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James Stevenson-Wallace
Chief Executive
Electricity Authority
PO Box 10041
Wellington

Automatic under-frequency load shedding (AUFLS) security performance and ongoing improvement

Dear James

This letter addresses the three points Andy Doube raised in our discussion regarding AUFLS and extended reserves on 28 June 2019. My response is based on the information currently available to the system operator. Importantly it does not include any new analysis at this stage to reconfirm the capability or case for a 4-block AUFLS scheme.

Confirm if the current New Zealand 2-block AUFLS arrangements are fit for purpose

Under the Code the system operator has the accountability to define credible system events, identify and implement the appropriate controls for such events, in order to achieve the principal performance objectives (the PPOs).

The purpose of AUFLS is to act as a control in response to an extended contingent event (ECE). An ECE is a credible event where the most efficient way to achieve the system reliability required is to rely on automated load shedding, in addition to other controls such as frequency reserves.

In the credible event framework, the main ECE risk being managed is the simultaneous loss of both HVDC poles. From time to time other events may be treated as an ECE, for example instantaneous tripping of multiple generating units due to a temporary identified single point of failure.

The system operator is confident, from a system security perspective, that the present 2-block AUFLS scheme in both the North and South Islands, along with the other controls we have in place (the reserve management tool (RMT), real-time monitoring tools, instantaneous reserves and over frequency arming), are robust and able to manage an ECE, provided asset owners are meeting their AUFLS obligations.

The initial 2010 AUFLS investigation came to the same conclusion. It added the caveat that the overall 2-block scheme design did not provide confidence that it would be effective for large events, not currently defined as an ECE. For instance the full loss of Huntly power station, which was then capable of 1,400 MW total output[1]. Through our regular credible event reviews since 2010, we have not yet identified

[1] The total maximum continuous output at Huntly station is now 1,047 MW following the decommissioning of one Rankine unit and only two other Rankine units able to run simultaneously.

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or classified any ECE risks with a greater system impact than an HVDC bipole tripping at 1,200 MW transfer[2].

We have some minor concerns over the impact of asset owner over-provision of AUFLS, given the present scheme only specifies a minimum amount of load per block. However the successful performance of AUFLS during events in 2011 (Huntly station separation of 874 MW) and 2013 (HVDC 892 MW runback), which each triggered the first block of North Island AUFLS, provide some assurance that obligations are being met. They also provide confidence that the scheme is robust enough to accommodate some under-provision and over-provision of AUFLS by asset owners.

The 2011 Huntly station separation AUFLS event and more recent 2017 South Island splitting AUFLS event were 'other' events. As such they were not considered credible at the time, and were not being treated as ECE risks. Both events highlight the benefit of having AUFLS as a backstop for mitigating high impact/low probability events, where under the credible event framework, the cost and benefit of relying on other available controls to avoid the loss of all or part of the power system in one island, is not justifiable.

Confirm changes that the system operator has made since it raised an issue with the North Island 2-block AUFLS arrangement in 2010. Has the system operator put in place management activities to further enhance the current AUFLS arrangements?

The largest credible ECE being securely covered by instantaneous reserves and AUFLS still remains a HVDC bipole tripping. Since 2010, we have continued to improve the tools we are using in real-time to predict the system response to an ECE.

Since December 2011, we have had North Island over frequency arming (OFA) contracts in place to mitigate over-frequency caused by the loss of the HVDC bipole during high southwards transfer. This OFA is also available to be used to mitigate any "frequency overshoot" resulting from excess load being shed by AUFLS operation. This excess load shedding may be due to either the block size being larger than required for the event or due to asset owners over-provision of AUFLS.

In 2016 we introduced the transient stability assessment tool (TSAT) online into the control room. This has provided our co-ordinators with an improved ability to assess how the power system will respond to an ECE. TSAT alerts co-ordinators to arm sufficient OFA generators, or in rare occasions to redispatch the HVDC transfer, to mitigate any potential frequency overshoot due to AUFLS tripping excess load.

Does the system operator think a North Island 4-block AUFLS scheme is still worth pursuing from a system security and resilience point of view?

In 2013 we published an AUFLS scheme design technical summary which compared the existing North Island scheme with alternatives. The report concluded a 4-block scheme (10%, 10%, 6%, and 6%) using a 'rate of frequency change' rely on the fourth block had the best overall technical performance, estimated at $11m/year benefit over the 2-block scheme.

Our view is still that there is an opportunity to improve the flexibility and resilience of AUFLS by providing a 4-block North Island scheme. In our studies 4-blocks provided a better match between the amount of load shed and the size of system event. Avoiding excess load being shed would reduce consumer impact

[2] HVDC maximum capability of 1,200 MW includes headroom for frequency modulation and reserve sharing, limiting maximum energy transfer. Refer to our HVDC utilisation reports available here for typical transfer levels: https://www.transpower.co.nz/system-operator/market-insights

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and overall interruption cost for an ECE or 'other' event. This 4-block scheme would minimise any 'frequency overshoot' which could result in increased OFA event charges.

Added resilience would be further enhanced through a proposed 'rate of frequency change' facility for one of the four blocks. This is a useful mitigation for events resulting in rapid frequency decline during periods of low system inertia in the North Island.

This low system inertia condition is likely to occur more frequently in the future when there is high HVDC north flow and low or no thermal generation in the North Island. It will also occur as additional new inverter connected generation, such as wind or solar, displaces synchronous generation.

Approach to working with the Authority to ensure a fit for purpose AUFLS arrangement

I appreciate the opportunity to provide this assurance and update to the Authority. The system operator takes its obligation to ensure the successful management of credible events in meeting the Code mandated PPOs very seriously. Given the criticality of this control for both credible ECEs and mitigating 'other' events, we are committed to working with the Authority in addressing any technical concerns from the work on Extended Reserves project with the current 2-block scheme, or importantly future AUFLS arrangements based on a 4-block scheme. If necessary this includes reconsidering the case for, and nature of, future AUFLS block requirements to account for the changes since the original need was identified.

Regards,

John Clarke

GM Operations