

Under-supply of AUFLS in the South Island

26 April 2012

Note: This paper has been prepared for the purpose of SRC discussions. Content should not be interpreted as representing the views or policy of the Electricity Authority.

1 Under-supply of AUFLS in the South Island

- 1.1.1 At the 13 December 2011 meeting the SRC received a paper (copy attached) discussing the potential implications of there being no automatic under-frequency load shedding (AUFLS) installed at the Tiwai Point grid exit point (GXP). The SRC had been invited to comment on this situation by the Authority Board.
- 1.1.2 The SRC concluded that the Chair should write to the Authority Board on behalf of the SRC advising that the SRC is of the view that the non-supply of AUFLS at Tiwai Point is not a security risk as the system operator procures additional reserves to compensate for the deficit of AUFLS at the Tiwai Point GXP when extended contingent events are binding.¹ The secretariat was asked to seek further information on the actual cost of procuring these additional reserves to support this conclusion.
- 1.1.3 The secretariat has written to the system operator seeking the requested information, and a copy of this letter and the system operator's response (dated 18 January 2012) are attached.² As the answer to this question was not as clear cut as had been anticipated, the SRC Chair requested that discussion on this matter be held over until this meeting. The proposed letter from the SRC to the Authority has not yet been sent.
- 1.1.4 The Authority has subsequently sought further clarification of the system operator's response in light of the 13 December 2011 AUFLS event in the North Island. A copy of that letter and the system operator's response are also attached.
- 1.1.5 In summary:
- a) it appears that South Island security remains robust to the recognised extended contingent events without AUFLS at Tiwai without significant additional costs;
 - b) the South Island system is less robust for 'other' events (often referred to as "black swan" events that are rare and difficult to predict and plan for) than it would be if the full quantity of AUFLS was available; and
 - c) it appears that AUFLS is likely to be available at Tiwai Point from 1 January 2013, although this is not yet confirmed.
- 1.1.6 Does the SRC still endorse its conclusion from the 13 December 2011 meeting that the non-supply of AUFLS at Tiwai Point is not a security risk? And does the SRC want to change or add to the proposed content of the letter to the Authority Board?

¹ See paragraph 38 of the draft minutes of the 13 December 2011 meeting.

² Note that a similar question of costs was also raised by the Authority Board, so the letter from the Authority is essentially from both the Authority and the SRC.

Appendix A Copy of introductory paper from 13 December 2011 meeting

Under-supply of AUFLS requirements in the South Island

Prepared by: Fraser Clark
General Manager Operations Development

Discussion

2 December 2011

Under-supply of AUFLS requirements in the South Island

Rationale

1. As there is no automatic under-frequency load shedding (AUFLS) system installed for Tiwai Point, the AUFLS currently available in the South Island may not be sufficient to prevent the development of cascade failure.
2. The Electricity Industry Participation Code (Code) places an obligation on Transpower as the South Island Grid Owner (Grid Owner) to ensure that an AUFLS system is installed for each South Island grid exit point (GXP). For a variety of reasons (practical, legal and contractual), the Grid Owner claims it has never been possible for it to ensure that an AUFLS system is installed for Tiwai Point. The contractual matters include the influence of the Rio Tinto agreements on the obligations of the Rio Tinto parties.¹ Part 16 of the Code includes special provisions that relate to these agreements. Some of the parties consider that these agreements provide a “ring fence” in relation to any requirement to comply with the AUFLS obligation in the Code.
3. These circumstances may change following the expiry of the Rio Tinto agreements on 31 December 2012 but the Electricity Authority (Authority) has not received any information regarding any actual or planned activities to address this non-compliance.
4. A Code breach regarding this matter is currently before the Authority’s Compliance Committee (Committee). The Committee has requested that the Authority raise the matter with the Security and Reliability Council (SRC) as it is a matter that may influence the performance or the electricity system and reliability of supply. The Committee is considering the options available to it for addressing this non-compliance. The SRC is invited to provide its views on the need for action on the issue and any recommended course of action to the Committee if it considers it necessary and appropriate for it to do so. Any views should be limited to the impact of the under-supply of AUFLS in the South Island on security and reliability matters rather than approaches that could or should be taken by the Committee under the compliance regime.

Next steps

5. If the SRC considers it necessary and appropriate to do so, the secretariat will prepare a note for the Committee on behalf of the SRC with any perspectives on the issue that the SRC wishes to provide.

Introduction and background

6. On 1 August 2009, an under-frequency event (UFE) in the South Island caused the frequency to drop to 47.72 Hz. This was within 0.2 Hz of activating the South Island automatic under-frequency load shedding (AUFLS) system.

¹ The Rio Tinto parties are New Zealand Aluminum Smelters Limited (NZAS), RTA Power (NZ) Limited (RTA Power), Meridian Energy Limited (Meridian Energy) and Transpower New Zealand Limited (Transpower).

7. Following inquiries into the UFE, the Grid Owner advised that an AUFLS system was installed for each South Island GXP, except for Tiwai Point. The absence of an AUFLS system at Tiwai Point was contrary to the Electricity Governance Rules (Rules).
8. Since 1 March 2004, the Rules, and now the Code, have required the Grid Owner to ensure that an AUFLS system is installed for each South Island GXP.² As there is no AUFLS system installed for Tiwai Point, the Grid Owner has been in breach of the Rules, and the Code, since 1 March 2004. This matter is now before the Compliance Committee for consideration.
9. The provision of AUFLS is currently being reviewed by the System Operator and the Authority as part of the Under Frequency Management project. That project has deferred its analysis of options for the AUFLS scheme in the South Island until there is further clarity of the future of AUFLS provision at the Tiwai Point GXP. Work to date has indicated that the inclusion of AUFLS response at this GXP would decrease the amount of reserve required to cover high HVDC south flow and improve the South Island AUFLS safety net.³ The expectation is that increasing the total quantity of AUFLS in the South Island will have the greatest economic benefit, though the full analysis has yet to be undertaken. The Under Frequency Management project is being pursued in stages with any Code amendments and the implementation of any changes to the AUFLS scheme not expected to occur until 2013.

Load shedding systems

10. The relevant provisions in the Code relating to load shedding systems are set out at the end of this document.
11. In short summary, the Rules and the Code have required the installation of an AUFLS system for each South Island GXP that provides automatic disconnection of two blocks of demand (each block being a minimum of 16% of the total pre-event demand).
12. The Grid Owner has installed an AUFLS system that provides automatic disconnection of two blocks of at least 16% of the total pre-event demand across all the South Island GXPs, except for Tiwai Point. If an average demand of 500MW at Tiwai Point is included, the South Island AUFLS available are in the range of 11-13% of total South Island demand for high demand trading periods, and 9-11% for low demand trading periods.
13. It appears, for some years, the Grid Owner and the System Operator had the understanding there was enough AUFLS available in the South Island and the system was not at risk. However, the 1 August 2009 UFE showed, if the South Island AUFLS system had been triggered, the AUFLS available may not have been enough to arrest the frequency drop, and therefore could not prevent the development of a cascade failure.
14. There were a number of learnings from the 1 August 2009 UFE for the System Operator and the generators⁴. In general terms, the industry is now better prepared if a similar UFE event occurred

² For historical reasons, the responsibility for AUFLS in the South Island lies with the Grid Owner, whereas in the North Island this responsibility lies with the distribution companies.

³ See the report 'Automatic Under-Frequency Load Shedding (AUFLS) – Scheme Options Economic and Provision Review' prepared by the System Operator in August 2011 that is available – together with other reports from the Under Frequency Management project – from <http://www.systemoperator.co.nz/ufm>. This report is part of 'Workstream II' of that project.

⁴ A number of factors contributed to the event and actions have been taken on a number of modelling and unit operation issues to try and prevent a similar event from occurring again in the future. A report on the event is available at http://www.systemoperator.co.nz/f1688,28048637/aug-09-event-public-report-final-3_.pdf.

again. However, fundamentally, the available AUFLS in the South Island remains less than what the Code requires.

Code provisions

15. The relevant relevant provisions of technical code B of schedule 8.3 of the Code provide:

7. Load shedding systems

- (1) Each North Island **distributor** must ensure, at all times, that an **automatic under-frequency load shedding** system is installed in accordance with subclause (6) for each **grid exit point** to which its **local network** is connected.
- (2) Every South Island **grid owner** must ensure, at all times, that an **automatic under-frequency load shedding** system is installed in accordance with subclause (6) for each **grid exit point** in the South Island.
- (6) An **automatic under-frequency load shedding** system required to be provided in accordance with subclause (1), must enable, at all times, automatic disconnection of 2 blocks of **demand** (each block being a minimum of 16% of the total pre-event **demand**) at that **grid exit point** subject to subclause (8), with block one disconnecting **demand**—
...
(b) in the South Island, within 0.4 seconds after the frequency reduces to, and remains at or below 47.5 Hertz;
and block two disconnecting **demand**—
...
(d) in the South Island,—
 - (i) 15 seconds after the frequency reduces to, and remains at or below, 47.5 Hertz; or
 - (ii) within 0.4 seconds after the frequency reduces to, and remains at or below, 45.5 Hertz.

Appendix B Correspondence

B.1.1 The following correspondence is included:

- a) email from the Authority to the system operator, 'SRC - Quantity and cost of additional SI IR procured to manage lack of AUFLS at Tiwai', 21 December 2011;
- b) letter from the system operator to the Authority, 'Impact of the non-provision of AUFLS at the Tiwai GXP', 18 January 2012;
- c) letter from the Authority to the system operator, 'Impact of non-provision of AUFLS at the Tiwai GXP', 29 March 2012; and
- d) un-titled letter from the system operator to the Authority, 20 April 2012.

From: Fraser Clark
To: ["John Campbell"](#)
Cc: [Darryl Renner](#)
Subject: SRC - Quantity and cost of additional SI IR procured to manage lack of AUFLS at Tiwai
Date: Wednesday, 21 December 2011 5:39:00 p.m.

Hello John

At last week's SRC meeting you indicated that you would be able to provide us/the SRC with some information on the quantity of additional IR that the SO has had to procure to cover for the absence of AUFLS at Tiwai and the cost of providing that IR. We need to prepare a letter from the SRC to the Board on this issue in time for the inclusion in the January Board papers. Would it be possible for you to arrange for this information to be sent through to us by about mid-January (and ideally earlier, given the need to circulate the letter around the members and reach a consolidated view)?

Our Board has also directly expressed an interest in the cost of this additional IR so it would probably be good if you could send us the data in a spreadsheet – rather than just as consolidated annual figures – so that we can get a sense of how variable it is.

Please let me know if this is going to be a problem for you.

Thanks
Fraser

Fraser Clark
General Manager Operations Development

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18 January 2012

Fraser Clark
Electricity Authority
General Manager Operations Development
Electricity Authority
PO Box 10041
WELLINGTON 6143

By Email

Dear Fraser

IMPACT OF THE NON-PROVISION OF AUFLS AT THE TIWAI GXP

This letter responds to your email of 21 December 2011 requesting the System Operator to provide you/the SRC with information on the quantity of additional instantaneous reserves (IR) that the SO has had to procure to cover for the absence of AUFLS at the Tiwai (TWI) GXP, and the costs of providing that IR.

How do costs arise?

When the Extended Contingent Event (ECE) (as defined in the Policy Statement), becomes the binding risk, the System Operator may use AUFLS, supplemented by IR, to cover that risk. Consequently, if there is insufficient availability of AUFLS to cover the ECE, this must be compensated for by an increase in IR, which is procured from the market at a cost.

However, there is also an alternative outcome. Because IR is procured in the market, the cost is optimised by the market solver, SPD. SPD may choose as 'the least cost option' to reduce the size of the ECE risk and therefore procure less reserve. In this situation, the cost arises in the energy market, rather than the reserves market. For example, if the risk relates to HVDC south transfer, this transfer may be reduced by SPD and replaced by more expensive South Island generation.

What are the costs since the AUFLS obligation was introduced?

The System Operator can only provide an estimated range of the potential costs, rather than an exact calculation of the costs that have been incurred. This is because:

- there is no specific data available that identifies, for each trading period, the additional quantity of reserves that would be required due to the non-provision of AUFLS at TWI. To produce this data would require extensive analysis and remodelling within SPD and RMT to identify which trading periods are potentially affected and then determine any additional quantity of reserve or reduction of risk and associated costs. Some of these data sets may no longer be available.

- the nature of the load at TWI does not lend itself to easily providing 2 x 16% block of AUFLS. Therefore, assumptions would have to be made as to how compliance could be achieved and what, if any, impact this would have on the supply of IR from the GXP. Any analysis would also preclude any reaction by the market to this potential change in IR supply.

In order to arrive at its estimate, the System Operator therefore looked at the number of trading periods that procurement may be necessary, the likely amount that would need to be procured and the cost of IR. This analysis is set out in further detail below.

How often is the procurement of additional IR necessary (ie how often does the ECE bind)?

There are two potential ECE events in the South Island - the loss of the HVDC with high south transfer and the loss of a Manapouri (MAN) bus section with 3 generating units. High south transfer occurs periodically for a few trading periods a day, most often during an extended dry period. MAN bus risks are also only occasional and are likely to occur for short periods during very high inflow events.

If a dry period was to extend for 2 months and the ECE was to bind for 16 trading periods a day over this time, then this would result in approximately 1000 trading periods out of 17520 (or around 6 % of the time). In other years, it may be as little as 1 or 2 %.

How much additional reserve would be required?

In July 2010, the System Operator did some work for the Commission's compliance team on the impact of the non-compliance at the TWI GXP. As part of that work, we looked at the additional amount of reserve that would be required for a range of load and risk scenarios. Our conclusion, in summary, was that a range of 30 to 100 MW of additional Fast Instantaneous Reserve (FIR) would be required.

What do SI reserves cost?

The cost of reserves in the South Island is historically low in a normal year. For example, in 2011, the average cost of FIR was \$1.02 per MW/h. In a dry year, however, the cost can change significantly as reserves become the constraint which limits HVDC south transfer. For example, the average price for FIR in 2008 was \$8.71. However, in the dry months between April and September the average was \$16.47.

Based on the above analysis, the System Operator has therefore estimated that the cost of the non-provision of AUFLS at the TWI GXP could range from:

- a low of \$5,355 per annum, ie $(\$1.02 \times 30\text{MW} / 2) \times 350$ trading periods to
- a high of \$837,000 per annum, ie $(\$16.74 \times 100\text{MW} / 2) \times 1000$ trading periods.

It should be stressed these prices are only intended to provide the SRC with an indicative scale of the issue, not the actual costs incurred. There are many other factors that cannot be fully accounted for, such as the price suppressing effect of FIR being offered at TWI GXP during extended dry periods requiring high levels of HVDC south transfer.

What is the real risk of not having compliance at TWI GXP?

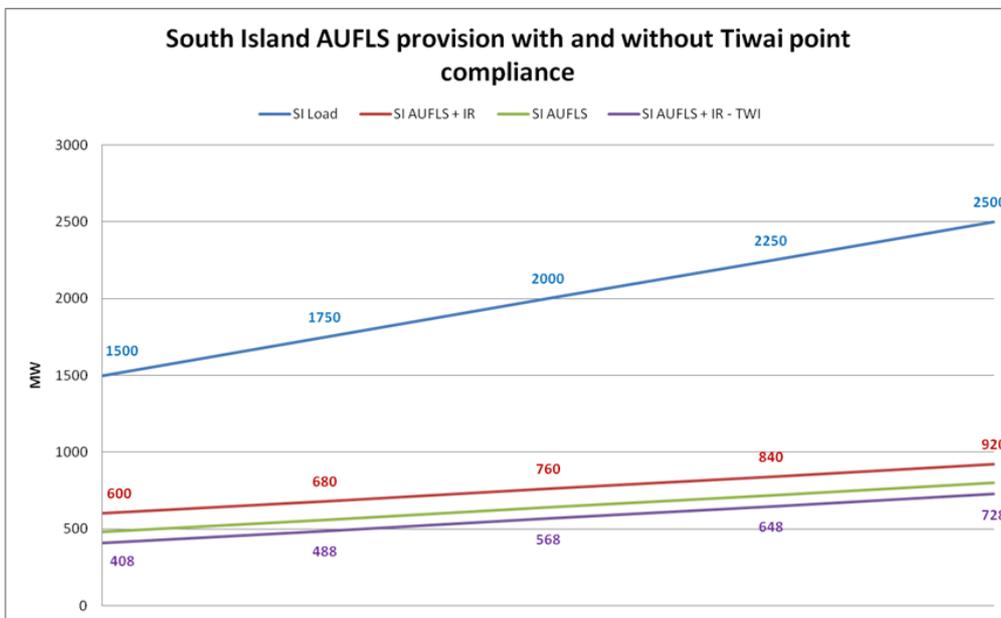
While AUFLS is available to assist in managing the ECE risk, it also serves another purpose – to prevent a complete system collapse in the event of an unexpected and significant system event, such as that which occurred in the North Island on 13 December 2011, when the Huntly station tripped.

Although this event caused a percentage of consumers to lose their power supply for a few hours, if AUFLS hadn't operated and the system had collapsed, the result would have been power outages for all consumers, potentially for up to 2 days.

These large and rare 'black swan' events are unspecified in their magnitude, location and timing, and, whilst rare, they do happen somewhere in the world a couple of times each year. The question is how big a black swan can we handle?

Our current security standard gives us 32% of load as AUFLS. This means we can manage, with a high level of confidence, an event that is 32% + the quantity of IR procured at the time of the event, without a system collapse.

However, any reduction in the quantity of AUFLS translates to the System Operator only being able to manage a correspondingly smaller black swan event before system collapse. In the South Island, this would mean a reduction of around 200MW in the size of the event that can be covered using AUFLS (assuming a constant load at TWI GXP), as outlined in the graph below.



I trust this letter answers your query. Please let us know if you require any further information.

Yours sincerely

Kieran Devine
General Manager System Operations

29 March 2012

System Operator
Transpower New Zealand Ltd.
PO Box 1021
Wellington 6140

By Email

Attention: Kieran Devine

Dear Kieran

Impact of non-provision of AUFLS at the Tiwai GXP

Thank you for your letter of 18 January 2012 on this matter, that responded to a letter from the Authority on 21 December 2011. Your letter was provided to the Authority Board for their consideration and they have sought further clarification of some of the information that you have presented.

The last page of your letter discusses the potential for large and rare 'black swan' events, and the role that AUFLS (together with the quantity of IR procured at the time) plays in responding to these events. The letter notes that the size of any 'black swan' event that can currently be covered using AUFLS is approximately 200 MW less than the event that could be covered if AUFLS was available at the Tiwai GXP (assuming constant load at that GXP).

On 13 December 2011 there was an under-frequency event that caused the operation of AUFLS in the North Island. We understand this event to have been a 'black swan' event, in the sense that it was larger than the extended contingent event (ECE) that was being covered at the time. The Authority would like to understand from the system operator what the implications would be of a similar (i.e. larger than the ECE) event in the South Island without AUFLS available at Tiwai. Would such an event be expected to result in a 'black out' in the South Island?

Status of AUFLS at Tiwai

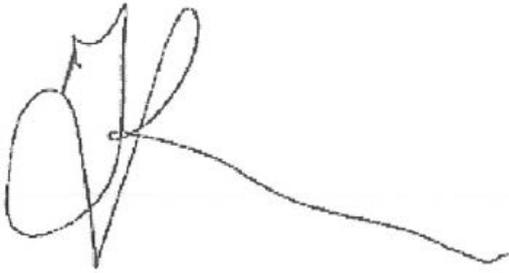
On a related matter, when we met earlier this week you indicated that Transpower had been making some progress regarding the future of AUFLS at Tiwai when the Rio Tinto agreements expire at the end of this year. As discussed, I expect that the Authority Board would welcome an update from you (or Transpower, as the party with the AUFLS obligation, if this is most appropriate) on the status of AUFLS at Tiwai from 1 January 2013 when you are in a position to provide one. I expect that the wider industry would also be very interested in this information, given the heightened awareness of AUFLS events following 13 December.

The Authority has also been considering whether some form of Code amendment is necessary to ensure that the full AUFLS requirement can be procured in the South Island. If the full requirement can be achieved through other measures and under the existing Code, this would mean that the time and resources required for the Code amendment process (for all parties) may not be required.

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Thanks again for your support on this matter.

Yours sincerely

A handwritten signature in black ink, consisting of several loops and a long horizontal tail extending to the right.

Fraser Clark
General Manager Operations Development

cc: Darryl Renner (Authority)

20 April 2012

Fraser Clark
General Manager Operations Development
Electricity Authority
PO Box 10041
Wellington

Dear Fraser

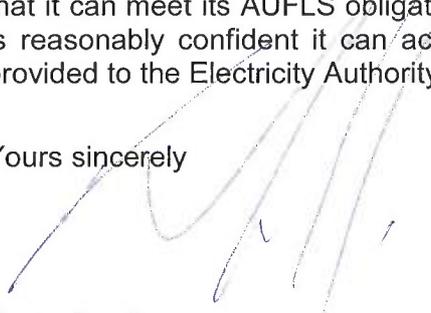
Thank you for your letter dated 29 March 2012 regarding the impact of the non-provision of AUFLS at the Tiwai GXP.

You have asked whether an event the magnitude of the 13 December AUFLS event would be expected to result in a 'black out' in the South Island. Given the smaller size of total load in the South Island (as compared with the North Island), an event with the same magnitude of loss as the 13 December event is likely to result in black start being required regardless of whether or not AUFLS is provided at the Tiwai GXP.

A comparable event in the South Island however would be an event which has a similar proportion of load lost to the total island load such as the loss of one of the large hydrological stations. Without AUFLS at Tiwai GXP, the loss of one of these stations (e.g., Clyde or Benmore) may result in a widespread loss of supply in the South Island. Whether or not this occurs is dependent on the system configuration (including DC flows) and system conditions at the time of the event. For example, the loss of 500MW at Benmore at a time of low South Island load without AUFLS at the Tiwai GXP would result in a black out of the South Island. On the other hand, the loss of 500MW at Benmore at a time of high South Island load without AUFLS at the Tiwai GXP would not result in a black out of the South Island. In summary, the provision of AUFLS at the Tiwai GXP will allow the system to recover from "black swan" events of a greater magnitude and under more system conditions than is currently the case.

You have also requested an update to the status of AUFLS at the Tiwai GXP when the Rio Tinto agreements expire at the end of the year. Transpower, as grid owner, is working with Rio Tinto to ensure that it can meet its AUFLS obligations under the existing code provisions from 1 Jan 2013. At this stage it is reasonably confident it can achieve compliance with the code obligation. A progress update will be provided to the Electricity Authority, or earlier if it is established that a code change is indeed required.

Yours sincerely



Kevin Small
Acting General Manager - System Operator