

SRC – Under frequency management

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System Operator
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1 Introduction and purpose

This paper summarises the recent Common Quality work streams completed by the System Operator. In August 2011, the System Operator has published:

- (i) Stage II of the Automatic Under Frequency Load Shedding (AUFLS) review; a follow-up of the technical work completed in late 2010 on the effectiveness of the current AUFLS arrangements
- (ii) Reserve Review; a review of the arrangements for procuring reserves to mitigate the risk of under-frequency events on the system
- (iii) Normal frequency review; a review of the effectiveness of the current arrangements for normal frequency regulation, including the probability standard contained in the codes.

All the above work was done by the System Operator under the Technical Advisory Services Contract (TASC).

The cost of the work completed under (i) and (ii) was shared with the Electricity Authority in recognition of the System Operator's role as a reasonable and prudent System Operator under the Codes. The work streams are sub projects of the overall project work to review the effectiveness and efficiency of the current industry under-frequency arrangements.

2 Summary

The paragraphs below summarise the key outcomes from the work undertaken:

2.1 Automatic Under Frequency Load Shedding (AUFLS)

The results of the technical review completed in 2010 concluded that the overall design of the AUFLS scheme provides the System Operator with insufficient confidence that it will be effective to prevent the system from collapsing from large risks that are not currently identified. Furthermore there is concern that the current AUFLS scheme could result in over-frequency and potentially system collapse from defined risks.

To address the issues identified in the technical review, the System Operator has been working through the process of identifying technical options and undertaking cost-benefit analysis on those technical options. In addition, following a number of participants raising concerns regarding inefficiencies in the current AUFLS provision method (which can result in limiting participation in the instantaneous reserves market), the System Operator has also been investigating opportunities to improve AUFLS provision efficiency.

The System Operator has concluded that using df/dt relays results in a net benefit in the range of \$16 million to \$89 million over 15 years and the use of such relays would be appropriate as an AUFLS scheme for the North Island.

The System Operator believes it is prudent to hold off proposing new AUFLS schemes in the South Island until there is further clarity of the future of AUFLS

provision at the Tiwai grid exit point. In the interim, the System Operator has identified that increasing the trip setting of the second AUFLS block to 46 Hz will offer considerable improvement of the current South Island AUFLS scheme.

As a part of the review, the System Operator conducted a discussion of AUFLS provision options, including a dynamic procurement option, with industry at workshops held in April 2011. From the workshop discussion, there did not appear to be any widespread desire for dynamic market arrangements nor a lack of firm proposals as to how such market arrangements would ensure the provision of AUFLS load.

The continued use of a mandated AUFLS scheme will be required in the interim. The System Operator, in its report, has outlined options available within the current code that may assist with limiting the over-provision associated with a mandated AUFLS scheme and increase the efficiency of providing AUFLS load.

The technical options, and associated benefit analysis, will be presented and discussed with industry at the upcoming System Operator workshops in August 2011. Following from the workshops, the System Operator will consider industry feedback before making a recommendation to the Electricity Authority.

2.2 Reserve Review

The System Operator and the Electricity Authority, in line with the industry Common Quality Development Plan, agreed to review the Under-Frequency Management arrangements. The purpose of the Under-frequency review was to propose strategies and measures that offer the most reliable, secure, and cost effective under-frequency management system to provide greater certainty on system integrity during major under-frequency events, and to operate an efficient market

The review included the various assumptions used in the System Operator's Reserve Management Tool (RMT) to calculate reserve procurement quantities. The System Operator recommends the following improvements to the modelling within RMT:

- Changing the current 60s simulation in RMT to 10s
- Modelling the actual delivery times and quantities for Interruptible Load
- Using the actual HVDC transfer limit of 250MW rather than the modelled 25MW

The above changes will have an impact on participants with respect to data resolution and the likely occurrence of more severe under-frequency events. As such, industry endorsement of the changes is critical, and software, code, and procurement contract changes are likely to be necessary before the changes can be implemented.

The System Operator has also concluded that a mix of reserves is essential and beneficial for managing system disturbances. Therefore, to retain an appropriate mix of products and ensure provision of one type of reserve is not inadvertently incentivised over another, a transparent approach for all reserve providers for testing and monitoring is desirable.

Further, as the New Zealand power system changes and evolves; more changes in its generation mix are expected. It is expected that with higher HVDC transfer, the frequency will reach its minimum in less than the mandated 6s. The System Operator therefore recommends further investigation of faster reserve products such as faster operating IL, df/dt operated reserves, faster spinning reserve, and system inertia.

2.3 Normal Frequency Review

2.3.1 *Normal frequency limits and standards*

This work stream was one of the frequency related initiatives the Authority instigated as part of its strategic common quality development plan. The System Operator looked specifically at the appropriateness of the normal frequency band (currently 50 Hz $\pm$ 0.2 Hz) and the probability standard, which specifies the number of allowable excursions into the defined frequency bands under the System Operator's Principal Performance Obligations (PPO). In addition, the System Operator reviewed the appropriateness of the size of the frequency keeping MW band required of the Frequency Keeper (currently 50 MW).

The System Operator concluded that the normal frequency band is optimal for New Zealand. While widening the normal frequency band may decrease frequency keeping costs, it would increase reserve requirements, potentially resulting in a higher overall cost of electricity supply. It could also lead to security concerns. The relatively small network and comparatively few generators and consumers mean that frequency control is only possible through highly tuned controllers to maintain supply reliability¹. The current normal frequency band is already wider than the band in most countries surveyed and therefore considering the unique challenges posed by the relatively small size of the New Zealand transmission system it is unreasonable to widen it further.

For the current frequency bands, the average number of deviations over the previous seven years has been less than the prescribed number for the current probability standard limits. However, it is the System Operator's view that changing the probability standards will not drive changes to system frequency management and/or System Operator operational practices to manage system frequency. The System Operator does not currently operate the power system to specifically meet a probability particular standard. A change to the probability standard is not recommended. Instead, clarification of the purpose of the standard as a PPO is strongly recommended.

However, from the analysis it was noted that deviations into the bands 49.8 to 49.5 Hz and 50.2 to 50.5 Hz have increased markedly and are still increasing. The causes of these deviations needs to be identified and understood to ensure there is no unknown power system risks or additional actions that need to be taken to mitigate the risks.

¹ Graeme A. Chown, The Economic Analysis of Relaxing Frequency Control, 2007, p. 3

No discernable interdependence was found between the frequency keeping band, normal frequency band, and the probability standard

The frequency keeping trials performed in 2008 have clearly shown that a band of ± 50 MW is still required in the North Island. However, in the South Island, frequency keeping trials have shown that the band could be relaxed further during overnight hours. A new frequency keeping trial band of ± 10 MW is recommended in the South Island from 0100 to 0500.

2.3.2 Time Error

The Electricity Industry Participation Code requires the error between actual time and a synchronous clock connected to the power grid to be no more than five seconds. However, the uses for which time error was originally developed have become obsolete, and there is evidence that artificially raising or lowering the frequency to correct the time error can become a system reliability issue.

Transpower recommends consulting New Zealand electricity market participants to determine whether a Code requirement for time error is still necessary. If time error is not used, Transpower recommends a six-month trial for removing the 5-second time error requirement from the Code.

2.3.3 Generator AOPOs within the Normal Frequency Band

The System Operator reviewed the Asset Owner Performance Obligations relating to the responsiveness of generating units to frequency deviations within the normal band. Some of the requirements in the Code are unclear or have been misinterpreted. The System Operator has suggested Code changes to provide clear guidelines for asset owners with respect to dead band, droop, and proportional and integral gain settings.

3 Conclusions

The Authority and the System Operator have put in a significant amount of effort over the last 6 months to progress the common quality initiatives on the Common Quality Work Plan. The majority of the initial studies have been completed. The recommendations arising from the review undertaken will require further works and are, in some cases, substantial changes. The System Operator and the Electricity Authority will continue to develop and progress the recommendations in the form of a prioritised implementation plan.