 at 17:42 p.m.

I trust this clarifies the Grid Owners understanding of the event. If you require any clarification or additional information, please feel free to contact me.

Yours sincerely,

Melanie Marr
Grid Compliance Manager

CC:
Samantha Naidoo
Corporate Counsel – Compliance & Impartiality Manager
Christina Leong
Graduate Power Systems Engineer

Appendix A – Response to System Operator request for information regarding the 23 October 2025 UFE at 17:42 p.m.

Event Summary

On 23 October 2025 the WRK-TAB-1 circuit was returned to service after an outage. TAB and TAC was generating at the time at Tauhara B. When TAB662 was closed, TAB and TAC generation removed themselves from the grid shortly after. The Transpower grid remained stable with no tripping and no grid fault present.

Detailed account of the event:

Request 1 – Sequence of events

Could you please provide a thorough description of the sequence of events as observed from your perspective during the under-frequency event that occurred on 23 October 2025. This should include any operational anomalies, equipment behaviour, or control actions taken around the time of the event.

A simplified network diagram is shown in Figure 2. When considering the SCADA logs (see Figure 3) obtained from PI data and the relay event logs the sequence of events can be stated as provided in Table 1.

Table 1: Sequence of events based on the available protection records.

No	Time	Event	Comment
1	Base	• TAB-WRK-1 circuit out of service. • TAB and TAC were generating (See Figure 4 and Figure 5).	• TAB-WRK-1 was out of service • From SCADA logs the WRK162 CB was operated many occasions prior to the event. • It is assumed the required isolations were in place and disconnectors were opened as there were no other tripping's or indications of network faults related to the testing.
2	Time not relevant	WRK162 CB closed state	• WRK162 was closed. • The relay event record shows a stable line voltage at TAB662 end and at the WRK162 end. This can be seen in the event files where the voltage is available just prior to the TAB662 CB being closed. See Figure 9. • The voltage angle difference across TAB662 CB remained at approximately 23 degrees. See Figure 12.
3	17:42:48.741 (Zero time-21 ms)	TAB662 CB close pulse (OUT307) is issued to the CB.	• From the relay event record, see Figure 10. • The first phase started to close 21 ms after the close pulse was issued. • The frequency was stable at 50 Hz. • The voltage angle difference across TAB662 CB remained at approximately 23 degrees. See Figure 12.
4	17:42:48.762 (Zero time)	TAB662 CB started to close	• From the relay event record, see Figure 9. • The Y-phase started to close first followed by the B-phase and then the R-phase. • All three phases started to close within 6 ms of each other. • The frequency was stable at 50 Hz (Figure 10).

			• The voltage angle difference across TAB662 CB remained at approximately 23 degrees. See Figure 12. • The TAB anti-island scheme registers the change in the network (Figure 6 and Figure 7).
5:	17:42:48.797 (+ 35 ms)	Line current started to pass through the TAB-WRK-1 circuit	• From the relay event record, see Figure 9. • The phase currents started to flow 35 ms after the TAB662 CB started to close. • This was a step change in current followed by a steady decay of the current. • The phase currents do have a decaying DC offset. • The phase currents are 180 degrees out of phase with similar magnitudes and shapes, indicating that there is no fault on the circuit. This is also enforced by no reasonable dip in voltage and no main protection being triggered i.e. dif. • The frequency was stable at 50 Hz (Figure 10). • The voltage angle difference across TAB662 CB is starting to change from 23 degrees. See Figure 12. • It is observed that the TAB bus voltage is moving towards the TAB-WRK-1 line voltage (grid voltage). See Figure 12.
6	17:42:48:814 (+ 52 ms)	TAB662 CBs were all closed	• The frequency was stable at 50 Hz (Figure 10). • The voltage angle difference across TAB662 CB is almost stable with no difference. See Figure 12. • The TAB anti-island scheme registers the change in the network (see Figure 6 and Figure 7). Also, there are no indication of the anti-island protection issuing asserting an output to trip a CB or providing an intertrip.
7	17:42:48:923 (+ 155 ms)	The frequency drops from 50 Hz to 49.92 Hz	• The time is referenced to Figure 10. • The slight drop in frequency cannot definitively be explained. It may be the TAB and TAC generators starting to respond to the new network state.
8	17:42:49:091 (+ 323 ms)	The frequency drops from 49.92 Hz to 49.81 Hz	• The time is referenced to Figure 10. • The decaying line current makes a step change reduction. This may possibly be where the generation (TAB and or TAC) are removed from the grid. • There are no indication of the anti-island protection issuing asserting an output to trip a CB or providing an intertrip (see Figure 6 and Figure 7).
9	17:42:49:091 (+ 373 ms)	The frequency recovers from 49.81 Hz to 49.9 Hz	• The time is referenced to Figure 10.
10	17:42:49:214 (+ 446 ms)	The frequency drops again from 49.9 Hz to 49.2 Hz	• The time is referenced to Figure 11. • This drop in frequency may be due to the TAB and TAC generation that are removed and the load being supplied at the time. This cannot be verified from this event data. • The Transpower protection remained stable through out these periods and there was no evidence of a trip or open being issued to any CB during these.

Request 2 – Potential cause

Furthermore, we request your assessment of the potential causes that may have contributed to the under-frequency event.

The under-frequency event is caused by the sudden removal of TAB and TAC generation and the resulting generation-load mismatch in that part of the grid.

Having TAB-WRK-1 removed from and then returned to service, or any of the other 220 kV circuits around the WRK-TAB-HRP-RDF-WHI loop, is considered normal operation of the grid. When TAB-WRK is removed from service and then returned, the following two points are observed which may contribute to the generator protection not being secure.

1. The angle voltage difference across the TAB662 CB was approximately 23 degrees prior to closing.

2. The change in grid impedance presented to the generators. Each of the WRK-WHI-RDF and WRK-TAB-HRP-RDF 220 kV paths has an approximate positive sequence impedance of 40 ohms at 83 degrees. See Figure 2. The TAB-WRK-1 circuit only has a 2 ohm impedance. When the circuit is out, the generators are generating into a large series impedance (78 ohms maximum to WRK) and when the TAB-WRK-1 circuit is switched back, this series impedance is drastically reduced to potentially 2 ohms to WRK (78 and 2 ohms in parallel). This may require the generators to react and change their operating point. This may also be a function of the generators operating point (how much the generator was generating) at the time and the required load demand in that part of the grid. This can only be confirmed by dynamic studies.

Request 3 – System fault

SCADA alarm logs indicate a three-phase fault was detected by TAB CB662 at 17:42:51, whereas PMU and Power Quality data show no indication of a fault. Please explain this discrepancy, and if CB662 did detect a fault please explain why it did not operate to clear the fault.

The protection records obtained do not indicate the presence of a fault on the grid during the closing of the circuit breaker. When the WRK162 end was closed, this remained in service and when TAB662 was closed, this too remained in service with no voltage dip on the protection records.

Also, there was no operation or trigger of any main protection elements such as the line differential or any buszone protection. This indicates that there was no fault on any grid equipment, i.e. circuit or busbar. With no accompanying voltage deviation, this was not a power system fault.

In summary, there was no power system fault and Transpower's protection remained secure during the switching event.

Log files

Request 4 – Provide event files

Please provide SER files and data logs for relays associated with the following circuit breakers:
TAB CB662, CB652, CB742, and CB1022 WRK CB162.

As there were no fault and no subsequent trip in the grid, there were very little fault records available for this event. The status of all available records is provided in
Table 2 and the file identification is provided in Table 3. All the relevant available records are provided with this request for information.

Table 2: The status of Transpower event records for this TAB and TAC tripping.

Location	Type				Comment
	F	U	S	O	
TAB662	X	X	X	-	SEL411L Line protection event records.
TAB652	-	-	-	-	Transpower only have a buszone protection and point on wave relay. No records available for these relays as nothing was triggered.
TAB742	-	-	X	-	TAB T11 has a dual differential scheme. The SER is provided for the SEL487 relay and the 7UT85 does not have any records available. The SEL487 relay does not have any entries for the event in question as there was no trip.
TAB1022	-	-	X	-	The SEL311C feeder relay does not have any entries for the event in question. Only the SER is provided that also show this.
TAB anti-island	-	-	X	-	The anti-islanding protection did not issue a trip and no event file was generated as a result. The SER does indicate how the grid is changing during switching.
WRK162	X	X	X	-	SEL411L Line protection event records.
TAB682	-	-	X	-	The SEL411L relay does not have any entries for the event in question. Only the SER is provided that also show this.
HRP232	-	-	X	-	The SEL411L relay does not have any entries for the event in question. Only the SER is provided that also show this.

Note: F – Filtered, U – Unfiltered, S – sequence of events (SER), O – Other

Table 3: Table of files provided for each location and identification thereof

Location	File	Comment
TAB662	LDIF1 -SEL-411L-1_10_23_2025_17_42_48_806_200.CEV	Filtered
	LDIF1 -SEL-411L-1_10_23_2025_17_42_48_806_200.CFG	Unfiltered - COMTRADE
	LDIF1 -SEL-411L-1_10_23_2025_17_42_48_806_200.DAT	Unfiltered - COMTRADE
	LDIF1 -SEL-411L-1_10_23_2025_17_42_48_806_200.HDR	Unfiltered - COMTRADE
	TAB662_SEL411L_20251125.txt	SER
TAB742	TAB1022_T11_SEL487E_20251125.txt	SER
TAB1022	TAB1022_SEL311C_20251125.txt	SER
TAB anti-island	TAB_Anti_island_SEL451_20251024.txt	SER
WRK162	LDIF1 -SEL-411L-1_10_23_2025_17_42_48_808_200.CEV	Filtered
	LDIF1 -SEL-411L-1_10_23_2025_17_42_48_808_200.CFG	Unfiltered - COMTRADE
	LDIF1 -SEL-411L-1_10_23_2025_17_42_48_808_200.DAT	Unfiltered - COMTRADE
	LDIF1 -SEL-411L-1_10_23_2025_17_42_48_808_200.HDR	Unfiltered - COMTRADE
	WRK162_SEL411L_20251125.txt	SER
TAB682	TAB682_SEL411L_20251125.txt	SER
HRP232	HRP232_SEL411L_20251125.txt	SER

Other information

Communications from Contact Energy indicate there may have been a large angle difference between WRK and TAB when the TAB-WRK circuit was closed, resulting in a trip of TAB and TAC.
To assist with our investigation, please provide the following:

Request 5 – Angle difference

Data on the angle difference between TAB and WRK at the instant CB662 was closed

- The difference in voltage angle across TAB662 was approximately 23 degrees up until the time TAB was closed. This is from the event record in Figure 12.

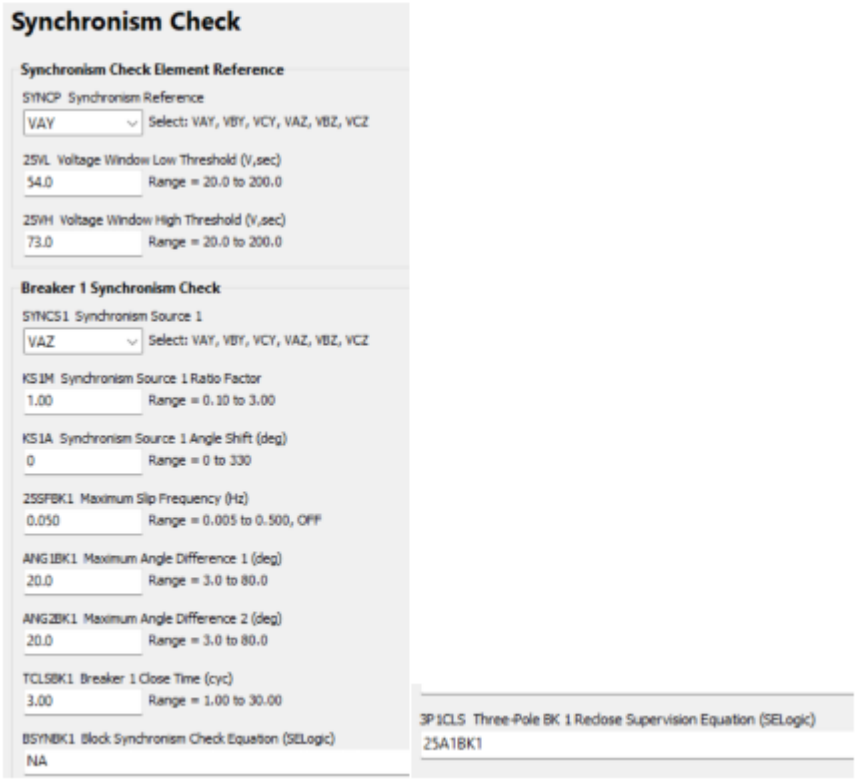
Request 6 – Manual closing

Details of any functionality that prevents the manual closing of CB662 if angle difference across the breaker exceeds a threshold. Please include details of how the threshold was determined

There is no functionality that prevents the manual closing of TAB662 on the account of a voltage angle difference across the CB. This is consistent with all parts of the grid, where there is no supervising of manual close of the circuit breaker for synchronising conditions, i.e. slip or phase angle. The synchronisation requirements for closing TAB662 are only used during auto-reclosing restorations.

During an auto-reclose event, the synchronisation settings are relevant. These are shown in Figure 1 In the synchronisation logic, the maximum angle difference used is 20 degrees (ANGiBK1). The three pole auto-reclose supervision equation is also shown in Figure 1.

Figure 1 - TAB662 Synchronisation settings and three pole auto reclose supervision equation.



Request 7 – TAB662 Closing Functionality

Details of the closing functionality of CB662, for example are all three phases closed simultaneously or separately

TAB662 is a single pole circuit breaker but no point on wave closing is applied so the circuit breaker behaves as three-pole circuit breaker when closed. The protection relays only provide a single close output the circuit breaker on OUT307. This then gets daisy chained to each phase and subsequent closing coil of the CB. In Figure 10 the close output (OUT307) can be observed, and CB open and close contacts can also be observed. The relevant part of the relay assembled form is provided in Figure 8 to interpret to binaries shown.

Request 8 – Prior studies on voltage angle difference

Details of any studies that were completed prior to this event which considered the expected angle difference between TAB and WRK in this scenario

The Grid Owner can confirm no studies were completed prior to this event that considered the expected angle difference between TAB and WRK in this scenario or received any connection studies from Contact Energy about the expected angle difference.

Request 9 – Correspondence with Contact

Details of any correspondence with Contact Energy prior to this event related to procedures for manually closing either the TAB-WRK or HRP-TAB circuits. Specifically, we are interested if either party has previously raised concerns about angle difference when a circuit is closed.

The Grid Owner has had no prior correspondence with Contact Energy regarding procedures for manually closing either the TAB-WRK or HRP-TAB circuits. Furthermore, no concerns about angle difference when a circuit is closed have been raised with us.

Request 10 – Any other relevant information

Any other information you consider relevant to this event

The Grid Owner has no further information to add.

Assessment of causation under the Code:

Request 11 - Assessment of causation under the Code

Based on your operational data could you please provide your assessment of whether or not your actions or the behaviour of your assets could have been the causer of the under-frequency event as per the Code. Please provide a reasoned explanation for your assessment.

The definition of "causer" is set out in Part 1 of the Code. It provides, in paragraph (a) of the definition that "if the under-frequency event is caused by an interruption to or reduction of electricity supply, or an increase in electricity demand, from a single participant's asset or assets, that participant is the causer unless another participant's act or omission or property causes the interruption or reduction or increase, in which case the other participant is the causer".

The under-frequency event was triggered by a reduction in electricity supply when Tauhara generation tripped. Tauhara is Contact Energy's asset. Prima facie, that means Contact Energy is the causer, unless the proviso in paragraph (a) of the definition of causer applies. In this case, as indicated in the information we have provided in this response, there was no act or omission by, or property of, Transpower as the grid owner that caused the

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interruption. The interruption was caused solely by the operation of Contact Energy's assets. Therefore, we consider Contact Energy is the causer.

TRANSPOWER

Unison Networks Limited

17 November 2025

Jason Larkin
Unison Networks Limited
1101 Omahu Road
Hastings

Dear Jason,

23 October 2025 (PM) Under-Frequency Event

At 17:42:53 on 23 October an under-frequency event occurred in the North Island when TAB and TAC generation tripped. We are specifically interested in the part of your network that is supplied from the TAB GXP, including the circuits which connect TAC generation. We are investigating the event and require the following information from you:

- Details of any faults that occurred in this part of your network during or up to 5 minutes prior to this event
- Protection logs for any circuit breakers in this part of your network which operated during or up to 5 minutes prior this event
- Any other information you consider relevant to this event
- **Assessment of causation under the Code**: Based on your operational data could you please provide your assessment of whether or not your actions or the behaviour of your assets could have been the causer of the under-frequency event as per the Code. Please provide a reasoned explanation for your assessment.

Please provide the above information to us in writing by **5pm 16th December.**

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,

Connor McCarthy
Power System Engineer

CC:
Samantha Naidoo
Corporate Counsel - Compliance & Impartiality

RE: Request for Information Regarding UFE on 23 October 2025 17:42:53

LV

Leon Viljoen <Leon.Viljoen@unison.co.nz>
To Connor McCarthy
Cc David Bredda (Unison); Rhett Mulinder; Edward Brown; jason larkin

IN CONFIDENCE

This sender Leon.Viljoen@unison.co.nz is from outside your organization.

33kV Tauhara_Te Huka Network Diagram.pdf
687 KB

THK_THR.docx
95 KB

Cyber Security Warning: This sender is from outside of the organisation. Please be cautious when opening the links or attachments.

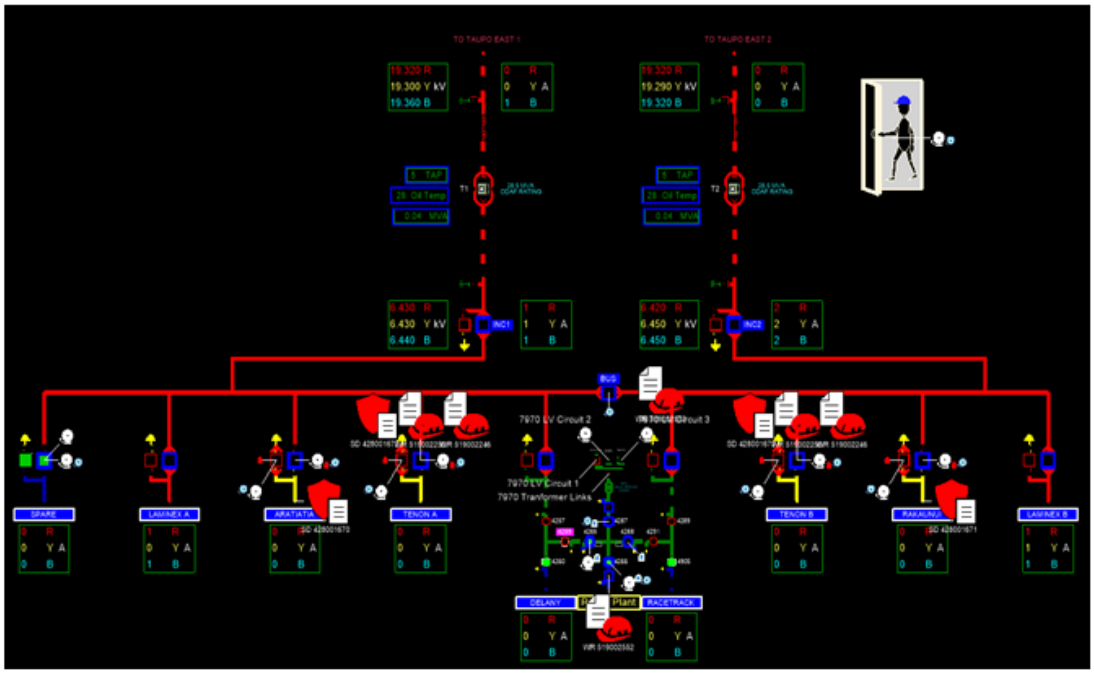
Hi Connor,

RE: Request for Information Regarding UFE on 23 October 2025 17:42:53

Background:
Taupo East substation is a brand new 33/11kV substation, presently in commissioning phase.
The 2x 33/11kV Tx's at Taupo East have been livened and parallelled through the 11kV bus, with no 11kV feeders presently in service/on load.
Section of network of interest has been highlighted in orange. Refer to attached 33kV Tauhara_Te Huka Network Diagram.

Feedback:
No 33kV were recorded 5min before the UFE.
Prove of no trip events (HIS & SER). Refer to THK_THR document.
No remote SCADA open commands. SER's have been checked.
No event recordings or SER's for Taupo East.

Taupo East ZS SCADA Tile to indicate no load connected:



Hope you find the above in order.

Kind Regards

Leon Viljoen
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Glossary

Term	Definition
CB	Circuit Breaker
CT	Current Transformer
Code	Electricity Industry Participation Code 2010
EMT	Electromagnetic Transient
GO	Grid Owner
MVA	Mega Volt Amperes
MW	Mega Watt
OEM	Original Equipment Manufacturer
PMU	Phasor Measurement Unit
POCP	Planned Outage Coordination Portal
RoCoF	Rate of Change of Frequency
SO	System Operator
TAB	Tauhara
TAC	Te Huka 3
WRK	Wairakei