

System Security Forecast 2010

Part C Security Analysis

Taranaki Region

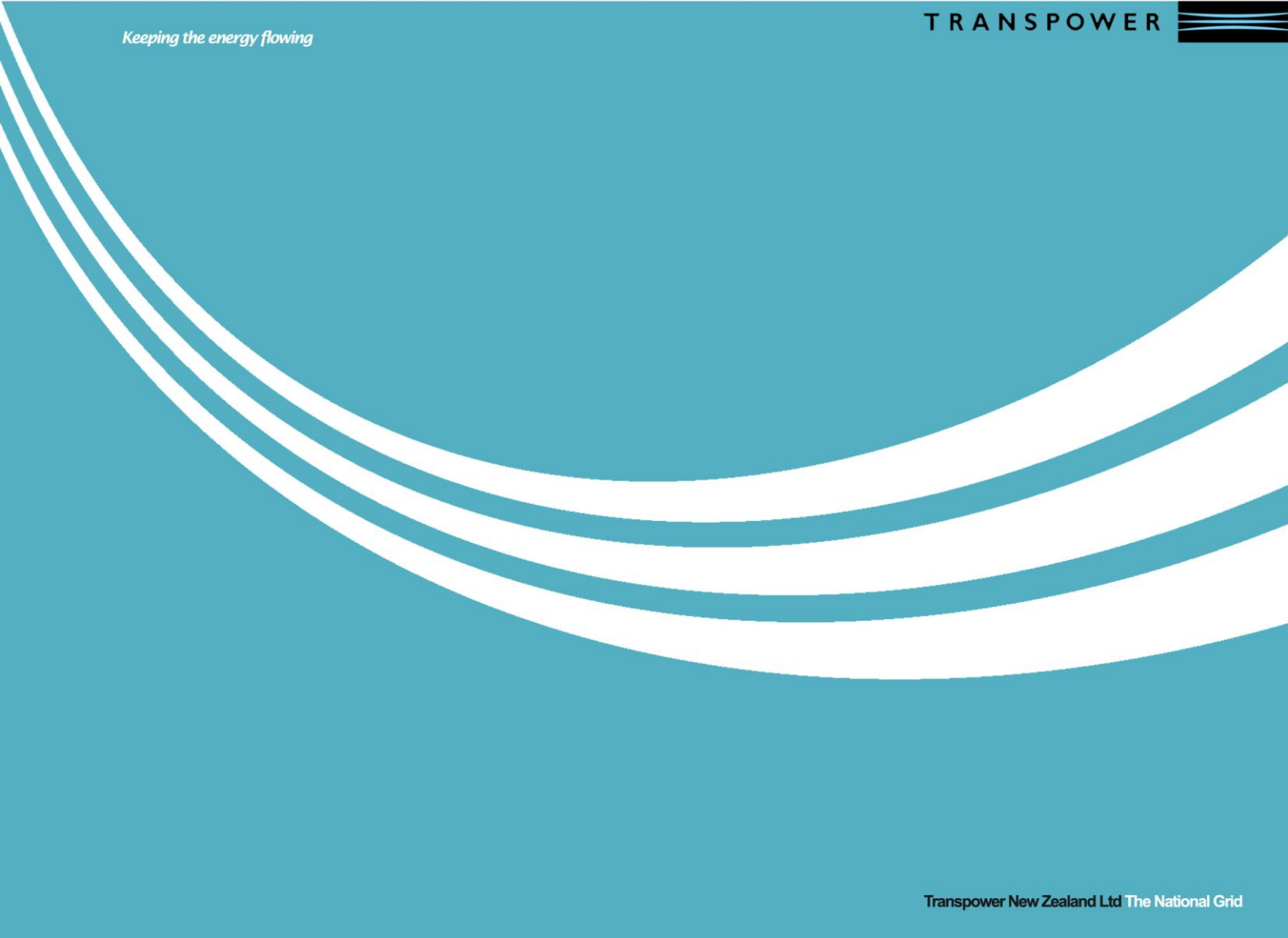
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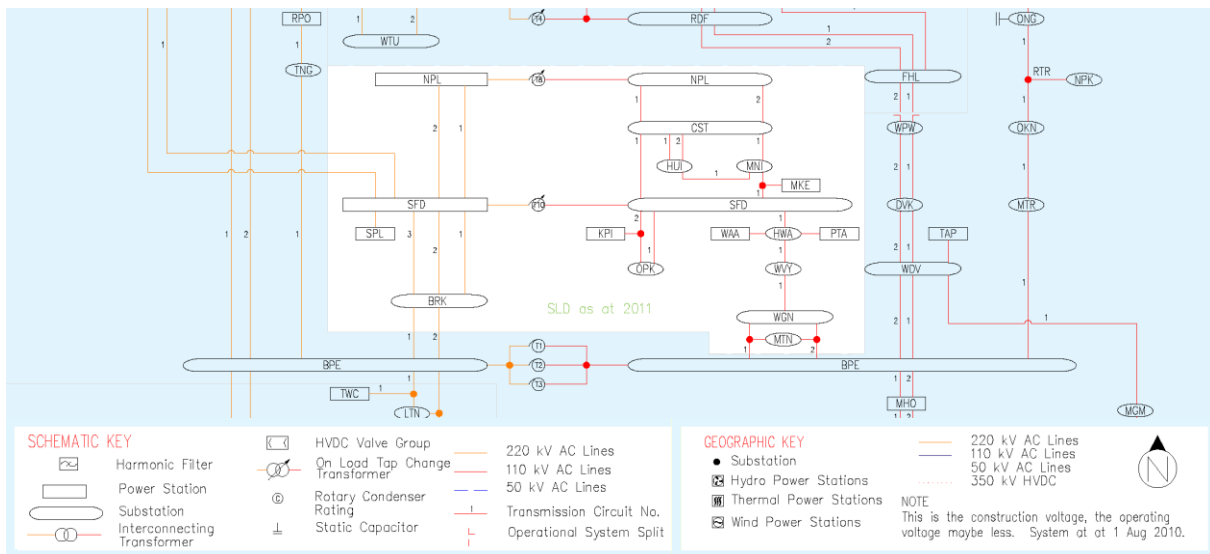
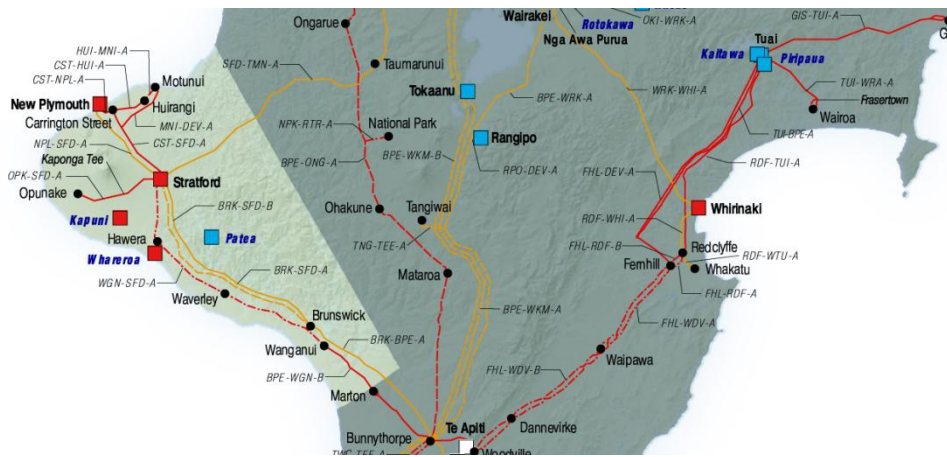
1. LIMIT GROUP ANALYSIS

Power system issues within the Taranaki region are described in this section.

1.1 NETWORK OVERVIEW

The Taranaki region is the area bordered by and including Marton in the east. It is supplied by 220 kV and 110 kV transmission circuits from the 220/110 kV interconnecting transformers located at New Plymouth and Stratford.

The Taranaki Region is shown geographically and schematically below.



The capability of assets in the region is assumed to be that declared by asset owners as at 2nd July 2010.

The assumptions regarding generation dispatch levels and the availability of reactive plant are summarised in Part B.

The table below shows the committed projects in the region as notified by asset owners. These committed projects have been considered in the analysis.

Asset	Upgrade	Location	Commissioning Date
<i>Stratford-Hawera-Waverly-Wanganui 110 kV circuit upgrade</i>	Replace conductor on the 110 kV Stratford-Hawera-Waverly-Wanganui Line	Taranaki	Oct 2012
<i>McKee</i>	2 x 50 MW gas generating units that tee connect into the MNI-SFD-1 110 kV circuit	Taranaki	End of 2012

Committed upgrades in the region

1.2 DEMAND AND GENERATION WITHIN THE LIMIT GROUP

The Taranaki region currently has approximately 700 MW of generation capacity. New Stratford Peaking Plant with a total generation capacity of 200 MW will be commissioned in 2010 with grid injection point at Stratford 220 kV bus. EC Prudent load values indicate a 2011 winter peak load of 234 MW which is forecasted to grow/increase to 244 MW in 2013. Generation capacity is significantly greater than peak demand, making the region an exporter of power. A power factor scatter graph for the region is shown in *Figure 1* and *Figure 2*.

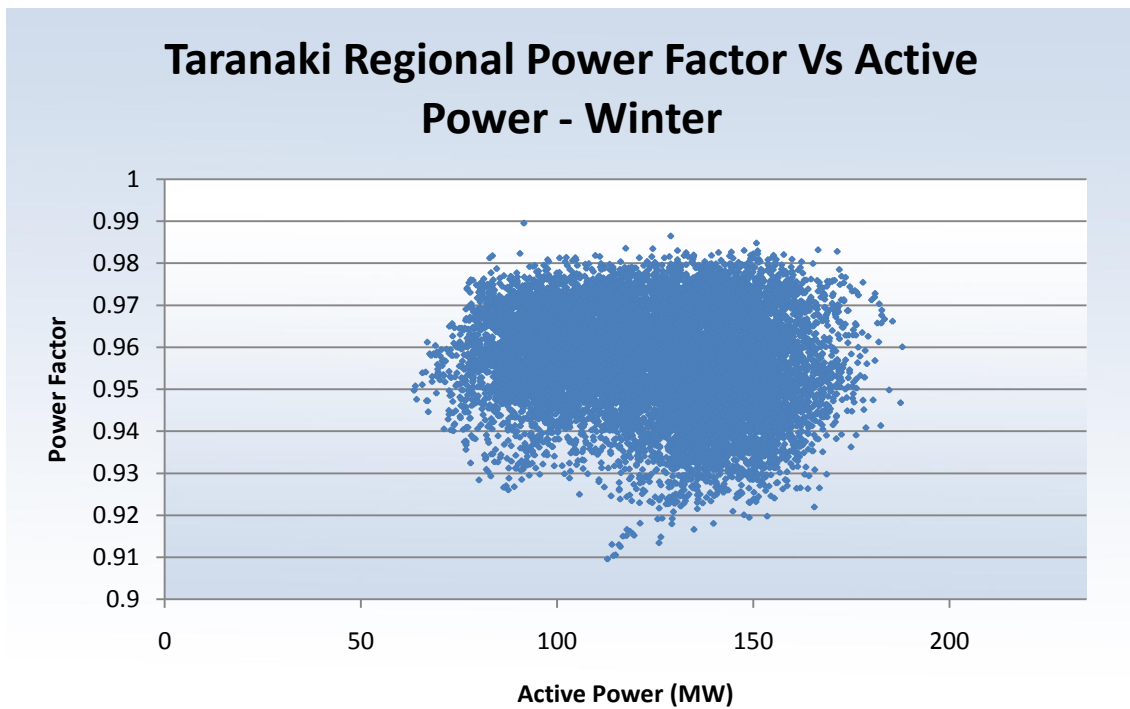


Figure 1: Taranaki regional power factor (winter)

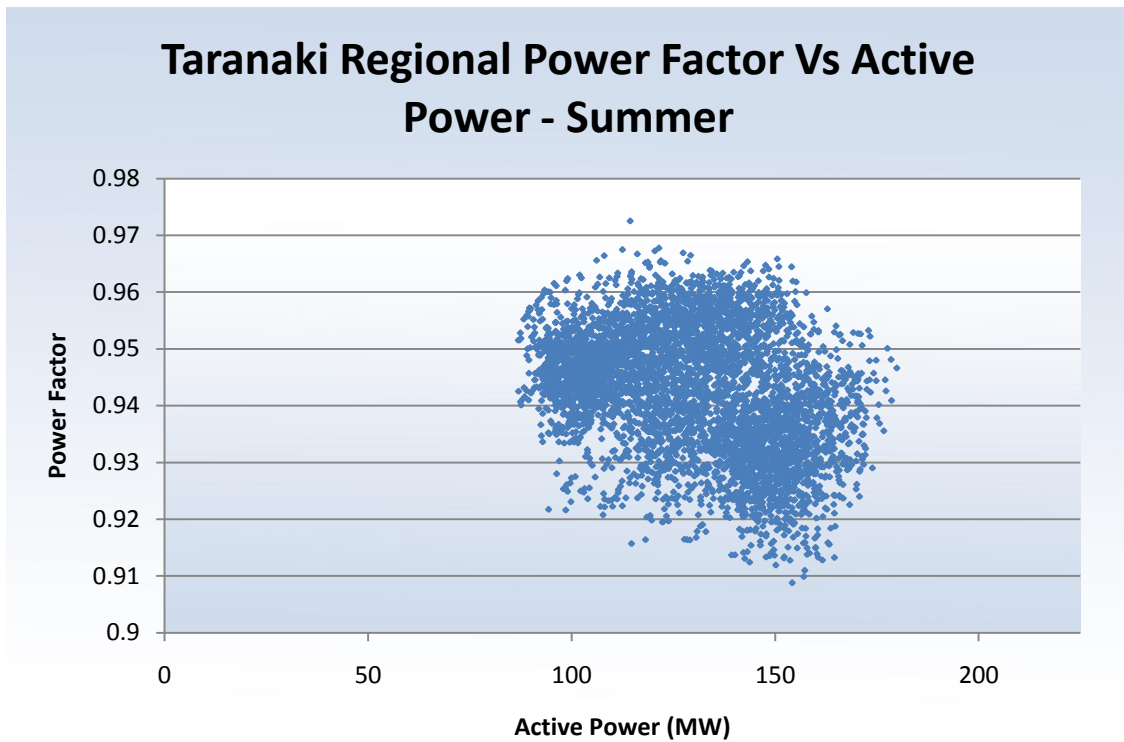


Figure 2: Taranaki regional power factor (summer)

For the purpose of these studies the minimum power factor has been assumed. For summer and winter peak the power factors are both 0.91.

1.3 KEY ASSETS

1.3.1 CRITICAL CONTINGENCIES

Contingency	Power System Issue	Management Measures	Analysis
<i>Loss of the Brunswick-Stratford 220 kV circuit</i>	Brunswick-Stratford 220 kV circuits exceed stated capability Low bus voltage at HWA, WVY, WGN, MTN during winter	Security constraints, Short term ratings	Transfer from Stratford to Brunswick of 500/610 MW (summer/winter) Transfer from Stratford to Brunswick 560 MW during winter
<i>Pre-contingent circuit loading on the Hawera-Waverley-1 110 kV circuit</i>	Hawera-Waverley-1 110 kV circuit exceeds steady state capability/ABSS operates	Special Protection Scheme	None
<i>Loss of the Patea- Hawera 110 kV circuit</i>	Hawera-Stratford-1 110 kV circuit exceeds stated capability	Security constraints, Load Management	Maximum load at Hawera of 37/42 MW @ 0.91pf (summer/winter)
<i>Loss of one of the Huntly-Stratford-1 or Stratford-Taumarunui-1 220 kV circuits</i>	Transient stability	Security constraints	Transfer from Stratford to Huntly limited to 395 MW



1.3.2 CRITICAL OUTAGES

Outage	Contingency	Power System Issue	Management Measures	Risk Assessment
<i>Bunnythorpe-Brunswick 220 kV circuit</i>	loss of the parallel Bunnythorpe-Brunswick circuit	Hawera-Waverley-1 110 kV circuit exceed stated capability	Security constraints, Short term ratings, Hawera ABSS and R72 offered	Transfer from Brunswick to Bunnythorpe and Hawera to Waverley of 140/165 MW (summer/winter)
<i>Brunswick-Stratford 220 kV circuit</i>	loss of a parallel Brunswick-Stratford circuit	Hawera-Waverley-1 110 kV circuit exceeds stated capability or remaining Brunswick-Stratford 220 kV circuit exceeds stated capability	Security constraints, Short term ratings	Transfer from Stratford to Brunswick and Hawera to Waverley of 330/400 MW (summer/winter)
<i>Hawera-Patea-1 110 kV circuit</i>	Loss of the Stratford-Hawera 110 kV circuit	Voltage falls below advised asset capability	Short term ratings, Load management, Security constraints, Grid Reconfiguration	Load distribution, Voltage at Bunnythorpe 110 kV bus, load power factor
<i>Bunnythorpe-Marton-Wanganui 110 kV circuit</i>	loss of the Hawera-Stratford 110 kV circuit	Voltage falls below advised asset capability	Short term ratings, Load management, Security constraints	Load distribution, Voltage at Bunnythorpe 110 kV bus, load power factor
<i>Hawera-Waverley-1 or the Hawera-Stratford-1 110 kV circuit</i>	Loss of the other circuit	Loss of supply to Hawera or Islanding from grid	Short term ratings, Load management, Security constraints	
<i>New Plymouth T8 220/110 kV transformer</i>	loss of Carrington Street-Stratford circuit	Voltage falls below advised asset capability	Short term ratings, Security constraints	Carrington St, Huirangi, Motunui and New Plymouth load limited to 80 MW (summer/winter)
<i>Outage of one of the Huntly-Stratford-1 or Stratford-Taumarunui-1 220 kV circuits</i>	Loss of one of the Huntly-Stratford-1 or Stratford-Taumarunui-1 220 kV circuits	Transient stability	Security constraints	Transfer from Stratford to Huntly limited to 220 MW

1.4 POWER SYSTEM CAPABILITY LIMITS ON LIMIT GROUP

1.4.1 POWER SYSTEM LIMITS

Power system capability limits that apply to the region a grid exit or grid injection point (or a collection of such points) are shown in the following table. You can navigate to the relevant issue by clicking on the section number in the right hand column of the following table.

Contingency	Limit Group	2011 summer/winter	2012 summer/winter	2013 summer/winter	Detailed Analysis Section
<i>Loss of the Brunswick-Stratford 220 kV circuit</i>	SFD-BRK Transfer	500/560 MW	500/560 MW	510/610 MW	2.1.1
<i>Loss of one of the Huntly-Stratford-1 or Stratford-Taumarunui-1 220 kV circuits</i>	SFD-HLY Transfer	395 MW	395 MW	395 MW	2.1.2
<i>Loss of the Hawera-Patea 110 kV circuit</i>	HWA load @ 0.91 pf	37/42 MW	37/42 MW	Not an issue	2.3.2

Outage	Contingency	Limit Group	2011 summer/winter	2012 summer/winter	2013 summer/winter	Detailed Analysis Section
<i>One of the Bunnythorpe-Brunswick 220 kV circuit</i>	loss of the parallel Bunnythorpe-Brunswick circuit	BRK-BPE-HWA-WVY Transfer	140/165 MW	140/165 MW	No longer an issue	2.2.1
<i>Brunswick-Stratford 220 kV circuit</i>	loss of a parallel Brunswick-Stratford circuit	SFD-BRK-HWA-WVY Transfer	330/400 MW	330/400 MW	340/410 MW	2.2.2
<i>Outage of the Bunnythorpe-Marton-Wanganui 110 kV circuit</i>	Loss of the Hawera-Stratford-1 110 kV circuit	Marton, Wanganui, Hawera and Waverley	See detailed analysis	See detailed analysis	See detailed analysis	2.4.1
<i>Outage of the Bunnythorpe-Marton-Wanganui 110 kV circuit</i>	Loss of the Bunnythorpe-Marton-Wanganui 110 kV circuit	Wanganui, Hawera and Waverley	See detailed analysis	See detailed analysis	See detailed analysis	2.4.2
<i>New Plymouth T8 220/110 kV transformer</i>	loss of Carrington Street -Stratford circuit	Carrington St, Huirangi, Motunui and New Plymouth	80 MW	80 MW	80 MW	2.4.4
<i>Outage of one of the Huntly-Stratford-1 or Stratford-Taumarunui-1 220 kV circuits</i>	Loss of one of the Huntly-Stratford-1 or Stratford-Taumarunui-1 220 kV circuits	SFD-HLY Transfer	220 MW	220 MW	220 MW	2.4.5

Power System Capability Limits



1.5 ASSUMPTIONS ON THE POWER SYSTEM

The Whareroa generation can only provide 35 MW of power and ± 4 Mvar to the grid. This was determined from 2009 recorded SCADA output.

The ABSS scheme operates by splitting the bus at Hawera 110 kV, opening HWA-CB-712 which will introduce R72, and HWA-TF-T1 or HWA-TF-T2 is removed from the circuit to stop the transfer of power through the 110 kV network.

1.6 LOSS OF SUPPLY OR CONNECTION DURING OUTAGES

The following GXPs/GIPs will lose supply or connection when the listed outages occur and the corresponding contingent event arises.

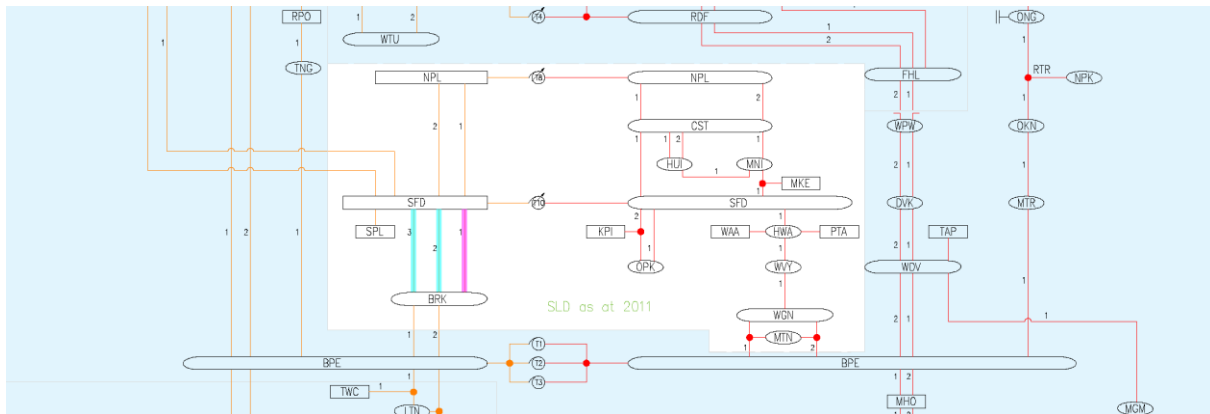
Grid Exit / Injection Point	Outage	Contingent Event
<i>Opunake</i>	Outage of one of the Opunake-Stratford 110 kV circuits.	Loss of the other Opunake-Stratford 110 kV circuit.
<i>Marton</i>	Outage of one of the Marton-Wanganui-Bunnythorpe 110 kV circuits	Loss of the other Marton-Wanganui-Bunnythorpe 110 kV circuit
<i>Waverly</i>	Outage of the Hawera-Waverly 110 kV circuit	Loss of the Waverly-Wanganui 110 kV circuit
<i>McKee Generation</i>	Outage/Loss of the Stratford-Motunui 110 kV circuit	N/A



2. POWER SYSTEM LIMIT ANALYSIS

2.1.1 LOSS OF A BRUNSWICK-STRATFORD 220 kV CIRCUIT

Grid Point	Power System Issue	Causing Factor	Indicative Limit	Operational Measures	Back to Limit Group
Taranaki Region	<p>Remaining Brunswick-Stratford 220 kV circuits exceeds stated capability</p> <p>Low bus voltage at HWA, WVY, WGN, MTN during winter</p>	Loss of a Brunswick-Stratford 220 kV circuit	<p>Transfer from Stratford to Brunswick of 500/610 MW (summer/winter)</p> <p>Transfer from Stratford to Brunswick 560 MW during winter</p>	<p>Security constraints</p> <p>Short term ratings</p>	1.4.1



Following the loss of a Brunswick-Stratford 220 kV circuit, a power system capability limit on generation at Whareroa and Patea is required to avoid the Hawera-Waverley-1 110 kV circuit exceeding stated capability. The combined generation is limited by the Hawera-Waverley-1 110 kV circuit rating of 51/62 MW (summer/winter).

A grid reconfiguration scheme offered by the grid owner, allows the limit on generation to be increased. The automatic grid configuration scheme consists of an Automatic Bus Splitting Scheme (ABSS) in combination with a series reactor (R72) installed at Hawera which will reconfigure the 110 kV network.

The ABSS will operate, causing the 110 kV bus at Hawera to be split, once the loading on the Hawera-Waverley-1 circuit exceeds its limit. Following the operation of the ABSS, Patea generation output and the Hawera load is connected to the Hawera-Stratford-1 110 kV circuit and the Whareroa generation output is connected into the Hawera-Waverley-1 110 kV circuit. The Whareroa generation is still limited by the line but the reconfiguration allows more power to be transferred.

2.1.1.1 Assumptions

For the purpose of the analysis, the following assumptions apply:

- HVDC south transfer
- Loss of Brunswick-Stratford-1 220 kV circuit considered
- ABSS and R72 are offered in

2.1.1.2 **Power System Analysis due to Asset Capability**

Power system capability limits on the transfer between Stratford and Brunswick are required to avoid the Brunswick-Stratford 2 and 3 circuits exceeding stated capability in a summer case only, following the loss of the Brunswick-Stratford-1 220 kV circuit. The winter load will cause a voltage collapse before these thermal limits are hit at the remaining Brunswick-Stratford 1 and 2 circuits. An indicative power system capability limit on the transfer from Stratford to Brunswick is 500/610 MW (summer/winter).

The Stratford-Hawera-Waverly-Wanganui 110 kV circuit upgrade will remove the need for the ABSS to be offered as the SFD-WGN 110 kV lines will no longer overload and will be within voltage limits. Although this upgrade increases the transfer limit on the SFD-WGN 110 kV lines the 500/610 MW (summer/winter) limits still apply for SFD-BRK 220 kV.

The limits are shown below.

Power System Issue	Stratford to Brunswick transfer
Loss of Brunswick-Stratford-3 220 kV circuit	500/610 MW

2.1.1.3 **Operational Measures**

The power system issue is managed by the application of short term ratings and security constraints.

2.1.1.4 **Sensitivity Studies**

A sudden reduction of Manawatu wind generation output at the time of high HVDC south transfer may cause the Brunswick-Stratford 220 kV circuits to exceed stated capability as generation north of Bunnythorpe is increased to cover the reduction in Manawatu wind generation output.

Sensitivity factors are a function of grid configuration. The loss of a transmission circuit changes the grid configuration and the sensitivity factors. Circuits will have different sensitivity factors for different contingent events. In order to determine whether circuits will exceed stated capabilities during contingent events with a sudden increase in Manawatu wind generation, the contingent event causing the largest sensitivity factor is analyzed for each circuit. It is assumed that the Hawera ABSS has been offered and that the Hawera 110 kV bus is automatically opened following the loss of a parallel 220 kV circuit.

The sensitivity factors for the 220 kV circuits between Bunnythorpe and Stratford are shown below.

Circuit	Contingent Event	Connection Point/Wind Farm	Sensitivity Factors
Brunswick-Stratford 220 kV circuits	Loss of the parallel Brunswick-Stratford circuit	Woodville – Te Apiti	.17
		Linton – Tararua (Part)	.19
		Bunnythorpe – Tararua (part)	.19
Bunnythorpe-Brunswick 220 kV	Loss of the parallel Bunnythorpe-	Woodville – Te Apiti	.32

Circuit	Contingent Event	Connection Point/Wind Farm	Sensitivity Factors
<i>circuits</i>	Brunswick circuit	Linton – Tararua (Part)	.35
		Bunnythorpe – Tararua (part)	.35

The table above shows the average sensitivity of the Brunswick-Stratford 220 kV circuit to Manawatu generation output to be approximately 19%.

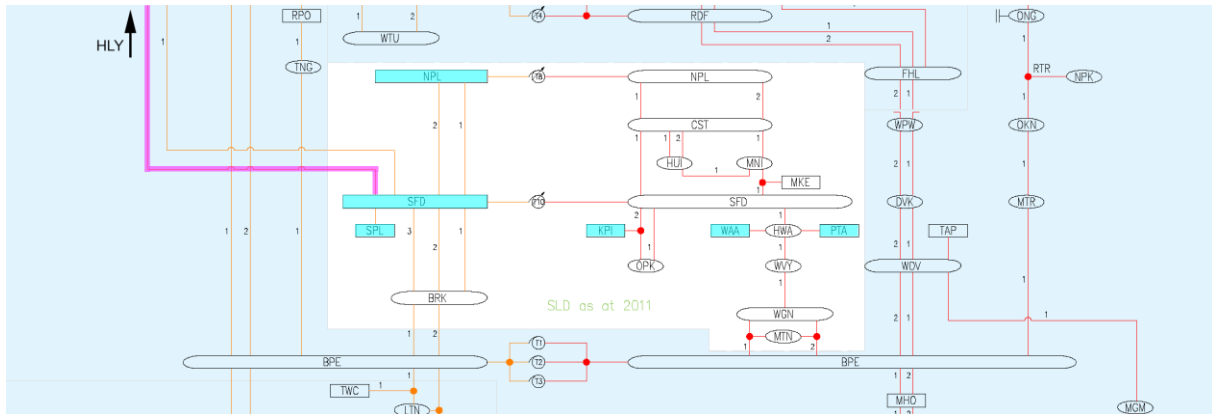
E.g. the transfer on Brunswick-Stratford 220 kV will increase/decrease by 19 MW when Linton wind generation decreases/increases by 100 MW.

The loading on the Bunnythorpe-Stratford 220 kV circuits is sensitive to changes in wind generation output within the Manawatu Region and may cause either circuit to exceed stated capability following the loss of a parallel circuit at certain times.



2.1.2 LOSS OF A HUNTLY-STRATFORD OR STRATFORD-TAUMARUNUI 220 kV CIRCUIT

Grid Point	Power System Issue	Causing Factor	Indicative Limit	Operational Measures	Back to Limit Group
Taranaki Region	Transient Instability	Loss of a Huntly-Stratford or Stratford-Taumarunui 220 kV circuit	Transfer from Stratford to Huntly limited to 395 MW (summer/winter)	Security constraints	1.4.1

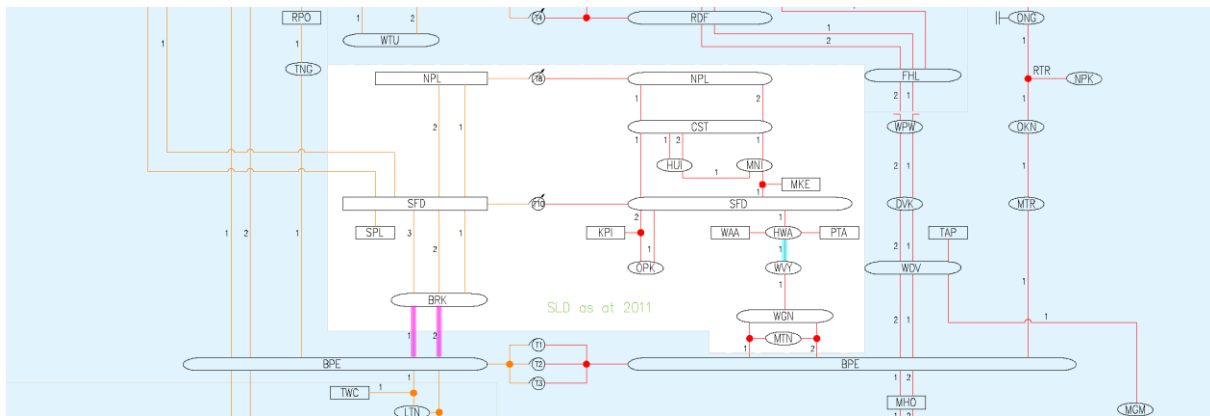


A three-phase circuit fault at the Stratford end of one of the 220 kV circuits between Stratford and Huntly can cause angular instability in the Taranaki generating units under high north transfer conditions. The transfer limit to avoid instability is 395 MW based on light load conditions and increases as system load is increased. This power system issue was managed previously by the thermal limitations of the Bunnythorpe-Tokaanu 220 kV circuits. Since their upgrade in July 2009 these circuits are no longer the limiting factor. Operational measures to manage the power system issue are the use of security constraints and re-dispatching of generation.

2.2 REGIONAL ISSUES DURING OUTAGES

2.2.1 OUTAGE OF A BUNNYTHORPE-BRUNSWICK 220 kV CIRCUIT AND THE LOSS OF ANOTHER CIRCUIT

Grid Exit Point	Power System Issues	Causing Factor	Indicative Limit	Operational Measures	Back to Limit Group
Taranaki	Hawera-Waverley-1 110 kV circuit exceed stated capability	Outage of one of the Bunnythorpe-Brunswick 220 kV circuits and the loss of another circuit	Transfer from Brunswick to Bunnythorpe and Hawera to Waverley of 140/165 MW (summer/winter)	Security constraints, Short term ratings, Hawera ABSS and R72 offered	1.4.1



During an outage of a Bunnythorpe-Brunswick 220 kV circuit, the loss of one of the remaining Bunnythorpe-Brunswick 220 kV circuit may result in the parallel 110 kV circuits exceeding their stated capability.

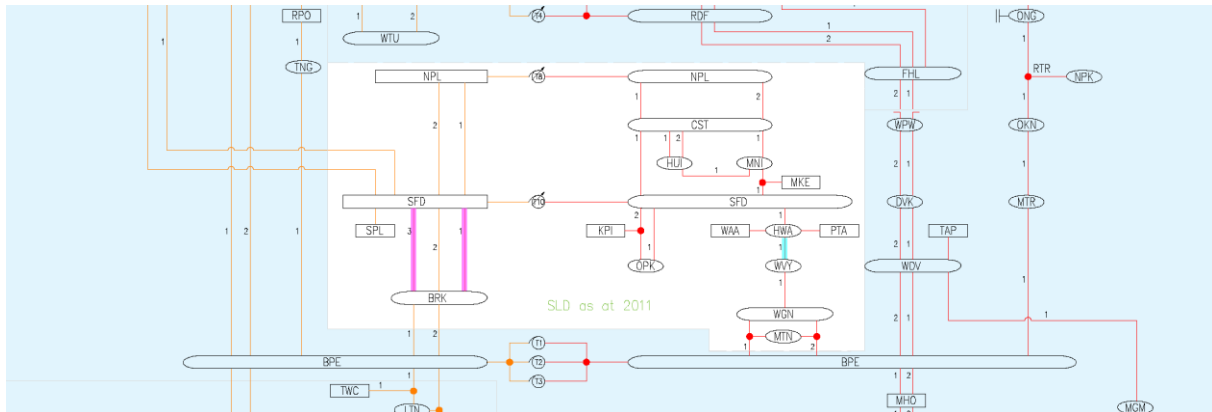
A power system capability limit is required during the outage to avoid the Hawera-Waverley-1 110 kV circuit exceeding stated capability following the loss of the remaining Bunnythorpe-Brunswick 220 kV circuit. An indicative power system capability limit on the combined transfer from Bunnythorpe to Brunswick and Hawera to Waverley is 140/165 MW (summer/winter). This assumes high HVDC north transfer and high Whareroa and Patea generation.

Operational measures to manage the power system issue is to apply short term ratings, security constraints and the grid owner offering the Hawera Auto Bus Splitting Scheme (ABSS) and reactor (R72) (see "Steady State circuit loading on the Hawera-Waverley-1 110 kV circuit" analysis for information on the Hawera ABSS and R72).

The 2013 Stratford-Bunnythorpe 110 kV grid upgrades will remove the need for the transfer limit on Brunswick-Bunnythorpe 220 kV network.

2.2.2 OUTAGE OF A BRUNSWICK-STRATFORD 220 kV CIRCUIT AND THE LOSS OF ANOTHER CIRCUIT

Grid Exit Point	Power System Issues	Causing Factor	Indicative Limit	Operational Measures	Back to Limit Group
<i>Taranaki</i>	Hawera-Waverley-1 110 kV circuit exceeds stated capability or Stratford-Brunswick 220 kV exceeds stated capability	Outage of a Brunswick-Stratford 220 kV circuit and the loss of another circuit	Transfer from Stratford to Brunswick and Hawera to Waverley of 330/400 MW (summer/winter)	Security constraints Short term ratings	1.4.1



During an outage of a Brunswick-Stratford 220 kV circuit, and the loss of another Brunswick-Stratford 220 kV circuits may result in the remaining 220 kV circuit exceeding stated capability or the parallel HWA-WVY 110 kV circuit exceeding stated capability.

The power system capability limit during the outage is required to avoid the Hawera-Waverley-1 110 kV circuit or the Brunswick-Stratford 220 kV circuit exceeding stated capability following the loss of one of the remaining Brunswick-Stratford 220 kV circuits. An indicative power system capability limit on the combined transfer from Stratford to Brunswick and Hawera to Waverley is 330/400 MW (summer/winter). This assumes maximum Whareroa and Patea generation output and low south transfer.

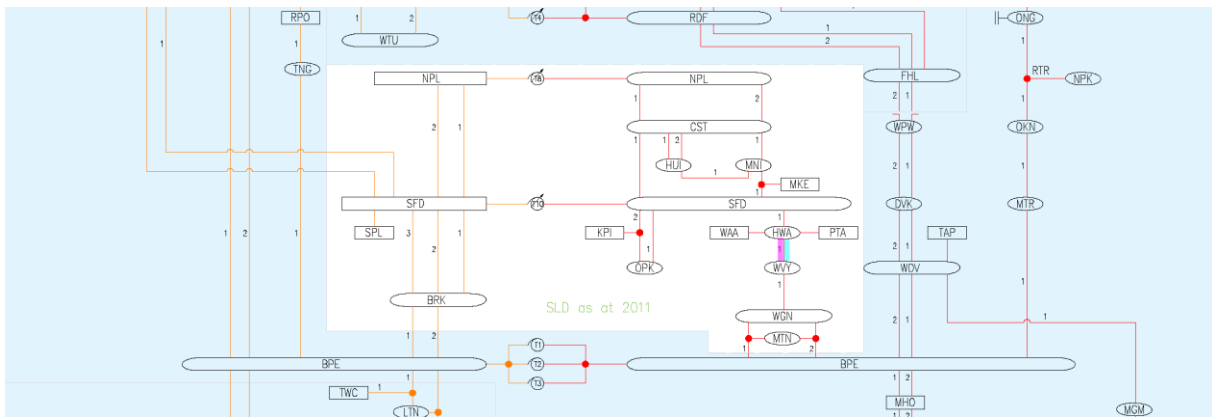
Operational measures to manage the power system issue are to apply short term ratings, and security constraints.

The upgrade of the SFD-WGN 110kV circuit in 2013 will then place the limiting factor solely on the remaining Brunswick-Stratford 220 kV circuit. The new transfer limit would then be 335/410 MW (summer/winter).

2.3 LOCAL ISSUES DURING NORMAL OPERATION

2.3.1 STEADY STATE CIRCUIT LOADING ON THE HAWERA-WAVERLEY-1 110 kV CIRCUIT

Grid Point	Power System Issue	Causing Factor	Indicative Limit	Operational Measures	Back to Limit Group
Hawera, Whareroa	Loading on Hawera-Waverley-1 110 kV circuit causes ABSS to operate	Steady state circuit loading on the Hawera-Waverley-1 110 kV circuit	None	Special Protection Scheme	1.4.1



The grid owner can offer an automatic grid reconfiguration in case the transfer capability through Hawera-Waverley-1 110 kV line is exceeded. The scheme consists of an Automatic Bus Splitting Scheme (ABSS) in combination with a series reactor (R72) installed between the Hawera-Waverley-1 110 kV circuit which will reconfigure the 110 kV network.

The ABSS will operate, causing the 110 kV bus at Hawera to be split, once the loading on the Hawera-Waverley-1 110 kV circuit exceeds a certain limit. Following the operation of the ABSS, Patea generation output and the Hawera load is connected to the Hawera-Stratford-1 110 kV circuit and the Whareroa generation output is connected into the Hawera-Waverley-1 110 kV circuit.

Following the update to the Whareroa generation capability (limited to 35 MW), it is not likely that the Hawera-Waverley-1 110 kV circuit will overload and cause the ABSS to operate. However, when south transfer becomes high, the reactor R72 must be introduced into the circuit to prevent overloading.

2.3.1.1 Assumptions

For the purpose of the analysis, the following assumptions apply:

- HVDC south transfer
- Hawera R72 is offered in

2.3.1.2 Power System Capability Limits Due to assets Exceeding Stated Capability

The assets will no longer exceed the capability limits with Whareroa only producing 35 MW and the Hawera R72 reactor is offered in.

2.3.1.3 ***Operational Measures***

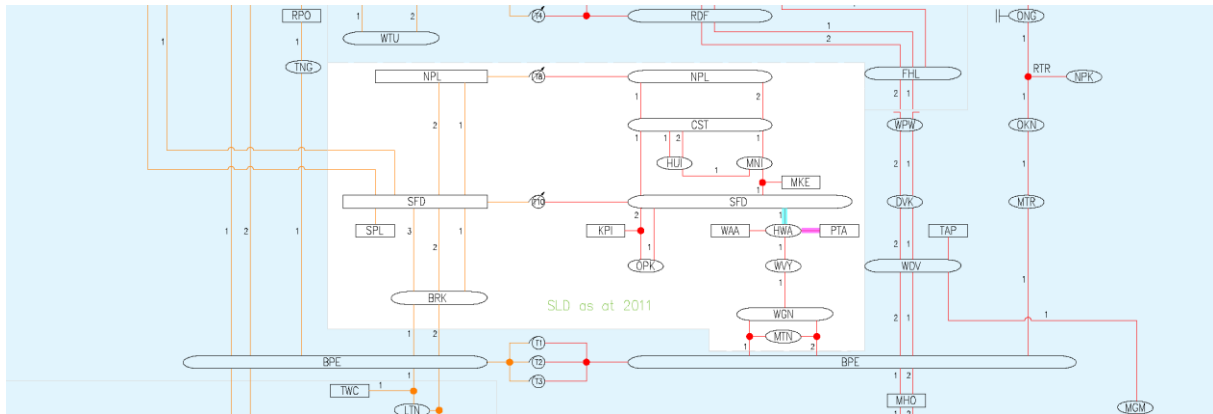
The power system issue is managed by the application of special protection schemes.

Once the 2013 SFD-BPE 110 kV upgrade is installed there will no longer be the need for the reactor R72.



2.3.2 LOSS OF THE HAWERA-PATEA-1 110 kV CIRCUIT

Grid Point	Power System Issue	Causing Factor	Indicative Limit	Operational Measures	Back to Limit Group
Hawera, Patea, Stratford	Steady state loading of Hawera-Stratford-1 110 kV circuit	Loss of Hawera-Patea 110 kV circuit	Maximum load at Hawera of 37/42 MW @ 0.91pf (summer/winter)	Security constraints, Load Management	1.4.1



The loss of a 110 kV circuit from Hawera to Patea may cause the Hawera-Stratford-1 110 kV circuit to exceed stated capability. This is possible under conditions of south flow and the Hawera ABSS and reactor R72 are in service.

The loss of the 110 kV circuit between Hawera and Patea will cause the loss of generation from Patea. This will overload the Hawera-Stratford-1 110 kV causing the ABSS to split the Hawera bus. During times of high demand at Hawera this could cause the Hawera-Stratford-1 110 kV circuit to exceed its stated capability.

2.3.2.1 Assumptions

For the purpose of the analysis, the following assumptions apply:

- HVDC south transfer
- Hawera R72, and ABBS is offered in

2.3.2.2 Power System Capability Limits Due to assets Exceeding Stated Capability

The indicative power system capability limit on the Hawera to Stratford 110 kV circuit is the line rating of 50/61 MW (summer/winter). The ABSS bus split can reduce the loading however it may still overload due to Hawera demand.

2.3.2.3 Operational Measures

The power system issue is managed by the application of security constraints and load management.

This is no longer an issue when the 2013 Stratford-Bunnythorpe 110 kV upgrade comes into service.

2.3.2.4 Summary of Power System Capability Limits

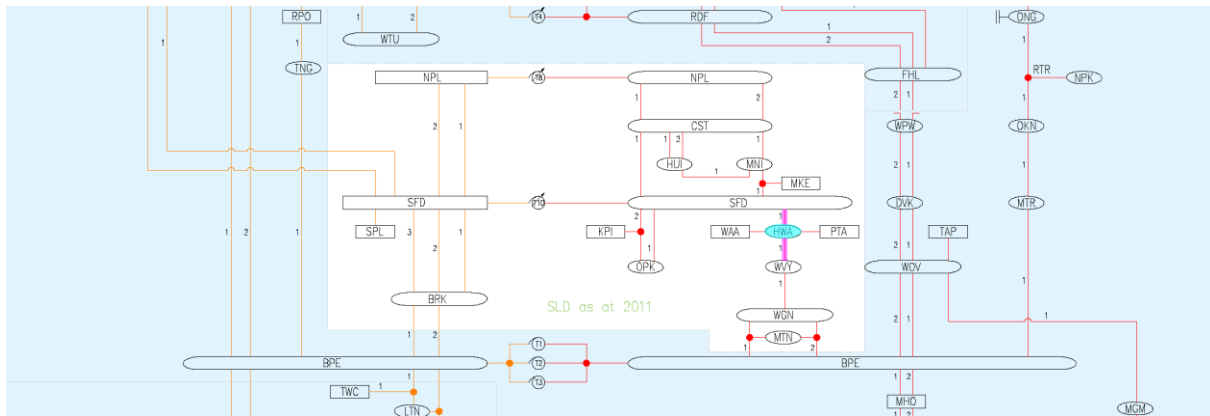
A summary of limits is shown below.



Power System Issue	Year	Circuit loading (summer/winter)	Hawera load @ 0.91pf with ABBS offered in (summer/winter)
<i>Hawera-Stratford-1 110 kV circuit</i>	2011	50/61 MW	37/42 MW
<i>Hawera-Stratford-1 110 kV circuit</i>	2012	50/61 MW	37/42 MW
<i>Hawera-Stratford-1 110 kV circuit</i>	2013	Non issue	Not an issue

2.4.2 OUTAGE OF THE HAWERA-WAVERLEY-1 OR THE HAWERA-STRATFORD-1 110 kV CIRCUIT AND LOSS OF ANOTHER CIRCUIT

Grid Exit Point	Power System Issue	Causing Factor	Indicative Limit	Operational Measures	Back to Limit Group
<i>Marton, Wanganui, Hawera and Waverley</i>	<p>Loss of supply to Hawera or Islanding from grid</p> <p>Voltage falls below advised asset capability or assets exceed stated capability</p>	Outage of the Hawera-Waverley-1 or the Hawera-Stratford-1 110 kV circuit and loss of another circuit	Load distribution, Voltage at Bunnythorpe 110 kV bus, load power factor	Short term ratings, Load management, Security constraints, Grid reconfiguration	1.4.1



An outage of the Hawera-Waverley-1 or the Hawera-Stratford-1 110 kV circuit and the loss of the other circuit is likely to result in a loss of supply to Hawera unless islanding of the Hawera load with generation at Patea and Whareroa is successful.

For an outage on the Hawera-Stratford-1 110 kV circuit the loss of a Bunnythorpe-Marton-Wanganui 110 kV circuit may cause grid voltage to fall below advised asset capability at Hawera, Wanganui and Waverley. This voltage decline is strongly affected by such factors as the voltage at the Bunnythorpe 110 kV bus, the power factor of the loads, and the distribution of the loading on the circuit. The lowest voltage occurs at Hawera due to the length of the supply coming from Bunnythorpe. Reducing load at Hawera increases the voltage of the system more than reducing load at Marton. This assumes maximum generation from Whareroa and Patea.

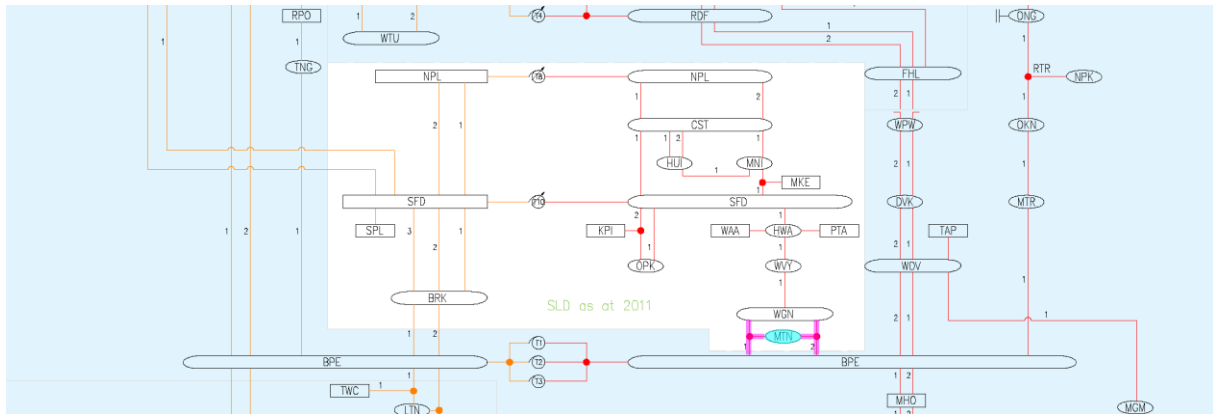
The loss of the Wanganui-Waverley-1 110 kV circuit, results in the Islanding of Patea, Whareroa, Hawera and Waverley and, if unsuccessful, a loss of supply to those stations.

Operational measures to manage the outage are:

- the application of security constraints,
- short term ratings,
- system split with reduced security,
- load management.

2.4.3 OUTAGE OF A BUNNYTHORPE–MARTON–WANGANUI 110 kV CIRCUIT AND LOSS OF ANOTHER CIRCUIT

Grid Exit Point	Power System Issue	Causing Factor	Indicative Limit	Operational Measures	Back to Limit Group
<i>Marion, Wanganui, Hawera and Waverley</i>	Voltage falls below advised asset capability	Outage of a Bunnythorpe–Marton–Wanganui 110 kV circuit and loss the other circuit	Load distribution, Voltage at Bunnythorpe 110 kV bus, load power factor	Short term ratings, Load management, Security constraints, Grid reconfiguration	1.3.2



During an outage on either one of the Bunnythorpe–Marton–Wanganui 110 kV circuits, the loss of the remaining circuit will result in loss of supply to Marton. It could also cause under voltage issues at Waverly or Wanganui.

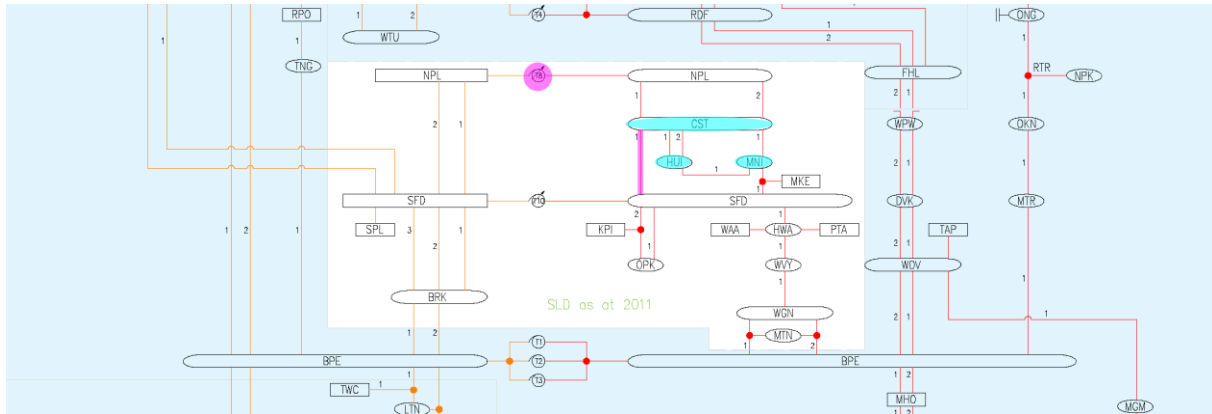
A system split between Wanganui and Waverly would reduce the need for load shedding at Wanganui although would reduce security.

Operational measures to manage the outage are:

- the application of security constraints,
- short term ratings,
- system split with reduced security,
- load management.

2.4.4 OUTAGE OF THE NEW PLYMOUTH T8 220/110 kV TRANSFORMER AND LOSS OF OTHER PLANT

Grid Exit Point	Power System Issues	Causing Factor	Indicative Limit	Operational Measures	Back to Limit Group
<i>Carrington St, Huirangi, Motunui and New Plymouth</i>	Low bus voltage at Carrington Street, Huirangi and Motunui	Outage of the New Plymouth T8 220/110 kV transformer and the loss of Carrington St-Stratford 110 kV circuit	Carrington St, Huirangi, Motunui and New Plymouth load limited to 80 MW (summer/winter)	Short term ratings Security constraints	1.4.1

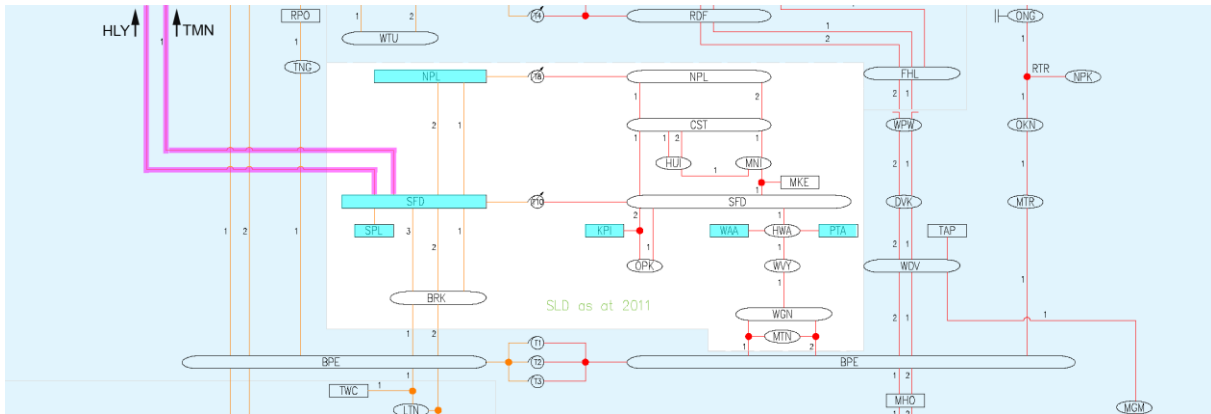


An outage of the New Plymouth T8 220/110 kV transformer and the loss of the Carrington Street–Stratford-1 110 kV may cause the voltage at Carrington Street, Huirangi and Motunui to fall below the ‘Code’ limits. A power system capability limit on the combined load at New Plymouth, Carrington Street, Huirangi and Motunui is 80 MW (summer/winter) to maintain bus voltage to within acceptable limits. Note that this limit is heavily dependent on the bus voltage at the Stratford 110 kV bus, and the power factor of the load.

Operational measures to manage the outage are the use of short term ratings and the application of security constraints and load management.

2.4.5 OUTAGE OF A HUNTLY-STRATFORD OR STRATFORD-TAUMARUNUI 220 kV CIRCUIT AND LOSS OF THE OTHER CIRCUIT

Grid Point	Power System Issue	Causing Factor	Indicative Limit	Operational Measures	Back to Limit Group
<i>Taranaki Region</i>	Transient Instability	Outage of a Huntly-Stratford or Stratford-Taumarunui 220 kV circuit and loss of the other circuit	Transfer from Stratford to Huntly limited to 220 MW (summer/winter)	Security constraints	1.4.1



During an outage of a Huntly-Stratford or Stratford-Taumarunui 220 kV circuit and loss of the other circuit, a three-phase circuit fault at the Stratford end of one of the 220 kV circuits between Stratford and Huntly can cause angular instability in the Taranaki generating units under high north transfer conditions. The transfer limit to avoid instability is 220 MW based on light load conditions and increases with an increase in system load. Operational measures to manage the power system issue are the use of security constraints and re-dispatching of generation.

