HVDC OUTAGES 2020
INDUSTRY BRIEFING

DATE 30TH OCTOBER 2019
POWERING NEW ZEALAND TODAY + TOMORROW
<table>
<thead>
<tr>
<th>Item</th>
<th>Approx. Timing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Welcome and outage schedule recap</td>
<td>10.30 am</td>
</tr>
<tr>
<td>Grid Owner (GO) Project Work Updates</td>
<td>10.35 am</td>
</tr>
<tr>
<td>• Reconductoring preparations</td>
<td></td>
</tr>
<tr>
<td>• VBE preparations</td>
<td></td>
</tr>
<tr>
<td>• Maintenance and investigations</td>
<td></td>
</tr>
<tr>
<td>System Operator (SO) update:</td>
<td>11.00 am</td>
</tr>
<tr>
<td>• NZ Generation Balance update</td>
<td></td>
</tr>
<tr>
<td>• System Operator (SO) update on hydrology</td>
<td></td>
</tr>
<tr>
<td>GO update on Pole 2 system testing</td>
<td>11.30 am</td>
</tr>
<tr>
<td>Other items:</td>
<td>11.45 am</td>
</tr>
<tr>
<td>• Contingency planning and recall times</td>
<td></td>
</tr>
<tr>
<td>• Communications</td>
<td></td>
</tr>
<tr>
<td>Electricity Authority reminder</td>
<td>12.00 pm</td>
</tr>
<tr>
<td>Closing Comments</td>
<td>12.10 pm</td>
</tr>
</tbody>
</table>
## Outage Programme Overview

<table>
<thead>
<tr>
<th>Month</th>
<th>Week</th>
<th>Events</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan</td>
<td>1</td>
<td>Pole 2 outage 780 MW transfer limit</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Bipole</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>Pole 2 outage 406 MW transfer limit</td>
</tr>
<tr>
<td>Feb</td>
<td>1</td>
<td>Pole 2 outage 780 MW transfer limit</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Bipole</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>Pole 2 testing 780 MW transfer limit</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>Pole 3 outage 500 MW</td>
</tr>
<tr>
<td>Mar</td>
<td>1</td>
<td>Pole 3 outage 500 MW transfer limit</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Bipole</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>Pole 3 + 1 electrode outage 406 MW transfer limit</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>Bipole</td>
</tr>
<tr>
<td>Apr</td>
<td>1</td>
<td>Pole 3 outage 500 MW transfer limit</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Pole 3 outage 500 MW transfer limit</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>Pole 3 outage 500 MW transfer limit</td>
</tr>
</tbody>
</table>

*Note: Events are hypothetical and for demonstration purposes.*
Two crews will be mobilised with one crew (Electrix) responsible for runs two and three. The other crew (Broadspectrum) are responsible for run one and other maintenance works on the line.

Preparations are advanced with access tracks upgraded and low voltage undercrossings being deviated or placed on cable underground.

The span 58A – 59A across the railway line and SH1 motorway will be deferred due to complexities of these crossings. Will be coordinated with future HVDC outages.
MAINTENANCE WORKS & INVESTIGATIONS - UPDATE

Scheduled / annual maintenance
• Routine visual inspection and electrical testing of primary plant at HVDC Converter Stations
• Part of Transpower’s routine preventive maintenance plan to ensure ongoing service performance and reliability of HVDC

Investigations and opportune work
• Additional electrical testing outside of routine maintenance
• Condition assessments for future planning, refurbishment
• Replacement/upgrade requiring outage longer than routine maintenance
POLE 2 VBE UPGRADE - UPDATE

Valve Base Electronics (VBE)
• Convert Pole Control firing pulses (electrical) to light pulses for distribution to valve stacks. End of life replacement
• Status: Factory acceptance tests completed 19-23 Aug, shipped to site HAY & BEN 22\textsuperscript{nd} Oct. Currently being mounted in control room and prepared for wiring installation and commissioning

Snubber Capacitor Assemblies
• Valve stacks (quadravalves). Replacing oil filled capacitors with dry type capacitors. End of life replacement
• Status: Capacitor manufacture and assembly progressing to schedule. Shipping to site HAY & BEN 3\textsuperscript{rd} Dec

Fibreoptic lightguides
• Distribute firing pulses to valve stacks. Condition replacement
• Very reliable but expected to be too brittle for handling during VBE and Capacitor replacement
• Status: Manufacture of HAY set complete. BEN manufacture in progress. Shipping to site HAY and BEN 3\textsuperscript{rd} Dec
POLE 2 VBE UPGRADE - UPDATE

Update by numbers
• 15,840 - number of snubber capacitors being removed from HAY and BEN valve stacks
• 150 - kilometers of fibreoptic cable being manufactured into lightguides
• 3000 - kilos weight of 6 VBE cabinets airfreighted to NZ for installation
• 11,200 - person hours of effort across 41 days of outage to complete the installation works

Site Preparations HAY and BEN
• Preparation of installation methodologies and ITP’s in progress
• Site establishment and setup HAY and BEN planned for December
SYSTEM OPERATOR
UPDATE

ANGELA HOUSTON, DAVID KATZ
NZGB ASSESSMENT - ASSUMPTIONS

NZGB standard assumptions
• Last years worst case load + 2%
• Uses outages that are in POCP
• Wind at 20%

• Shows our ability to meet peak demand based on expected capacity
• Doesn’t take into account system conditions that contributed to a peak
• Doesn’t account for fuel availability

Scenario analysis
Various scenarios to determine potential generation balance margins.
We’ve contacted some participants to assist us with those assumptions

NZGB results are indicative for planning purposes - participants should respond to this information
and further notices provided in real-time to ensure system security.

ANGELA HOUSTON
NZGB STANDARD ASSESSMENT

- Last year’s worst case load + 2%
- Uses outages from POCP
- Wind at 20%
- Doesn’t account for reduced gas

Ahuroa (8-23 Feb) and Pohokura (11-24 March) gas outages publicly notified
NZGB ASSESSMENT – REDUCED GAS

• 540 MW less thermal generation across HVDC outage
• Wind at 20%
• Further reduction of 200 MW during Ahuroa outage

N-1-G shortfalls
• 10-12 Feb and 7 Apr
NZGB ASSESSMENT – REDUCED GAS, NO WIND

- 540 MW less thermal generation across HVDC outage
- Wind 0% (less 110 MW)
- Further reduction of 200 MW during Ahuroa outage

N-1 shortfall: 11 Feb
N-1-G shortfalls:
10-14 Feb, 20 Feb and 7 Apr
NZGB ASSESSMENT – FURTHER UPDATES

Current process
• Monthly NZGB reports
• Publish CAN if NZGB report shows risk of shortfalls
• SO will continue to monitor NZGB and perform scenario analysis
• If any additional concerns, SO will publish further CANs and/or POCP assessments if appropriate

Role of industry participants
• Advise SO of any plans to add/change outages, and/or fuel availability information which may have an impact during the HVDC outages
• Update POCP
SECURITY OF SUPPLY - UPDATE

1. Security of Supply modelling reflects the capability of the power system. This is the ability for NZ to meet its total energy needs - GWh not MW.

2. Current modelling does not indicate energy issues during the HVDC outage.

3. What if we apply thermal fuel limitations?
   - Elevated risk, mainly in Q1
   - Modelling does not indicate any energy issues
SECURITY OF SUPPLY - UPDATE

1. When would the HVDC outage impact the likelihood of hitting the Watch/Alert/Emergency curve?
   - When monopole constrains the optimal amount of South Island transfer compared to a fully available DC link.
   - It is more likely the HVDC outage will limit north transfer.

2. What about the North Island hydro?
   - The North Island is about 15% of national storage.
   - Because of its size, a dry inflow sequence in the North Island alone should not cause energy issues.
   - Worst case, North Island peaking may become very expensive, or limited to total GWh of daily inflows.

3. What happens if NZ storage starts to deteriorate?
   - The System Operator will monitor the Electricity Risk Curves monthly including a low gas scenario.
   - If we observe deteriorating storage in either island we will assess the impact of the HVDC outage.
SYSTEM TESTING REQUIREMENTS

GREG SPENCE
POLE 2 SYSTEM TESTING

Test Planning

• Verify VBE functionality and Pole 2 performance. Approx 19 individual tests to be completed.
  • Pole 2 energisation and open line tests, VBE redundancy and failover tests at Pmin (30MW).
  • Power transfer ramping tests
  • AC and DC staged line fault tests
  • Other pole (Pole 3) commutation failure tests
• Comparison of Pole 2 performance before and after VBE replacement
• North Island staged line fault tests 1x AC and 1x DC – Sun 3rd Nov.

Test Plan Review

• Test programme formally reviewed by System Operator.
• Third party independent review (Internationally recognised HVDC consultancy).
• “Test programme extensive, considerable ground being covered to prove new VBE does not impact dynamic performance of the HVDC link.”

GREG SPENCE
POLE 2 SYSTEM TESTING

HVDC Transfer Requirements – System Conditions.
HVDC transfer scenarios:
• HVDC North up to 780MW (Test set A)
• HVDC South up to 200MW (Test set B).
Tests scheduled around naturally occurring HVDC transfer e.g. North transfer ramping tests.

Consideration of System Risk
• Pole 2 VBE does not create a secondary risk to AC Contingent Events (either frequency or voltage events).
• Pole control performance unaffected by VBE equipment.
• HVDC transfer considered a single Contingent Event during test period (Bipole CE)
• Pole 2 to operate for defined periods under test plan conditions within Pole 3 780MW North transfer limit
• Additional capacity of Pole 2 not offered during testing.

Test Scheduling
• Schedule tests early during the test period, complete tests as soon as possible.
• Confirmation of test timings published via CAN
POLE 2 SYSTEM TESTING

Recap – Expected system conditions
Weekday historic HVDC Bipole transfer

• North 0-800MW
• upward pressure on North transfer

HVDC capacity (Pole 3 Pmax =780MW) unlikely to constrain transfer — typically limited by NI reserve requirement.

• Bipole transfer considered single Contingent Event
  (P North 780MW max)
• No AC secondary risk

Target test range:
Greater than 200MW North (Test set A) or greater than 100MW South (Test set B).
CONTINGENCY PLANS & COMMUNICATIONS

RICKY SMITH, PATRICK O’MEARA, MATTHEW HANSEN
CONTINGENCY PLANNING

Comprehensive contingency plans being developed for Pole 2 and Pole 3 Outages

• Risks for each of the work streams identified through workshops
• Risks reviewed and ranked by likelihood and consequence for each work stream
• Combined risk reviews held to prioritise the key risks
• Contingency plan developed for Pole 2 Outage
• Contingency planning for Pole 3 Outage in progress.

Recall times for emergency system security events

• Worst case for Pole 2: 20 days driven by VBE Upgrade
• Worst case for Pole 3: 7 days driven by Reconductoring
## Communications - What to Expect

Keep industry up-to-date to allow participants to make informed market decisions

<table>
<thead>
<tr>
<th>Pre-outage</th>
<th>Work programme schedule</th>
<th>Channel*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potential industry teleconference</td>
<td>Nov/Dec TBC</td>
<td>CAN (as soon as possible)</td>
</tr>
<tr>
<td>Outline scheduled work</td>
<td></td>
<td>CAN - 19 Dec 2019</td>
</tr>
<tr>
<td><strong>During outage</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>First stage: Pole 2 &amp; VBE outages</td>
<td>7 Jan - 16 Feb 2020</td>
<td>CAN – 7 days prior to work start</td>
</tr>
<tr>
<td>Second stage: Testing of Pole 2</td>
<td>17 Feb – 26 Feb 2020</td>
<td>CAN – 7 days prior to work start</td>
</tr>
<tr>
<td>Third stage: Pole 3 outages</td>
<td>27 Feb - Apr 9 2020</td>
<td>CAN – 7 days prior to work start</td>
</tr>
<tr>
<td>Bi pole outages (4)</td>
<td>Sat Jan 18, Feb 1, Mar 7, Mar 21</td>
<td>CAN – 7 days prior to work start</td>
</tr>
<tr>
<td>Changes to outage schedule</td>
<td></td>
<td>CAN (as soon as possible)</td>
</tr>
<tr>
<td>Other assessment updates e.g. NZGB</td>
<td></td>
<td>CAN (as soon as possible)</td>
</tr>
<tr>
<td>Security of Supply ERC &amp; Simulated Storage Trajectory Updates</td>
<td>Currently Monthly or more regular if required</td>
<td>Transpower Website (subscription e-mail also available)</td>
</tr>
</tbody>
</table>

* All information will be available on the [dedicated webpage on Transpower’s website](#)
## COMMUNICATIONS - FROM REAL TIME OPERATIONS

<table>
<thead>
<tr>
<th>Time</th>
<th>Situation</th>
<th>Notice</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 days out to real-time</td>
<td>Low residual &lt;200MW uncleared energy</td>
<td>Issue low Residual CAN</td>
<td>Request update / increase generation and reserve offers</td>
</tr>
<tr>
<td>6 days to 1 hour</td>
<td>Deficit energy or reserve</td>
<td>Warning Notice</td>
<td>• Request increase generation and reserve offers</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• request reduced demand</td>
</tr>
<tr>
<td>1 hour to real-time</td>
<td>Deficit energy or reserve</td>
<td>• Grid Emergency</td>
<td>• Request increase generation and reserve offers</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Demand Allocation Notice</td>
<td>• Instruct demand load shedding (DAN)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Reduce Security margins ( AUFLS to cover CE)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Optimise Frequency Keeping, NMIR and FKC</td>
</tr>
</tbody>
</table>

CANs will be issued for changes to HVDC capacity or risk
Reminder from the Electricity Authority

- This reminder is about all aspects of the HVDC and Pohokura outages, not just the security implications
- Please make sure you have assessed the risks to your business posed by these outages
- Use all available information in the marketplace
- If you have additional information that the market could use, please release it
- If you can see a serious gap in information, please ask – the system operator, the other participant
- Do all you can to ensure you are fully informed, have assessed and mitigated your risks and have accepted your final risk position
QUESTIONS

KATHERINE MOORE
THANK YOU

KATHERINE MOORE