

System Security Forecast 2010

Part E

Dry Year Operational Issues

REVISED DECEMBER 2011



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I M P O R T A N T

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1. DRY YEAR RISK PERIOD

Hydro generation in New Zealand has limited storage. Extended periods of low inflows into hydro storage catchments can result storage levels reaching a point where action by the industry is required to avert the need to ration electricity to consumers. Industry actions include the Whirinaki power station being brought into service, North Island thermal units running at higher capacity factors, grid re-configurations to maximize the capacity of the grid to transfer electricity from thermal stations to demand centers, and the optimization of generator instantaneous reserves to manage under and over frequency limits.

In such dry year situations, South Island hydro storage can be preserved through transfer of power from the North Island via the HVDC link to help meet South Island demand. The HVDC link can transfer a maximum of 666 MW south. HVDC South transfer will be increased to 800 MW towards the end of 2012 with both Pole 2 and Pole 3 in service.

As of mid November 2011 New Zealand hydro storage was below the mean storage level and the average level for this time of year but risk level remains at 'Security Normal'. This has led to HVDC south transfers of up to 290 MW during the period of July to October. For up to date storage levels please see the following link:

<http://www.systemoperator.co.nz/latest-sos-update>

The purpose of this update is to highlight current issues with transmission capacity and to provide more details on the constraints on HVDC South transfer associated with under and over-frequency reserves.

2. TRANSMISSION CONSTRAINTS

There are three major AC power system constraints in the North Island under high south transfer situations:

- Transfer from Taranaki to Bunnythorpe
- Transfer from Whakamaru to Bunnythorpe;
- Transfer from Bunnythorpe to Haywards

This update covers recent issues with the Bunnythorpe to Haywards 110 kV transmission constraint.

2.1 TRANSFER BETWEEN BUNNYTHORPE AND HAYWARDS

There are several limitations on the power transfer between Bunnythorpe and Haywards. These relate to the capability of the parallel 110 kV network between Woodville and Bunnythorpe and voltage stability requirements for the Wellington region. The Bunnythorpe to Haywards limits are dependent on both the level of Wellington regional load, and the level and direction of HVDC transfer. The most recent constraint to bind was the Bunnythorpe-Woodville 110 kV circuits which is covered in section 2.1.1.



2.1.1 110 kV CAPACITY ISSUES

With the recent upgrade of the Mangamaire-Woodville and the Mangamaire-Masterton 110 kV circuits the limiting factor is now the loss of a Bunnythorpe-Woodville 110 kV circuit overloading the other. This overload is exacerbated if the Te Apiti generation runback scheme is enabled.

This issue is managed operationally by the application of security constraints, disabling of the Te Apiti scheme, and ultimately by splitting the 110 kV system at Mangamaire. With the system split in place the limit on transfer becomes the voltage stability limit during peak load periods.

This transmission constraint is discussed further in the update to the Central North Island section of the SSF.

3. GENERATOR INSTANTANEOUS RESERVE CONSTRAINTS

In practice, the period where the maximum amount of HVDC can be transferred south, transfer is limited by the amount and price of instantaneous reserves offered in the South Island. Under high HVDC South transfer, the amount of transfer on Pole 2 will set the instantaneous reserves requirement for the South Island. Once Pole 3 has been commissioned, the HVDC will become an ECE risk and this may no longer be the limiting factor. More details on this are given in section 3.1.

This section is an accompaniment to the relevant sections in Part D Frequency Principal Performance Obligations.

3.1 UNDER FREQUENCY RESERVES FOR HVDC SOUTH TRANSFER

In a dry year the quantity of HVDC that can be sent from the North Island to the South Island can be limited by the amount of under frequency reserves in the South Island available to cover it. The maximum HVDC south transfer is 666 MW (HVDC thermal limit) which is over a third of the supply to the South Island during the night and therefore can cause a significant frequency excursion.

Currently only Pole 2 is available for south transfer, therefore the whole transfer becomes a Contingent Event (CE) risk. When Pole 3 is commissioned the risk becomes an Extended Contingent Event (ECE). This will reduce the amount of reserves required as the AUFLS can be used to assist in restoring frequency. The following limits assume that Pole 2 only is in service.

Sustained Instantaneous Reserves (SIR) are purchased on a one to one basis to the value of the risk. Fast Instantaneous Reserves (FIR) are purchased to prevent the system frequency going below its minimum level. (48 Hz for a CE and 45 Hz for an ECE.)

3.1.1 ASSUMPTIONS

A typical overnight generation and load profile was used for the study, as during the day HVDC South transfer is usually limited by either the stability limits between Bunnythorpe and Haywards or by generation capacity in the North Island. The scenario generation levels were established after

consultation with market participants about their expected generation profile and by looking at the last period of very high HVDC south transfer in 2008.

The study assumes an increase to the available reserves in the South Island, which includes about 175 MW of Interruptible Load (IL), and an increase to certain generators Tail Water Depressed (TWD) reserve capacity. Only reasonably committed reserve improvements have been included in the study.

The target frequency of 48.15 Hz is currently used to compensate for variations to reserve levels caused by block dispatch. A study of the benefits of returning to a 48 Hz target is also included.

HVDC south transfer is varied for a fixed South Island demand of 1479 MW. Generation was varied to balance the variation in HVDC transfer mindful of the need to maximize reserves. The analysis also includes approximate values of FIR at intermediary values of HVDC south transfer.

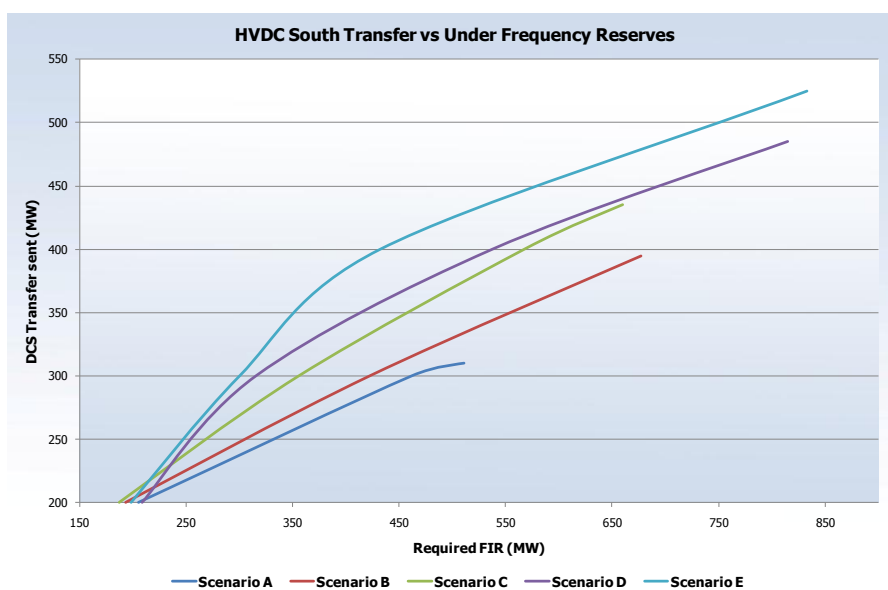
3.1.2 SCENARIOS

The following scenarios were studied:

Scenario	Description
A	Current Reserve levels
B	Addition of 175 MW of IL into the market
C	Modeling of the 175 MW of IL to its expected trip settings.
D	IL fully modelled and expected generator reserve improvements modelled
E	IL fully modelled and expected generator reserve improvements modelled and target frequency brought back to 48 Hz from 48.15 Hz

3.1.3 RESULTS

The HVDC south transfer limits for the study scenarios are shown in the graph below:



Under Frequency Reserves for HVDC South Transfer



The following can be noted:

With the current level of maximum reserves available in scenario A of 512 MW, the maximum HVDC south transfer is 310 MW. The transfer limit can be subsequently increased with additional reserves and modeling improvements outlined in scenarios B to E. For example, if the reserves available are increased to 833 MW with scenario E, then HVDC south transfer can be increased to 525 MW. The SO expects the updates described in scenarios B to E to be in place by winter 2012.

3.1.4 FURTHER DISCUSSION

The following points can be added to what has been discussed above:

- Modelling the Interruptible Load against its test results and not its code requirements gives significant market benefit. It increases the maximum transfer by 40 MW
- The maximum transfer levels were higher in 2008. Some of the discrepancy is due to better understanding of some TWD response
- The intermediate levels of DC south transfer and FIR values are prone to variation. They are an average of all types of available reserve. The actual source of the cleared reserve can vary the quantity of FIR required

3.2 OVER FREQUENCY RESERVES FOR HVDC SOUTH TRANSFER

The System Operator sometimes dispatches over-frequency reserves in the both the North and South Island during HVDC South transfer.

South Island system inertia is low during South transfer and very high levels of FIR may be required to rapidly arrest the frequency decline for the loss of pole 2. However there is a risk that the sudden FIR response may cause a subsequent over-frequency.

The sudden loss of pole 2 may cause an over- frequency event in the North Island during high HVDC south transfer. Sufficient over-frequency reserves are required to be dispatched to ensure that the post event North Island frequency does not reach 52 Hz. The level of the over-frequency is dependent on the level of demand in the North Island and the level and type of generation connected at the time of the event.

3.2.1 SCENARIOS

The System Operator has recently completed studies on the maximum allowable levels of HVDC south transfer for various generation scenarios in the North Island for a fixed level of demand with Over-Frequency Arming (OFA) in place at the relevant generating stations.

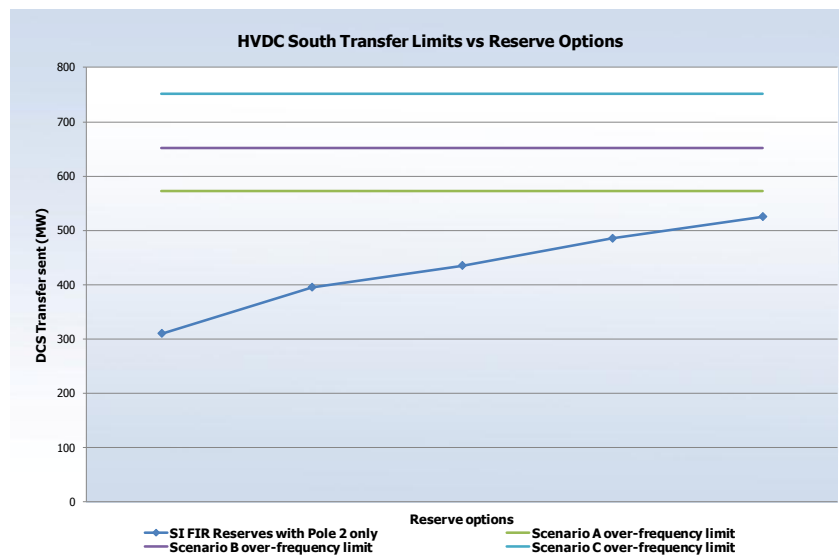


The following scenarios were studied:

Scenario	Generation Description
A	Must- run and high thermal
B	Must- run, medium thermal, and high hydro
C	Must- run, medium thermal, wind, and high hydro

3.2.2 RESULTS

HVDC south transfer limits for each of the over-frequency study scenarios above are compared with the maximum South Island FIR limits for the scenarios in section 3.1.2 in the graph below:



Over/Under-Frequency Reserves for HVDC South Transfer

The following can be noted:

With pole 2 only available the limiting constraint on HVDC south transfer is FIR reserves for an under-frequency event. The transfer limits for an over-frequency event are 572 MW, 652 MW, and 752 MW (noting that the existing HVDC thermal limit is 666 MW) for scenarios A to B in section 3.2.1 above respectively.

It should also be noted that with respect to the over frequency limits:

- Are highly dependent on which generation is connected
- Hydro refers to marginal and not run of the river hydro
- Wind refers to plant with dispensations to trip at 51 Hz

As mention in section 1 and section 3.1 HVDC south transfer will be increased to 800 MW towards the end of 2012 with both Pole 2 and Pole 3 in service and the risk becomes an ECE. This indicates that the North Island over-frequency reserve limits will then become the binding constraint on HVDC south transfer.