

System Security Forecast 2010

Part C Security Analysis

Hawkes Bay



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I M P O R T A N T

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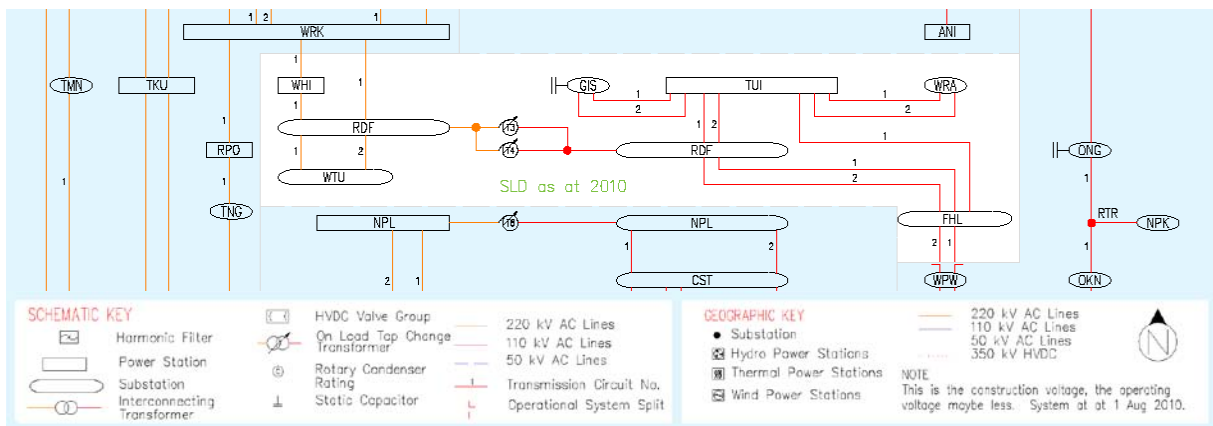
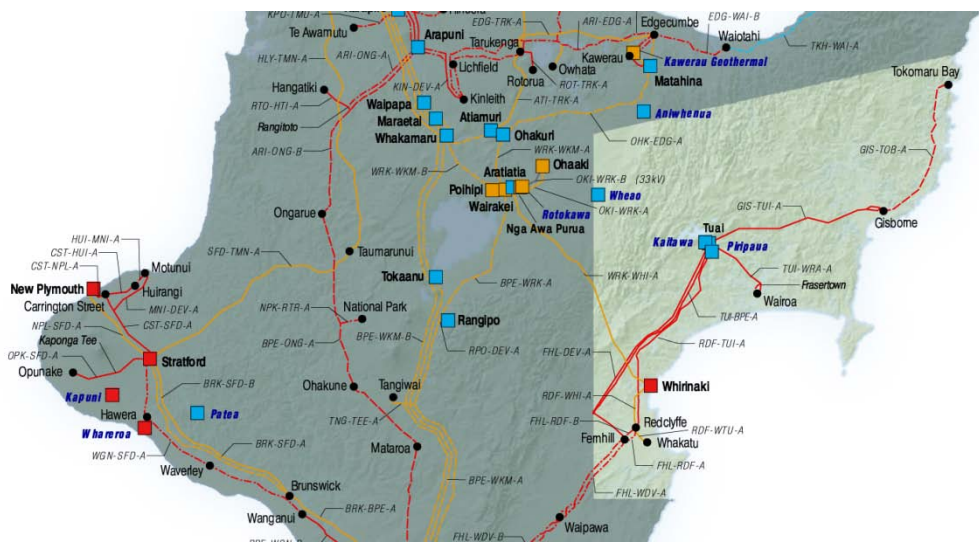
1. LIMIT GROUP ANALYSIS

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

1.1 NETWORK OVERVIEW

The Hawkes Bay region is the area bordered by and including the Fernhill substation in the south and Gisborne in the north. The region is supplied by 220 kV circuits from Wairakei, with 220/110 kV interconnecting transformers T3 and T4 (80/114/120 MVA) located at Redclyffe. The network is normally split at Fernhill/Waipawa to avoid the loading on assets in the 110 kV network between Bunnythorpe and Fernhill reaching stated capability. Capacitors are installed at the Gisborne substation to improve the network voltage and voltage stability.

The Hawkes Bay 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. There are no committed changes for the region. The assumptions regarding generation dispatch levels are summarized in Part B.

1.2 DEMAND AND GENERATION WITHIN THE LIMIT GROUP

The Hawkes Bay region has approximately 299 MW of generation capacity, 156 MW from Whirinaki¹ and 143 MW from the Waikaremoana Hydro Scheme². EC Prudent load values indicate a 2011 winter peak load of 289 MW which is forecasted to increase to 306 MW in 2013.

Power factor scatter graphs for the region are shown below in Figure 1 and Figure 2. It is observed that the power factor in winter varies between 1 and 0.955. In summer, the power factor varies between 1 and 0.961. For the purpose of these studies the Hawkes Bay load power factor has been assumed to be 0.96/0.95 (summer/winter).

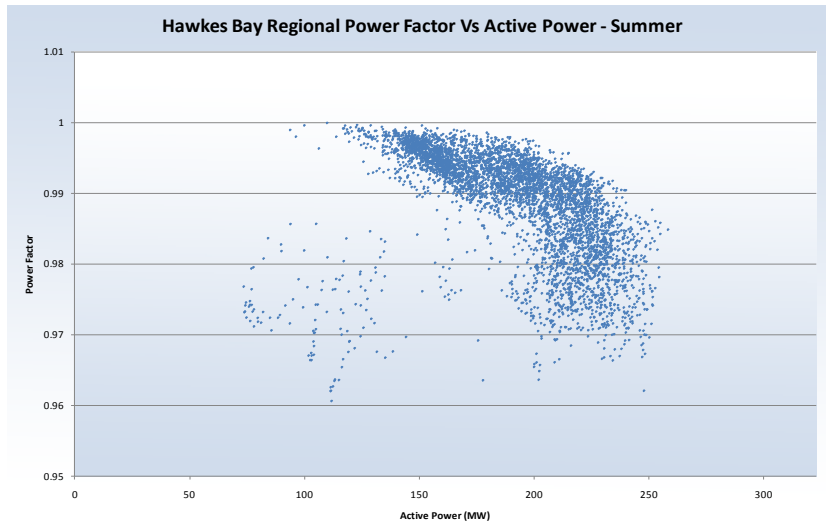


Figure 1 Power Factor Summer – Hawkes Bay

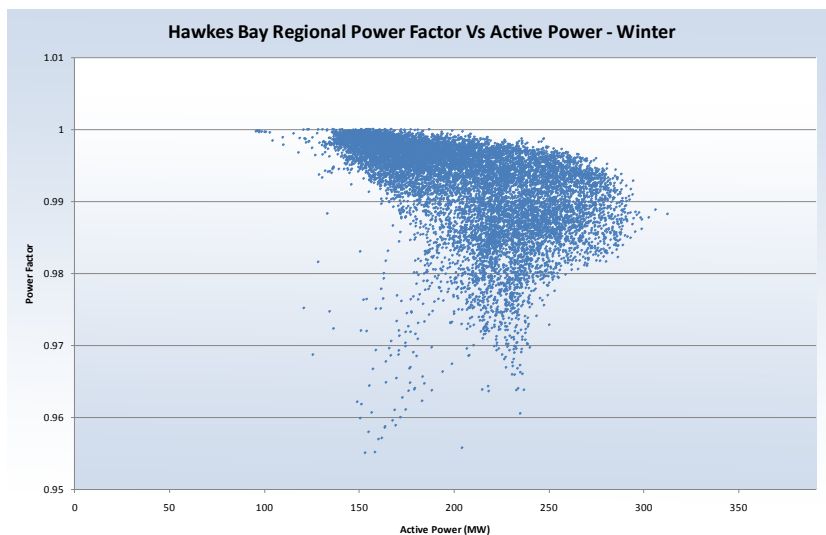


Figure 2 Power Factor Winter – Hawkes Bay

¹ The Whirinaki generation station (156 MW) is for emergency dispatch during dry years or as otherwise determined by the Electricity Commission, therefore, this is not counted as part of the region's normal generation.

² Generation from the Tuai, Kaitawa and Piripaua hydro generation stations are collectively referred to as the Waikaremoana Hydro Scheme and connected to the Tuai 110 kV bus.

1.3 KEY ASSETS AND POWER SYSTEM CAPABILITY LIMITS ON LIMIT GROUP

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. Detailed analysis for each issue can be found in Section 2. You can navigate to the relevant issue by clicking on the section number in the right hand column of the following table.

1.3.1 ASSUMPTIONS

The following assumptions are made, unless specified differently in the report:

- Waikaremoana Hydro generation is 119 MW (summer/winter); which refers to the combined generation from the Tuai, Kaitawa and Piripaua hydro generation stations;
- Gisborne Capacitors (12 Mvar) are in service.

1.3.2 CRITICAL CONTINGENCIES

Contingency	Limit Group	Power System Issue	Management Measures	Risk Assessment	Detailed Analysis Section
<i>Loss of either Wairakei-Whirinaki, Whirinaki-Redclyffe or Wairakei-Redclyffe 220 kV circuit without Waikaremoana Hydro generation</i>	Hawkes Bay	Bus voltages in the Hawkes Bay region may fall below stated capability	Short term rating; Load management; Dispatching local generation	Transfer limit is 293/271 MW (summer/winter)	2.1.1
<i>Loss of Redclyffe 220/110 kV interconnecting transformer T3 or T4 without Waikaremoana Hydro generation</i>	Hawkes Bay 110 kV	The remaining Redclyffe interconnecting transformer may exceed stated capability Bus voltages may fall below stated capability within Hawkes Bay 110 kV network	Short term rating; Load management; Dispatching local generation	Transfer limit is 109/116 MW (summer/winter)	2.2.2
<i>Loss of a Fernhill-Redclyffe 110 kV circuit without Waikaremoana Hydro generation</i>	Fernhill, Gisborne, Wairoa, Tuai	The remaining Fernhill-Redclyffe 110 kV circuit may exceed stated capability Bus voltages may fall below stated capability within Hawkes Bay 110 kV network	Security constraints; Short term ratings; Load management	Transfer limit is 53/66 MW (summer/winter)	2.3.1
<i>Loss of a Gisborne-Tuai 110 kV circuit without Waikaremoana Hydro generation and Gisborne Capacitor C1</i>	Gisborne	Bus voltages at Gisborne may fall below advised capability The remaining Gisborne-Tuai 110 kV circuit may exceed stated capability	Dispatching local generation; Load Management;	Transfer limit is 43/46 MW (summer/winter)	2.3.2

1.3.3 CRITICAL OUTAGES

Outage	Contingency	Limit Group	Power System Issue	Management Measures	Risk Assessment	Detailed Analysis Section
<i>Outage of Wairakei-Whirinaki or Whirinaki-Redclyffe 220 kV circuit</i>	Loss of the other Whirinaki 220 kV circuit without Waikaremoana Hydro	Hawkes Bay	Loss of supply to Whirinaki 11 kV load Bus voltages in the Hawkes Bay region may fall below stated	Short term rating; Load management	Transfer limit is 266/242 MW (summer/winter)	2.2.1



Outage	Contingency	Limit Group	Power System Issue	Management Measures	Risk Assessment	Detailed Analysis Section
	generation		capability			
<i>Outage of Redclyffe 220/110 kV interconnecting transformer T3 or T4</i>	Loss of another Hawkes Bay circuit without Waikaremoana Hydro generation	Hawkes Bay 110 kV	The remaining Redclyffe interconnecting transformer may exceed stated capability Bus voltages in the Hawkes Bay region may fall below stated capability	Short term rating; Load management	Transfer limit is 231/245 MW (summer/winter)	2.2.3
<i>Outage of a Fernhill-Redclyffe 110 kV circuit</i>	Loss of a Redclyffe-Tuai 110 kV circuit without Waikaremoana Hydro generation	Fernhill, Gisborne, Tuai, Wairoa	The remaining Fernhill-Redclyffe 110 kV circuit may exceed stated capability	Security constraint; Short term ratings; Load management	Transfer limit is 54/66 MW (summer/winter)	2.4.1
<i>Outage of Fernhill-Tuai 110 kV circuit</i>	Loss of a Redclyffe-Tuai 110 kV circuit without Waikaremoana Hydro generation	Gisborne, Wairoa	The remaining Redclyffe-Tuai 110 kV circuit may exceed stated capability Bus voltages may fall below stated capability within Hawkes Bay 110 kV network	Security constraint; Short term ratings; Load management	Transfer limit is 56/55 MW (summer/winter)	2.4.2

1.3.4 LOSS OF SUPPLY DURING OUTAGES

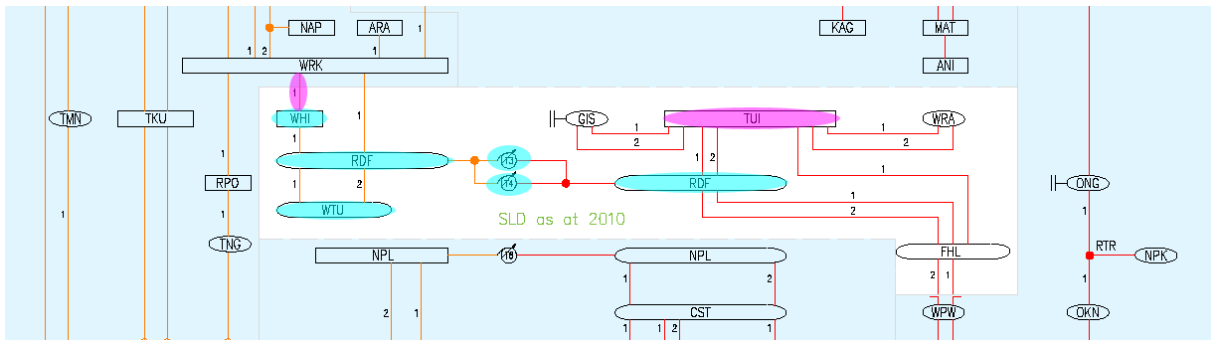
Outage	Contingency	Limit Group	Power System Issue	Management Measures
<i>Outage of Wairakei-Redclyffe 220 kV circuit</i>	Loss of either Whirinaki-Redclyffe or Wairakei-Whirinaki 220 kV circuit	Hawkes Bay	Loss of supply	Partial load restoration from Waikaremoana Hydro generation
<i>Outage of a Redclyffe-Whakatu 220 kV circuits</i>	Loss of the remaining Redclyffe-Whakatu 220 kV circuit	Whakatu	Loss of supply	N/A
<i>Outage of a Gisborne-Tuai 110 kV circuits</i>	Loss of the remaining Gisborne-Tuai 110 kV circuit	Gisborne	Loss of supply	N/A
<i>Outage of a Tuai-Wairoa 110 kV circuits</i>	Loss of the remaining Tuai-Wairoa 110 kV circuit	Wairoa	Loss of supply	N/A

2. APPENDIX

2.1 REGIONAL ISSUES DURING NORMAL OPERATION

2.1.1 LOSS OF EITHER WAIRAKEI-WHIRINAKI, WHIRINAKI-REDCLYFFE OR WAIRAKEI-REDCLYFFE 220 kV CIRCUIT

Grid Exit Point	Power System Issue	Causing Factor	Indicative Limit	Operational Measures
Hawkes Bay	Bus voltages in the Hawkes Bay region may fall below stated capability	Loss of either Wairakei-Whirinaki, Whirinaki-Redclyffe or Wairakei-Redclyffe 220 kV circuit without Waikaremoana Hydro generation	Transfer limit on the Redclyffe-Wairakei and Wairakei-Whirinaki 220 kV circuits into Hawkes Bay is 293/271 MW (summer/winter)	Short term rating; Load management; Dispatching local generation



The Hawkes Bay regional load is supplied through two 220 kV circuits from Wairakei to Redclyffe. The loss of one of these circuits whilst Waikaremoana Hydro Scheme is unavailable for dispatch, may cause bus voltages in the Hawkes Bay region to fall below stated capability. The indicative power system capability limits have been assessed for two generation scenarios, Waikaremoana Hydro Scheme available and unavailable for dispatch.

Waikaremoana Generation	Loss of Whirinaki-Wairakei 220 kV circuit	Loss of Redclyffe-Wairakei 220 kV circuit	Loss of Redclyffe-Whirinaki 220 kV circuit
<i>Unavailable</i>	Low voltage issues on the Whakatu, Whirinaki and Redclyffe 220 kV bus. Hawkes Bay load manage to 272 MW (winter). No load management is required for summer.	Low voltage issues on the Whakatu, Whirinaki and Redclyffe 220 kV bus. Hawkes Bay load manage to 269 MW (winter). No load management is required for summer.	Low voltage issues on the Whakatu and Redclyffe 220 kV bus. Hawkes Bay load manage to 263 MW (winter). No load management is required for summer.
<i>119 MW, 51 Mvar</i>	No issues	No issues	No issues

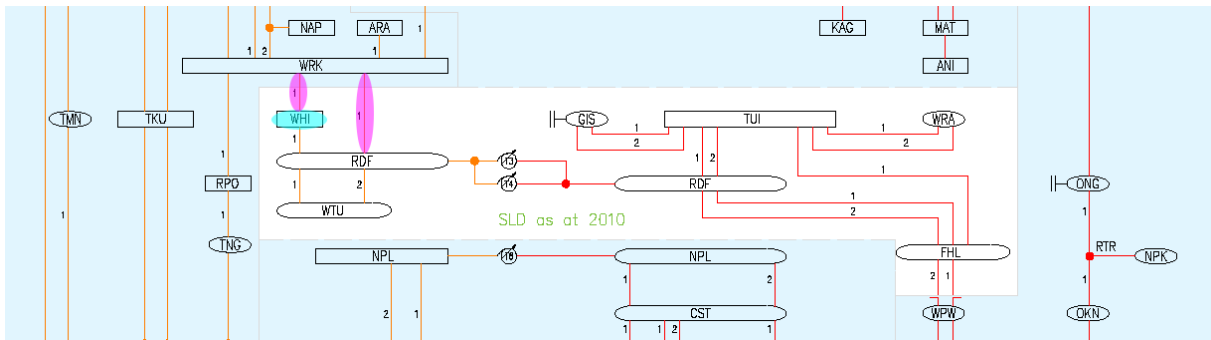
Operational measures to manage the power system issue are:

- short term ratings,
- load management.

2.2 REGIONAL ISSUES DURING OUTAGES

2.2.1 OUTAGE OF WAIRAKEI-WHIRINAKI OR WHIRINAKI-REDCLYFFE AND LOSS OF THE REMAINING WHIRINAKI 220 kV CIRCUIT

Grid Exit Point	Power System Issue	Causing Factor	Indicative Limit	Operational Measures
Hawkes Bay	Loss of supply to Whirinaki 11 kV load Bus voltages in the Hawkes Bay region may fall below stated capability	Outage of either Wairakei-Whirinaki or Whirinaki-Redclyffe and the loss of the remaining Whirinaki 220 kV circuit without Waikaremoana Hydro generation	Transfer limit on the Redclyffe-Wairakei and Wairakei-Whirinaki 220 kV circuits into Hawkes Bay is 266/242 MW (summer/winter)	Short term rating; Load management



During an outage of either the Wairakei-Whirinaki or Whirinaki-Redclyffe 220 kV circuit, the loss of the remaining Whirinaki 220 kV circuit will result in loss of supply to the Whirinaki 11 kV load, whilst Waikaremoana Hydro Scheme is unavailable for dispatch may cause bus voltages in the Hawkes Bay region to fall below stated capability.

The indicative power system capability limits have been assessed for two generation scenarios, Waikaremoana Hydro Scheme available and unavailable for dispatch.

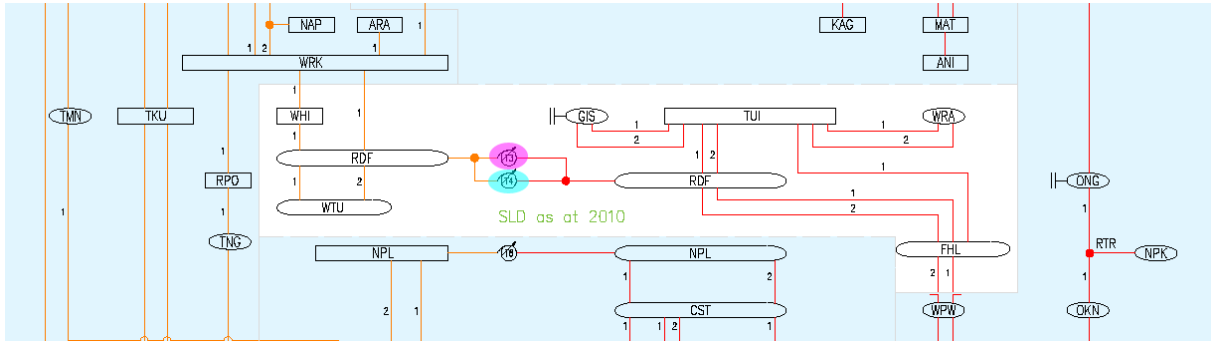
Waikaremoana Generation	Comments
Unavailable	Loss of supply to Whirinaki 220 kV and 11 kV bus. Hawkes Bay voltage is the critical issue. Hawkes Bay load manage to 228 MW (winter), excluding Whirinaki 11 kV load.
119 MW, 51 Mvar	Loss of supply to Whirinaki 220 kV and 11 kV bus. No voltage issues.

Operational measures to manage the power system issue are:

- short term ratings,
- load management.

2.2.2 LOSS OF A REDCLYFFE 220/110 kV INTERCONNECTING TRANSFORMER

Grid Exit Point	Power System Issue	Causing Factor	Indicative Limit	Operational Measures
Hawkes Bay 110 kV	<p>The remaining Redclyffe interconnecting transformer may exceed stated capability</p> <p>Bus voltages may fall below stated capability within Hawkes Bay 110 kV network</p>	Loss of Redclyffe 220/110 kV interconnecting transformer T3 or T4 without Waikaremoana Hydro generation	Transfer limit on the Redclyffe T3 and T4 into Hawkes Bay 110 kV network is 109/116 MW (summer/winter)	Short term rating; Load management



The loss of one of the Redclyffe 220/110 kV interconnecting transformers, T3 or T4 (80/114/120 MVA), whilst Waikaremoana Hydro Scheme is unavailable for dispatch may cause the remaining transformer to exceed stated capability and bus voltages in the Hawkes Bay region to fall below stated capability.

The indicative power system capability limits have been assessed for two generation scenarios, Waikaremoana Hydro Scheme available and unavailable for dispatch.

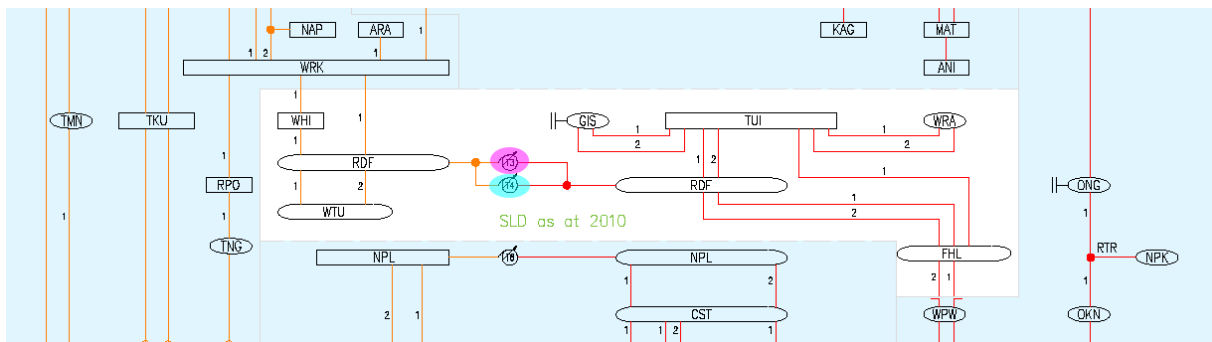
Waikaremoana Generation	Comments
Unavailable	<p>Low voltage issues within the Hawkes Bay 110 kV network.</p> <p>Seasonal post-contingent rating of the remaining Redclyffe interconnecting transformer is the critical issue.</p> <p>Hawkes Bay 110 kV load manage to 107/110 MW (summer/winter).</p>
119 MW, 51 Mvar	No issues

Operational measures to manage the power system issue are:

- short term ratings,
- load management.

2.2.3 OUTAGE OF A REDCLYFFE 220/110 kV INTERCONNECTING TRANSFORMER T3 OR T4 AND LOSS OF ANOTHER HAWKES BAY CIRCUIT

Grid Exit Point	Power System Issue	Causing Factor	Indicative Limit	Operational Measures
Hawkes Bay	<p>The remaining Redclyffe interconnecting transformer may exceed stated capability</p> <p>Bus voltages in the Hawkes Bay region may fall below stated capability</p>	Outage of either Redclyffe 220/110 kV interconnecting transformer T3 or T4 and the loss of another Hawkes Bay circuit, without Waikaremoana Hydro generation	Transfer limit on Wairakei-Redclyffe and Wairakei-Whirinaki 220 kV circuits into Hawkes Bay is 231/245 MW (summer/winter)	Short term rating; Load management; security constraints



During an outage of a Redclyffe 220/110 kV interconnecting transformer T3 or T4 (80/114/120 MVA), the loss of another circuit in the Hawkes Bay region, whilst Waikaremoana Hydro Scheme is unavailable for dispatch may cause the remaining Redclyffe interconnecting transformer to exceed stated capability, and bus voltages in the Hawkes Bay region to fall below stated capability.

The indicative power system capability limits have been assessed for two generation scenarios, Waikaremoana Hydro Scheme available and unavailable for dispatch.

Waikaremoana Generation	Loss of a 220 kV circuit	Loss of a 110 kV circuit
Unavailable	<p>Low voltage issues in the Hawkes Bay region.</p> <p>Seasonal post contingent rating of the remaining Redclyffe interconnecting transformer is the critical issue.</p> <p>Hawkes Bay 110 kV load manage to 107/111 MW (summer/winter).</p>	<p>Low voltage issues in the Hawkes Bay 110 kV network.</p> <p>Seasonal post contingent rating of the remaining Redclyffe interconnecting transformer is the critical issue.</p> <p>Hawkes Bay 110 kV load manage to 107/109 MW (summer/winter).</p>
119 MW, 51 MVar	No issues.	Same N-1 limits apply to each 110 kV circuits.

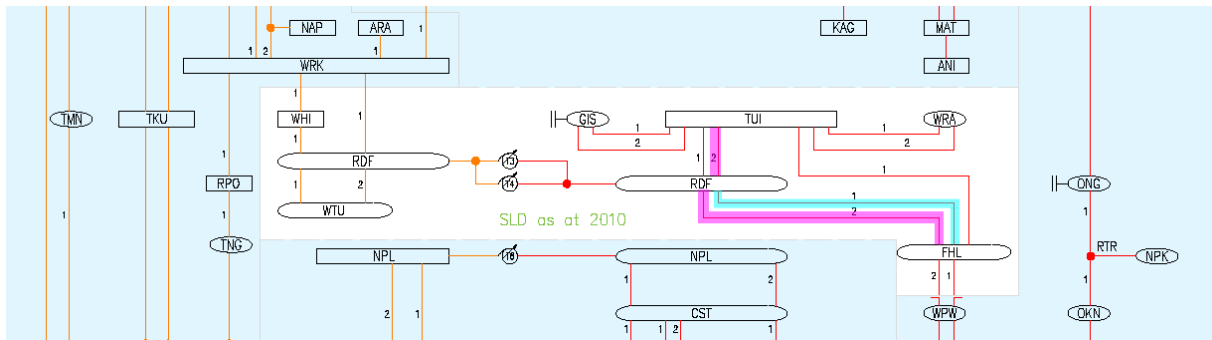
Operational measures to manage the power system issue are:

- short term ratings,
- security constraints,
- load management.

2.4 LOCAL ISSUES DURING OUTAGES

2.4.1 OUTAGE OF A FERNHILL-REDCLYFFE 110 kV CIRCUIT AND LOSS OF A REDCLYFFE-TUAI 110 kV CIRCUIT

Grid Exit Point	Power System Issue	Causing Factor	Indicative Limit	Operational Measures
<i>Fernhill, Gisborne, Wairoa, Tuai</i>	The remaining Fernhill-Redclyffe 110 kV circuit may exceed stated capability	Outage of a Fernhill-Redclyffe 110 kV circuit and the loss of a Redclyffe-Tuai 110 kV circuit without Waikaremoana Hydro generation	Transfer limit on Fernhill-Redclyffe 110 kV circuits is 54/66 MW (summer/winter)	Security constraints; Short term ratings; Load management



During an outage of one of the Fernhill-Redclyffe 110 kV circuits, the loss of a Redclyffe-Tuai 110 kV circuit whilst Waikaremoana Hydro generation is unavailable for dispatch, may cause the remaining Fernhill-Redclyffe 110 kV circuit to exceed stated capability

The indicative power system capability limits have been assessed for two generation scenarios, Waikaremoana Hydro Scheme available and unavailable for dispatch.

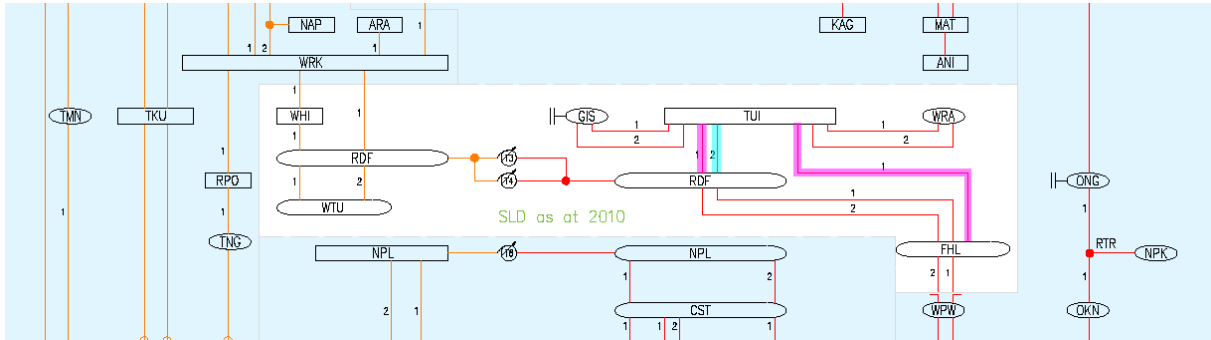
Waikaremoana Generation	Comments
<i>Unavailable</i>	Seasonal circuit rating of the remaining Fernhill-Redclyffe is the critical issue. The combined load at Fernhill, Gisborne, Tuai and Wairoa manage to 66/81 MW (summer/winter).
<i>119 MW, 51 Mvar</i>	No issues

Operational measures to manage the outage include:

- short term ratings,
- the application of security constraints,
- load management.

2.4.2 OUTAGE OF FERNHILL-TUAI 110 kV CIRCUIT AND LOSS OF A REDCLYFFE-TUAI 110 kV CIRCUIT

Grid Exit Point	Power System Issue	Causing Factor	Indicative Limit	Operational Measures
<i>Gisborne, Wairoa</i>	The remaining Redclyffe-Tuai 110 kV circuit may exceed stated capability Bus voltages may fall below stated capability within Hawkes Bay 110 kV network	Outage of the Fernhill-Tuai 110 kV circuit and the loss of a Redclyffe-Tuai 110 kV circuit without Waikaremoana Hydro generation	Transfer limit on Redclyffe-Tuai 110 kV circuit into Tuai 110 kV bus is 56/55 MW (summer/winter)	Security constraints; Short term ratings; Load management



During an outage of the Fernhill-Tuai 110 kV circuit, the loss of one of the Redclyffe-Tuai 110 kV circuits may cause the remaining Redclyffe-Tuai 110 kV circuit to exceed stated capability and bus voltages in the Hawkes Bay region to fall below stated capability.

The indicative power system capability limits have been assessed for two generation scenarios, Waikaremoana Hydro Scheme available and unavailable for dispatch.

Waikaremoana Generation	Comments
<i>Unavailable</i>	Low voltage issues on Gisborne 110 kV and 50 kV, Wairoa 11 kV, Tuai 110 kV and 11 kV bus; Overloading of the remaining Redclyffe-Tuai 110 kV circuit (summer). Redclyffe-Tuai circuit rating is the critical issue (summer). Gisborne 110 kV bus voltage is the critical issue (winter). The combined load at Gisborne and Wairoa manage to 51/50 MW (summer/winter).
<i>119 MW, 51 Mvar</i>	No issues in winter. Overloading of the remaining Redclyffe-Tuai 110 kV circuit (summer). Transfer limit on Redclyffe-Tuai 110 kV circuits into Redclyffe 110 kV bus is 58 MW (summer).

Operational measures to manage the outage include:

- short term ratings,
- the application of security constraints,
- load management.