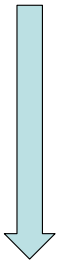
SRC report
Questions asked

1.The cause of the event, including the potential for it to be repeated either at Huntly or other parts of the electricity system (i.e. was the event "one of a kind" or potentially systemic);
2.The scale of the event, including the amount of generation disconnected and the resulting impact on the power system (i.e. the timeline of the event, including the change in system frequency over time, when and how interruptible load and reserves were activated, etc.);
3.How actual dynamic system performance corresponded with modelled system performance;
4.Whether the system performed as expected in a response to an event of this magnitude (we understand that the event was larger than the extended contingent event (ECE) that the system would have been planned to cover);
5.The extent of AUFLS activation, including whether the expected level and distribution of load shedding was achieved;
6.Whether the process of reconnecting load proceeded in the expected manner;
7.How the fault was identified and the measures that were implemented to ensure system security was maintained while this was occurring (including any consideration post-event as to whether this could have been achieved in a more efficient manner); and
8.The effectiveness of communication between Transpower and industry participants and the to the wider public.

What happened

- At 12:33pm, Genesis' Unit 5 and the Transpower circuit breaker tripped, leading to the two remaining generators operating at Huntly (Units 1, 2) to be disconnected.
- Prior to that, a dc power supply fault at Huntly had caused relay damage resulting in unexpected tripping of circuit breakers. The sequence of events immediately before and after this is shown below.
- The loss of HLY generation caused a fall in frequency and the activation of Interruptible Load and AUFLS across the North Island.

  – 12:11:39.8 pm- Unexpected opening of CB422
  – 12:11:39.9 pm - Unexpected opening of CB242
  – 12:30:44.8 pm – Unexpected opening of CB362
  – 12:30:47.4 pm - Attempted close CB242fails
  – 12:31:25.5 pm - Attempted close on CB422 fails.
  – 12:33:44.8 pm - Unit 5 Trips
  – 12:33:47.5 pm - Unit 2 trips
  – 12:34:07.5 pm - Unit 1 trips



~22 Minutes

Keeping the energy flowing TRANSPOWER

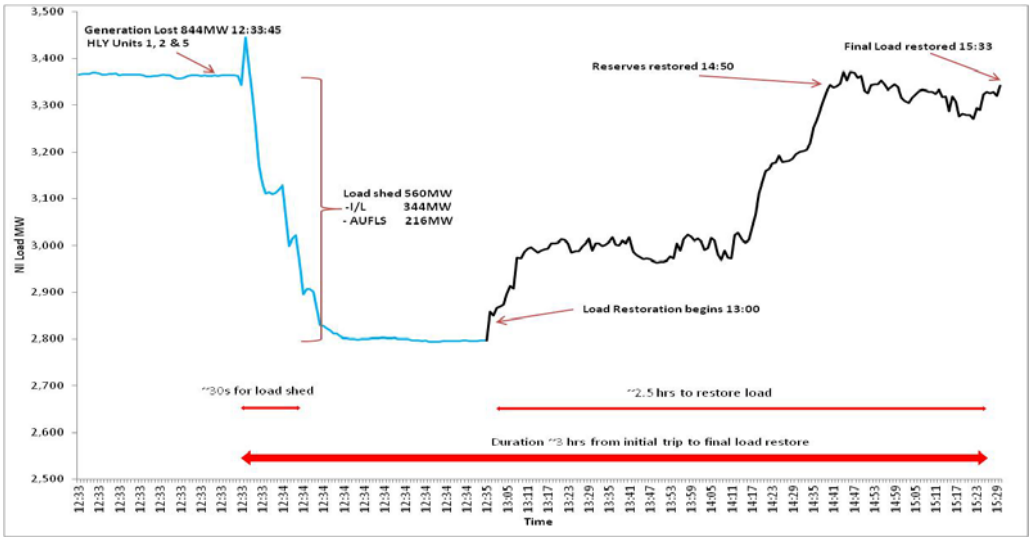
The information in this slide is summarised from the report by Transpower Grid Performance

Risk identification

Through a regulatory process the System Operator categorises events that it will manage against

- Some events are common and economic to cover against using reserves (contingent events) and, for rarer events, using reserves and AUFLS. (extended contingent events)
- There are also the very rare, large events that are difficult to identify and expensive to manage against. The loss of HLY station was one of these ‘black swan’ events .
- While reserves and AUFLS will still activate for ‘black swan’ events there is no certainty that they will be successful.

Load loss and restoration

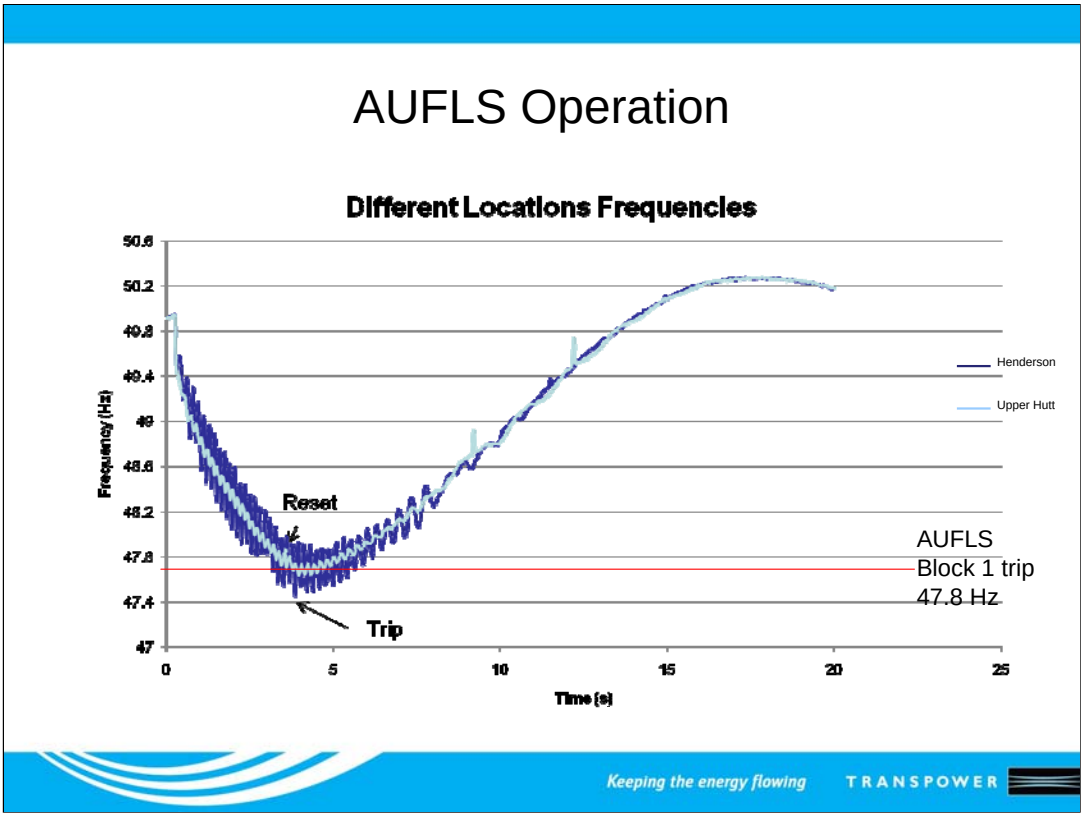


This slide shows the disconnection and reconnection of loads - note there are 2 time scales.
AUFLS disconnected 216MW, or 6.4% of load, while total shed is 16.5% .
The reason for the low amount of AUFLS tripping is discussed on the next slide.

How much of I/L water heating?

Of the 344 MW of IL about 115MW was hot water, with the balance being industrial load.

Note that the IL /AUFLS numbers can be hard to reconcile - for example they may exist on the same feeder and some AUFLS took up to 6 sec to operate which makes it look like IL.



AUFLS
The North Island AUFLS scheme is split into 2 blocks
Block 1 operates at 47.8 hz
Block 2 at 47.5 hz

Each block should contain 16% of the load in the Island
It is the accountability of Network companies and directly connected consumers (those without exemptions) to ensure this is available at all times.

Performance of AUFLS

In this event the frequency fell below 47.8 hz
Only 40% of the AUFLS relays in block 1 tripped.

The reason for this was the significant harmonic disturbance caused by the pole slipping of the HLY units, which caused the AUFLS to trip and then re-set within the guard time of the relay (around 120ms).
The guard time is import to prevent inadvertent operation of AUFLS relays due to “close in” earth faults.

Pole Slip

Pole slipping of this type is very rare and not seen to our knowledge before in NZ.
While the harmonics prevented the operation of relays, this is because the frequency with harmonics was sitting around the trigger frequency. Had the frequency continued to fall then the relays would have operated correctly. It is most unlikely that the pole slipping could have led to cascade failure.

System performance

- The current work on AUFLS being undertaken has raised a concerns:
  - Potential for over frequency.
    - With only 40 % of AUFLS tripping the rose to frequency to 50 Hz.. Had the full quantity of AUFLS tripped, then the frequency would have gone very high.
    - At 52 Hz the large gas fired plant will trip potentially, returning the frequency back below 48hz, but this time without the protection of an AUFLS scheme to stop it.
    - The AUFLS programme is currently testing a number of options around this see-saw effect including having more but smaller AUFLS blocks and triggering them on rate of change of frequency.
  - Fast rate of change of frequency creating relay discrimination issues.
    - Where the frequency falls too fast there can be insufficient time for the first AUFLS block to operate before the second is tripped, leading to unnecessary consumer disruption and potentially the over frequency issue discussed above. The staggered nature of the generator tripping in this event prevented this occurring.
- The system response to this event confirmed concerns with the current design.

The AUFLS programme is currently :
•developing a preferred solution,
•testing relay technologies
•developing implementation overviews with Network companies and
•drafting code changes.
There is at least 2 years work to do.

Restoration process

- Restoration was co-ordinated by the System Operator and we received full co-operation from network companies and direct connects and generators.
- The Codes are silent on the restoration of AUFLS and parties could have restored whenever they liked. This is a gap in the codes which could lead to insecure operation of the system.
  - This has been flagged and we are looking at ways to mange this and add clarity and operational certainty.
- Some confusion was experienced between the restoration of IL and AUFLS.
  - Ancillary Service Contracts and operational procedures will be reviewed and strengthened
- While most relays could be reset remotely by lines company operators, some delay was experienced as small number required onsite reset at substation.
- Public communication during the restoration was lead by Transpower. Feedback indicates messages were appropriate and timely.

Reserve management

- Cause of the fault was not immediately apparent.
- The System Operator therefore had to consider the probability of a repeat event
- 13/12 17:46 – Market advised that HLY station will be treated as a single risk

- As Genesis and Transpower provided information the SO was able to cover HLY U5 as a separate risk but remained of the view that a joint risk did still exist on units 1-4.
- 14/12 17:23 – Market advised HLY U5 now an independent risk from HLY U1-4 as of 18:00

- Full industry co-operation enabled operational procedures to be put in place that would protect consumers against the risk while enabling Genesis to generate from HLY U1-4.
- 22/12 19:00 – HLY risk status returned to normal

Conclusions

- Event was rare and complex.
- Systems worked largely as expected.
- Good co-operation from the industry enabled timely restoration and fault identification.
- The event reaffirmed the importance of the work currently underway to redevelop the AUFLS scheme.
- Transpower will continue to work on protection co-ordination with its customers applying the lessons learnt in this event.