

System Security Forecast 2010

Part C Security Analysis

West Coast Region



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I M P O R T A N T

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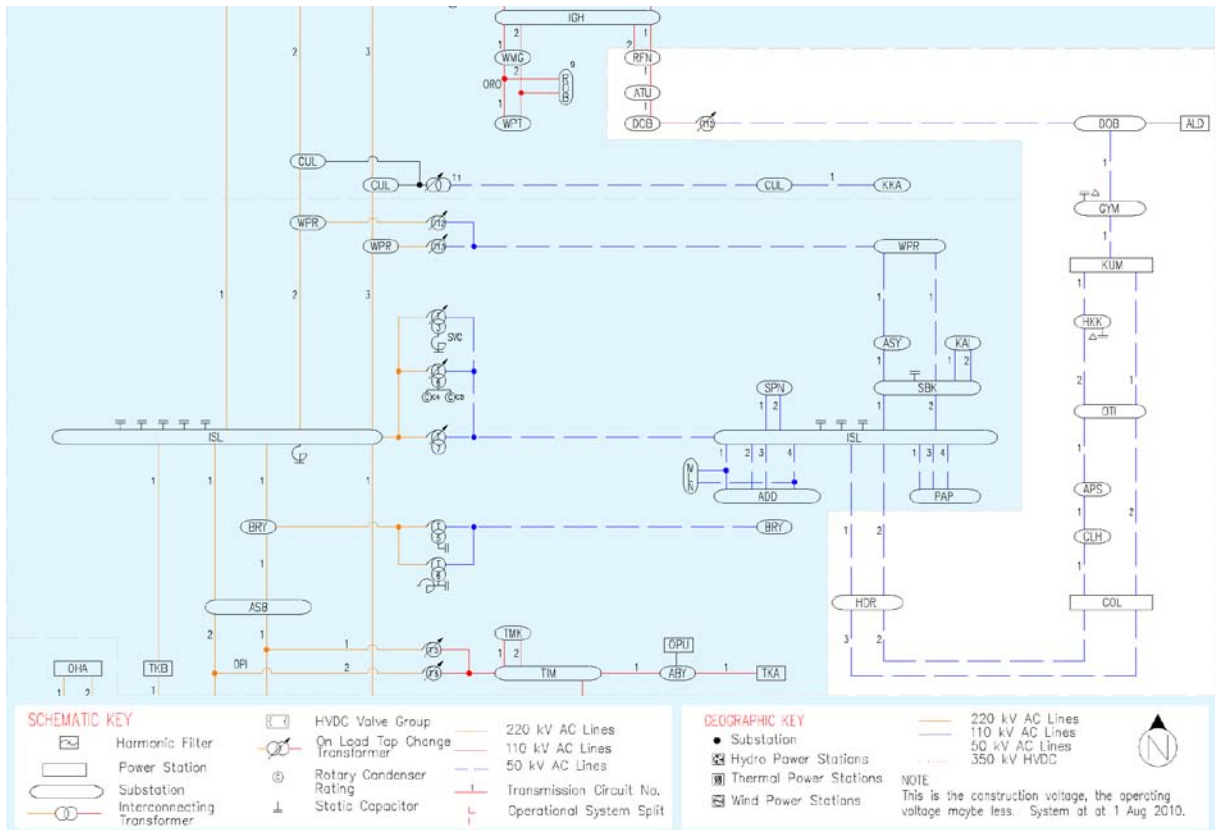
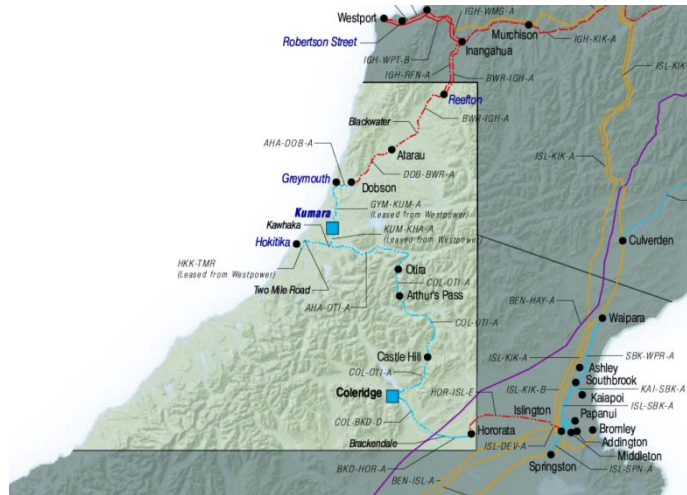
1. LIMIT GROUP ANALYSIS

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

1.1 NETWORK OVERVIEW

The West Coast region is the area bordered by and including Dobson in the north and Hororata in the south east. Power is predominantly supplied to the region through 110 kV and 66 kV transmission circuits (with an interconnecting transformer located at Dobson). There is local generation at Kumara and Coleridge. Static capacitors are installed at the Greymouth and Hokitika substation to improve the network voltage and voltage stability performance.

The West Coast 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 2 July 2010. The table below shows a list of committed projects in the region as notified by asset owners. These committed projects have been considered in the analysis.

Asset	Upgrade	Region	Commissioning Date
<i>Hokitika 11kV capacitors</i>	14Mvar, 11kV capacitors at Hokitika substation [West Coast 110 kV Transmission Security]	West Coast	July 2010
<i>Dobson (DOB) T11 Interconnecting Transformer</i>	Install a 2nd 110/66 kV Interconnecting transformer at Dobson [West Coast 110 kV Transmission Security] Will be operational following the commissioning of the new DOB-RFN 110 kV circuit	West Coast	July 2010
<i>New Dobson-Reefton 110 kV circuit</i>	Extended the 110 kV IGH-RFN 2 circuit to new Dobson interconnecting transformer	West Coast	Nov 2011

Committed upgrades in the region

1.2 SPECIAL PROTECTION SCHEME

The Special Protection Schemes also known as operational intertipping schemes in this region available to the system operator are listed in the table below.

Special Protection Scheme	Purpose	Armed
<i>Atarau Intertrip</i>	The existing transmission asset on the West Coast cannot support any additional load while maintaining n-1 security. Any additional load growth is therefore on "N" security and will be automatically tripped in the event of a circuit outage.	Normally enabled. When the second 110 kV circuit from IGH to DOB is commissioned, the ATU 432 intertrip will be normally out of service and enabled only during outages of the second 110 kV DOB circuit
<i>Coleridge Intertrip</i>	Used during single COL_HOR circuit outages	Enabled during the outage of COL_HOR circuit
<i>Hororata AUVLS</i>	Maintain steady state N-1 voltage stability	Normally enabled

1.3 DEMAND AND GENERATION WITHIN THE LIMIT GROUP

The West Coast region has around 55 MW of generation capacity both embedded and grid connected. The summer peak in West Coast is higher than the winter peak, and the EC prudent load values indicate a 2011 summer peak load of 52 MW, and it is forecast to increase to 63 MW in 2013. The actual peak demand in the region occurs in spring instead of summer and this is reflected in the study by scaling the EC prudent summer load values by an additional 5%. There is no projected increase in regional generation capacity. The regional load demand will be met by importing power from the grid via Dobson and Hororata interconnections.

A power factor scatter graph for the region is shown in *Figure 1* and *Figure 2*.

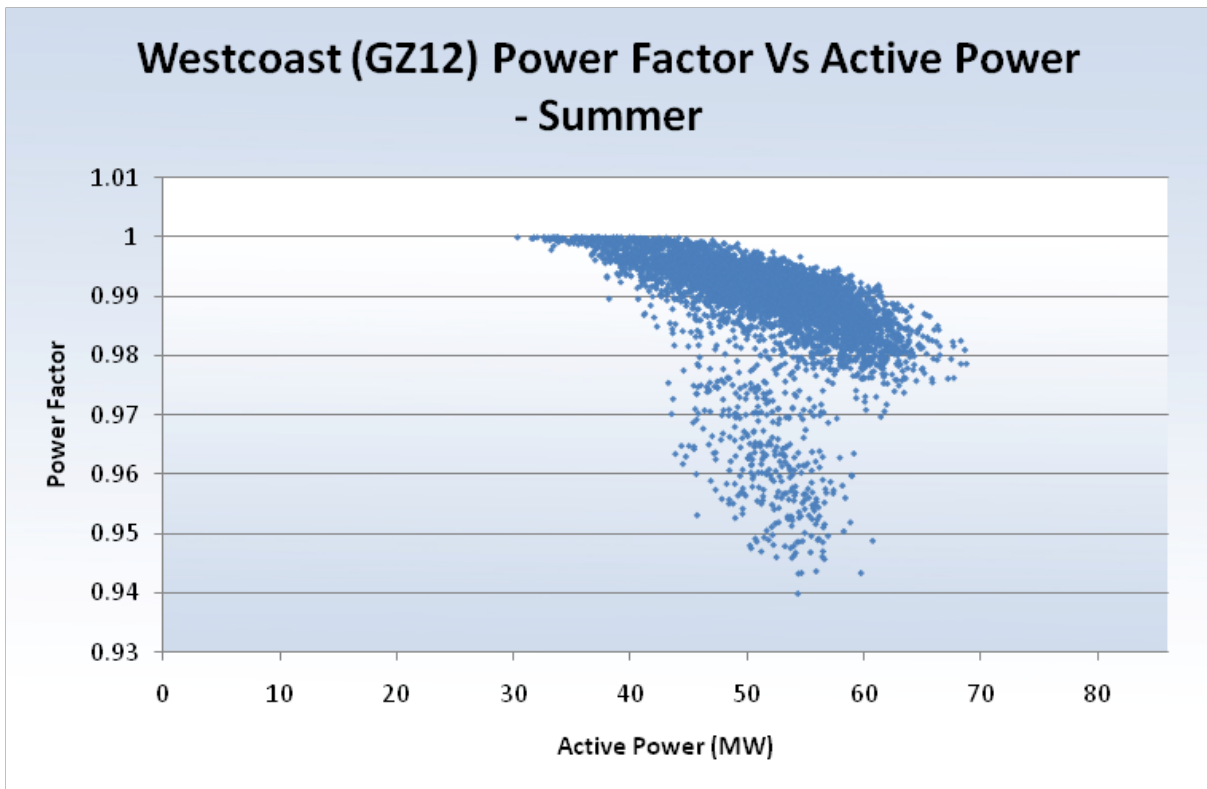


Figure 1: West coast regional power factor (Summer)

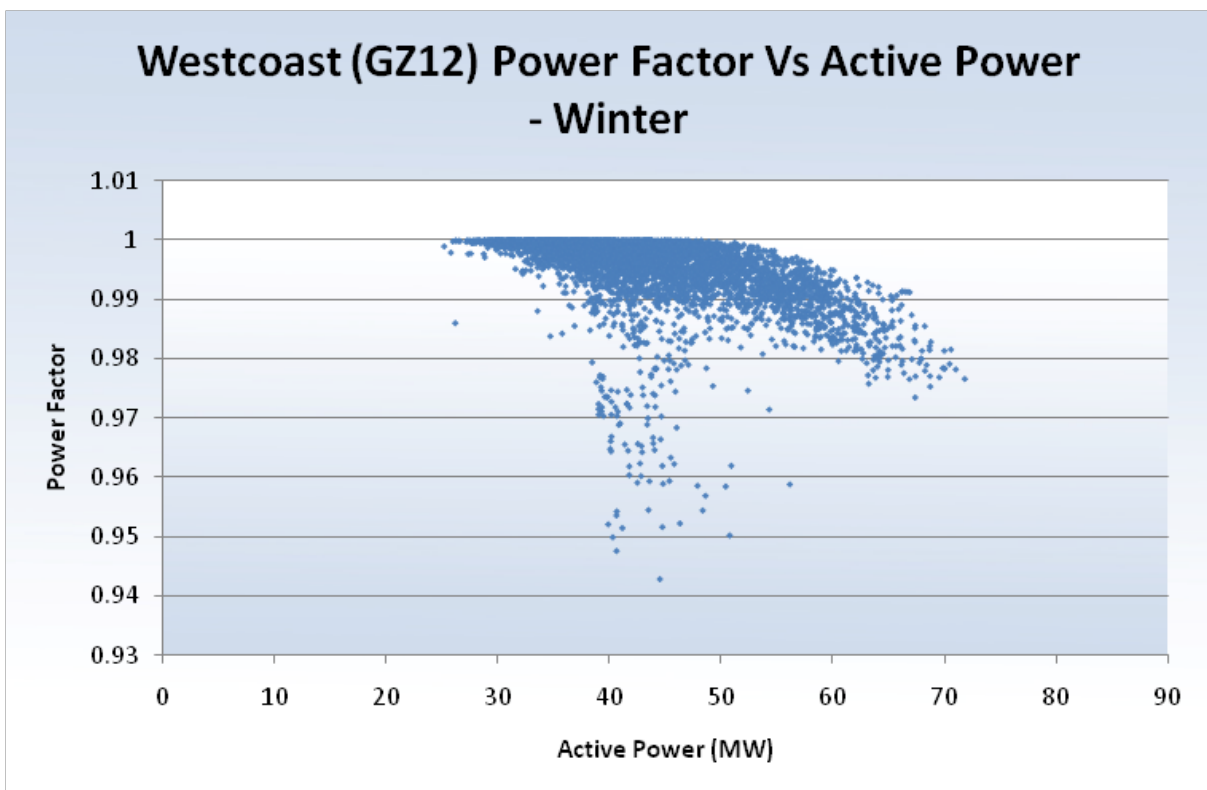


Figure 2: West coast regional power factor (winter)

For the purpose of these studies the minimum power factor has been assumed. For summer and winter peak the power factors are both 0.94.



1.4 KEY ASSETS

1.4.1 CRITICAL CONTINGENCIES

Contingency	Power System Issue	Management Measures	Analysis
<i>Loss of a 220kV circuit between Twizel and Islington</i>	Voltage instability	Refer to "Top of South Island" region for details	n/a
<i>Loss of the Dobson-Reefton-Inangahua-1 110 kV circuit</i>	n/a	n/a	n/a
<i>Loss of a Hororata-Islington 66 kV circuit</i>	n/a	n/a	n/a

1.4.2 CRITICAL OUTAGES

Outage	Contingency	Power System Issue	Management Measures	Risk Assessment
<i>Dobson-Reefton-Inangahua-1 110 kV circuit</i>	Loss of the Dobson-Greymouth or Greymouth-Kumara 66 kV circuit	Loss of supply at Dobson or Dobson and Greymouth	Special Protection Scheme at Atarau	Limit of 26 MW West Coast load (excluding Hororata and Atarau) pre-contingency
<i>Dobson-Reefton-Inangahua-1 110 kV circuit</i>	Loss of the Hokitika-Otira-2	Kumara-Otira-1 66 kV may exceed stated capability limit	Load Management Short term rating Dispatch local generation	
<i>Dobson-Reefton-Inangahua-1 110 kV circuit</i>	Loss of the Coleridge-Otira-2 or the parallel Castle Hill, Arthur's Pass and Otira circuit	Remaining Coleridge-Otira 66 kV circuit may exceed stated capability limit	Load Management Security constraint	
<i>Dobson-Reefton-Inangahua-2 110 kV circuit (post grid upgrade 2012)</i>	Loss of the Dobson-Greymouth 66 kV circuit	Voltage at Atarau may falls below stated capability limit	Atarau intertrip scheme	
<i>Dobson-Reefton-Inangahua-2 110 kV circuit (post grid upgrade 2012)</i>	Loss of any one circuit between Kumara, Hokitika, Otira and Coleridge	The line parallel to the contingent circuit or the remaining circuit may reach stated capability limit (90%)	Security constraints	
<i>Islington-Hororata-1 or 2 66 kV circuit (insufficient generation at Coleridge)</i>	Loss of the other parallel Islington-Hororata 66 kV circuit	Voltage at Hororata may falls below stated capability limit	Hororata AUVLS scheme Local generation	
<i>Coleridge-Hororata-2 66 kV circuit</i>	Loss of the parallel Coleridge-Hororata-3 66 kV circuit	Transient stability in the West Coast region	Special protection Scheme offer in the region	Constraint Coleridge generation to 15 MW
<i>Coleridge-Otira-2 66 kV</i>	Loss of the parallel Coleridge-Castle Hill-Arthur's Pass-Otira	Loss of supply at Castle Hill, Arthurs pass Dobson-Greymouth circuit may reach stated capability limit (93%)	n/a	

Outage	Contingency	Power System Issue	Management Measures	Risk Assessment
<i>Dobson-Greymouth or Greymouth-Kumara-1 66 kV circuit</i>	Loss of the other circuit	Loss supply Greymouth	n/a	
<i>Hokitika-Kumara-1 66 kV or Hokitika-Otira-1 66 kV</i>	Loss of the remaining circuit	Loss of supply at Hokitika	n/a	

1.5 KEY POWER SYSTEM CAPABILITY LIMITS ON LIMIT GROUP

1.5.1 REGIONAL POWER SYSTEM ISSUES .

Power system capability limits that apply to the region 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.

Contingency	Limit Group	2011 spring/winter	2012 spring/winter	2013 spring/winter	Detailed Analysis Section
<i>Loss of the Dobson-Reefton-Inangahua-1 110 kV circuit</i>	West Coast Load	n/a	n/a	n/a	2.1.1
<i>Loss of Hororata-Islington 66 kV circuit</i>	West Coast Load	n/a	n/a	n/a	2.3.1

Outage	Contingency	Limit Group	2011 spring/winter	2012 spring/winter	2013 spring/winter	Detailed Analysis Section
<i>Dobson-Reefton-Inangahua-1 110 kV circuit</i>	Loss of Hokitika-Otira-2 66 kV circuit	West Coast Load	26MW at pf 0.94 (exclude Hororata and Atarau)	n/a	n/a	2.2.1
<i>Dobson-Reefton-Inangahua-1 110 kV circuit</i>	Loss of any other circuit	West Coast Load	n/a	n/a	n/a	2.2.2
<i>Hororata-Islington-1 66 kV</i>	Parallel Hororata-Islington 66 kV circuit	West Coast Load	n/a	n/a	n/a	2.2.3
<i>Coleridge-Hororata-2 66 kV circuit</i>	Loss of the parallel Coleridge-Hororata-3 66 kV circuit	West Coast Load	n/a	n/a	n/a	2.2.4
<i>Coleridge-Otira-2 66 kV</i>	Loss of the parallel Coleridge-Castle Hill-Arthur's Pass-Otira	West Coast Load	n/a	n/a	n/a	2.2.5

1.6 ASSUMPTIONS ON THE POWER SYSTEM

Kumara generation is modelled as the net resultant of generation and load in the area. The total surplus generation is 6 MW. This was determined from 2009 recorded SCADA output.



Arnold generation is assumed to be out of service in all cases.

The Atarau intertrip scheme trips the 110 kV feeders in the event of a tripping of ATU 442 and the ATU voltage is below 102.3 kV. The intertrip is normally enabled. When the second 110 kV circuit from IGH to DOB is commissioned, the ATU intertrip will be normally out of service and enabled only during outages of the second 110 kV DOB circuit.

The Coleridge intertrip scheme installed on COL 252 and 332 are used during a planned or unplanned outage on one COL-HOR circuit but conditional on the West Coast being in normal configuration. If both COL-HOR circuits are out of service, limit on COL generations are applied to 15 MW max and remove ATU-RFN-IGN 1 auto reclose. The loading restriction is required to prevent a dynamic voltage instability condition arising on the west coast.

During the times of high load and low COL generation, there is a risk of voltage at the HOR 66 kV falling below 59.4 kV/0.9pu in the event of a HOR-ISL circuit tripping. During such an event the Automatic Under Voltage Load Shedding (AUVLS) scheme will operate at 59.41 kV to shed loads at HOR.

1.7 LOSS OF SUPPLY DURING OUTAGES

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

Grid Exit Point	Outage	Contingent Event
<i>Dobson</i>	Dobson-Reefton-Inangahua-1 110 kV (pre grid upgrade)	Loss of Dobson-Greymouth 66 kV
<i>Greymouth</i>	Dobson-Reefton-Inangahua-1 110 kV (pre grid upgrade) Greymouth-Kumara-1 66 kV	Loss of Greymouth-Kumara 66 kV Dobson-Greymouth-1 66 kV
<i>Hokitika</i>	Hokitika-Otira-1 66 kV	Hokitika-Kumara-1 66 kV
<i>Castle Hill, Arthurs Pass</i>	Colridge-Otira-2 66 kV	Coleridge-Castle Hill-1, Castle Hill-Arthurs Pass-1, Arthurs Pass - Otira-1 66 kV

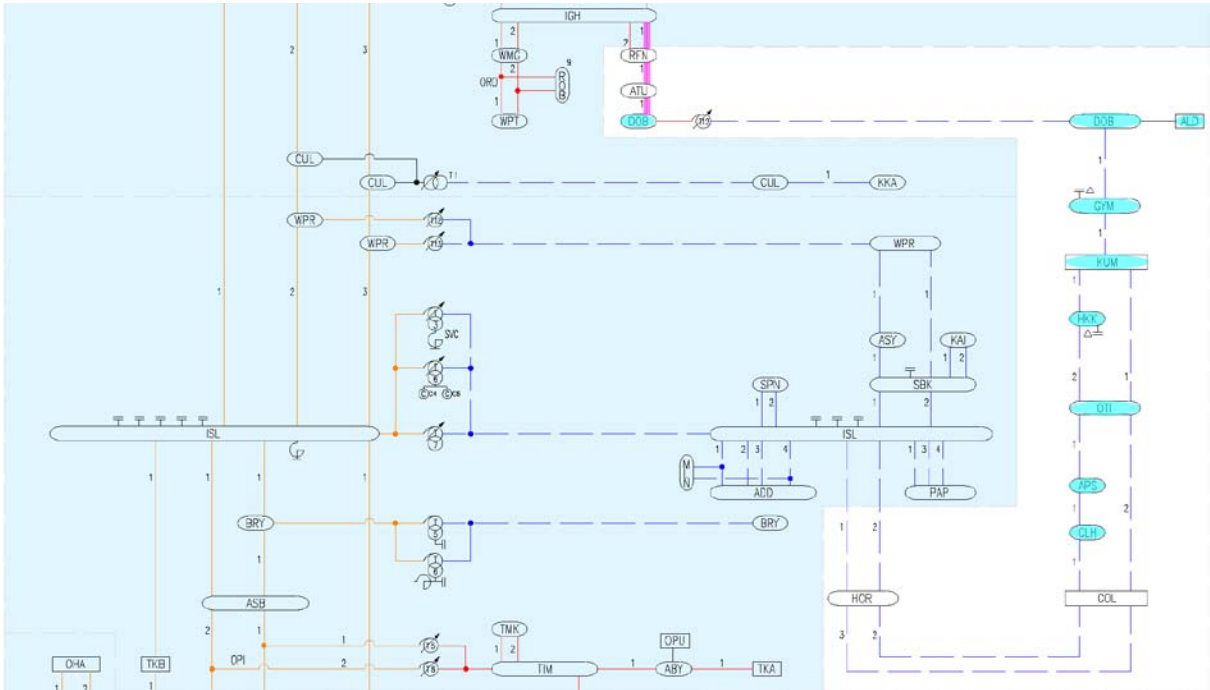


2. POWER SYSTEM LIMIT ANALYSIS

2.1 REGIONAL ISSUES DURING NORMAL OPERATION

2.1.1 LOSS OF THE DOBSON-REEFTON-INANGAHUA-1 110 kV CIRCUIT

Grid Exit Point	Power System Issue	Causing Factor	Indicative Limit	Operational Measures	Back to Limit Group
West Coast	Voltage falls below advised asset capability	Loss of the Dobson-Reefton-Inangahua-1 110 kV circuit	n/a	n/a	1.5.1



Dobson and the surrounding area are connected to the rest of the power system via 110 kV transmission circuits to Inangahua in the north and via 66 kV transmission circuits to Coleridge in the south.

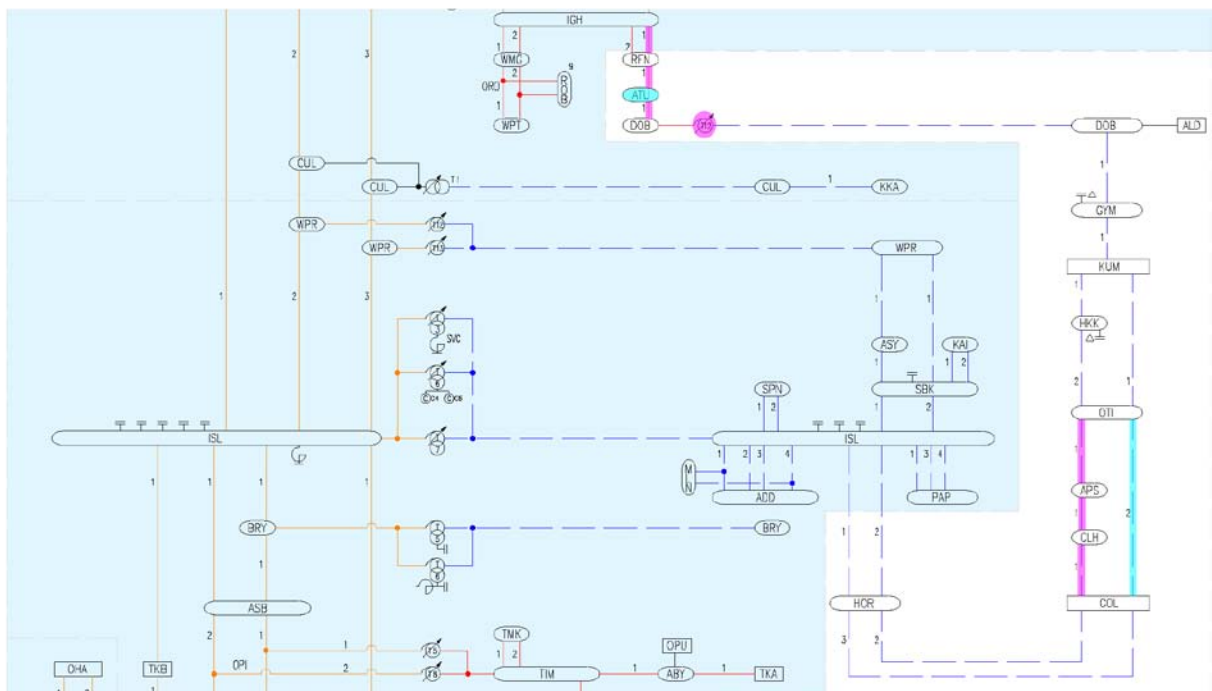
The additional 14 Mvar capacitor bank at Hokitika, commissioned early 2010 has improved the power system capability limit at the region and therefore removes the issue of low voltage at Hokitika and the surrounding area following the loss of the Dobson-Reefton-Inangahua-1 110 kV circuit.

The completion of West Coast Grid Upgrade project in Nov 2011 will improve the transfer capability of the region via the north infeed and further enhance the security and quality of supply to the region.

2.2 REGIONAL ISSUES DURING OUTAGES

2.2.1 OUTAGE OF THE DOBSON-REEFTON-INANGAHUA-1 110 kV CIRCUIT OR DOBSON T12 110/66 kV TRANSFORMER AND LOSS OF ANOTHER CIRCUIT

Grid Exit Point	Power System Issue	Causing Factor	Indicative Limit	Operational Measures	Back to Limit Group
<i>West Coast load (excluding Hororata)</i>	<p>Voltage falls below advised asset capability at Atarau</p> <p>Coleridge-Otira 66 kV may exceed stated capability limit</p> <p>Loss of supply</p>	<p>Outage of the Dobson-Reefton-Inangahua-1 110 kV circuit or Dobson T12 110/66 kV transformer and loss of another circuit</p>	<p>Limit of 26 MW West Coast load (excluding Hororata and Atarau)</p> <p>post grid upgrade</p> <p>n/a</p>	<p>Load Management</p> <p>Local generation</p> <p>Special Protection Scheme at Atarau</p>	1.5.1



Before the implementation of the West Coast Grid Upgrade project in Nov 2011, the West Coast region is supplied via a single circuit from Dobson from the north and through two circuits through Hororata-Islington 66 kV from the south. The outage of the single 110 kV circuit infeed from the north has significant impact on the security and quality of supply to the West Coast region.

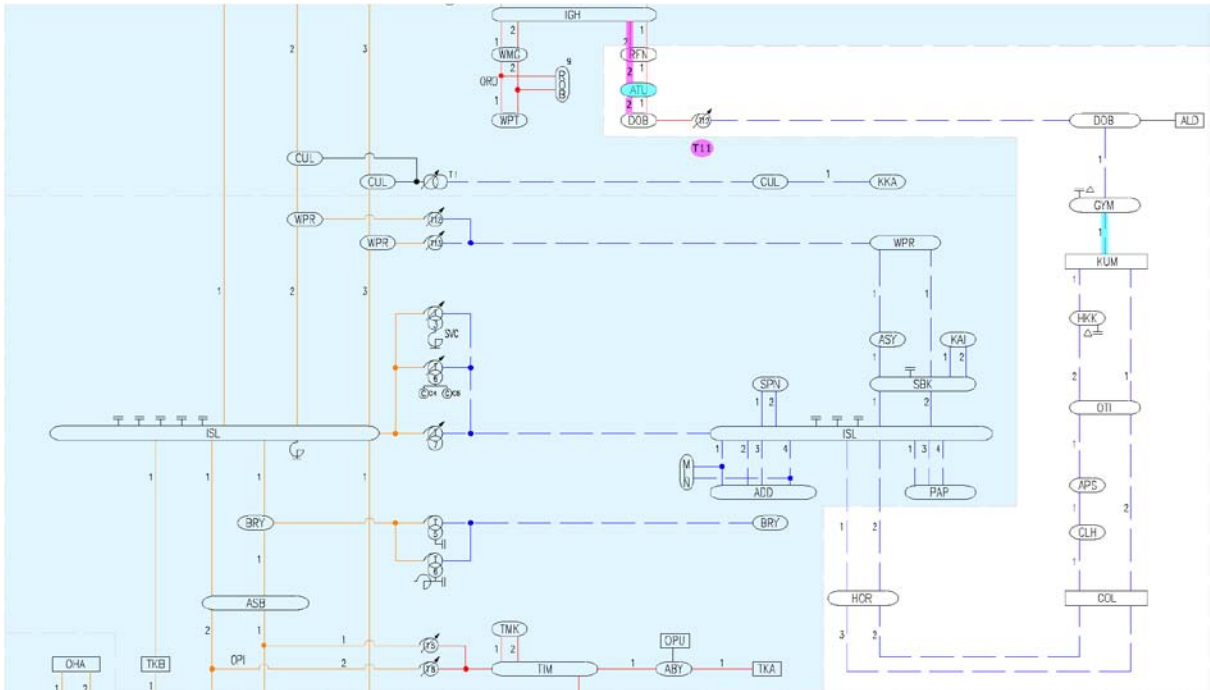
The loss of either Hokitika-Otira 66 kV circuit, Coleridge-Otira 2 or the parallel Castle Hill-Coleridge 1, Arthur's Pass and Otira 66 kV circuit will lead to circuits exceeding stated capability. With maximum local generation dispatched, a power system capability limit of approximately 26 MW is required for the West Coast load (excluding Hororata and Atarau) to ensure that this doesn't take place.

With the outage of Dobson-Reefton-Iganhahua-1 110 kV circuit, the loss of any circuits between Kumara, Greymouth and Dobson will result in the loss of supply to Dobson and/or Greymouth loads.

The implementation of the second circuit from Inangahua-Reefton-Dobson and Dobson T11 110/66 kV transformer as part of the West Coast Grid Upgrade project in Nov 2011 will remove this issue.

2.2.2 OUTAGE OF THE DOBSON-REEFTON-INANGAHUA-2 110 kV CIRCUIT OR DOBSON T11 110/66 kV TRANSFORMER AND LOSS OF ANOTHER CIRCUIT (POST GRID UPGRADE)

Grid Exit Point	Power System Issue	Causing Factor	Indicative Limit	Operational Measures	Back to Limit Group
West Coast load (excluding Hororata)	Voltage falls below advised asset capability at Atarau	Outage of the Dobson-Reefton-Inangahua-2 110 kV circuit or Dobson T11 110/66 kV transformer and loss of another circuit	n/a	Special Protection Scheme at Atarau	1.5.1



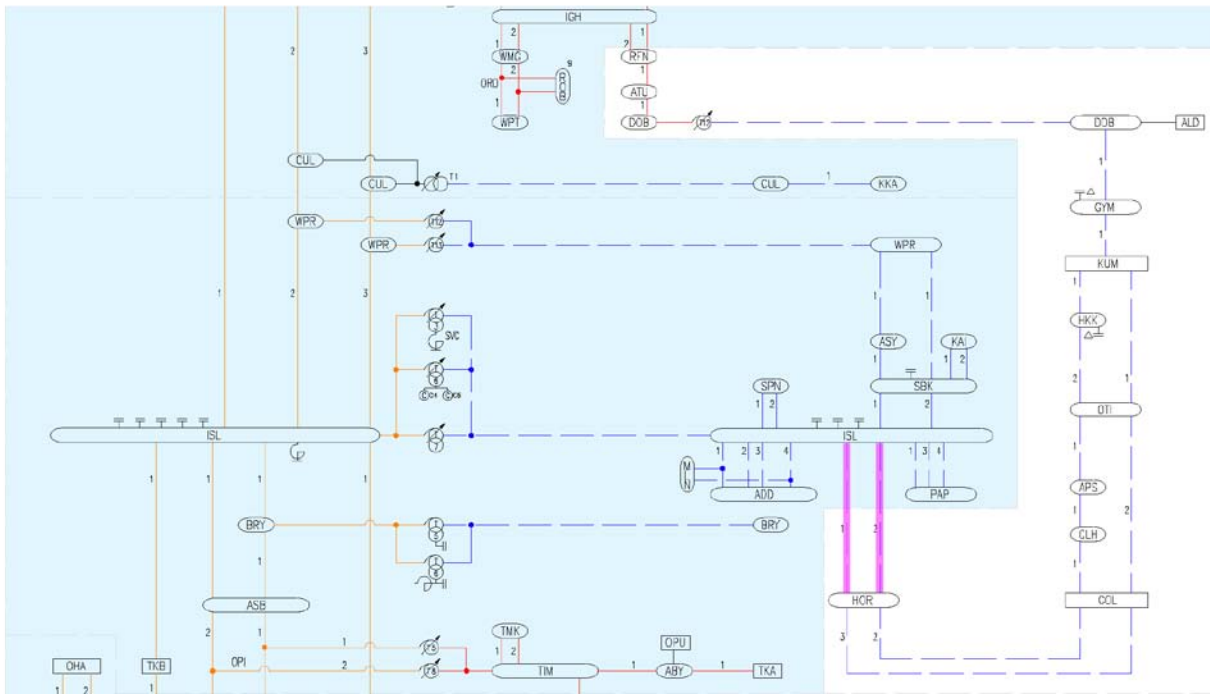
After the implementation of the West Coast Grid Upgrade project in Nov 2011, the second Dobson-Reefton-Inangahua-2 110 kV circuit and the Dobson T11 110/66 kV transformer will provide n-1 to the West Coast region.

During an outage of the Dobson-Reefton-Inangahua-2 or the Dobson T11 110/66 kV transformer and the loss of any circuit between Dobson and Kumara may cause the voltage at Atarau falls below the stated capability limit.

In such an event the Atarau special protection scheme will operate and trip the loads at Atarau in order to ensure the security and quality supply to the West Coast region.

2.2.3 OUTAGE OF A HORORATA-ISLINGTON 66 kV CIRCUIT AND LOSS OF THE OTHER CIRCUIT

Grid Exit Point	Power System Issue	Causing Factor	Indicative Limit	Operational Measures	Back to Limit Group
West Coast	n/a	Outage of a Hororata - Islington 66 kV circuit and loss of the other circuit	n/a	n/a	1.5.1



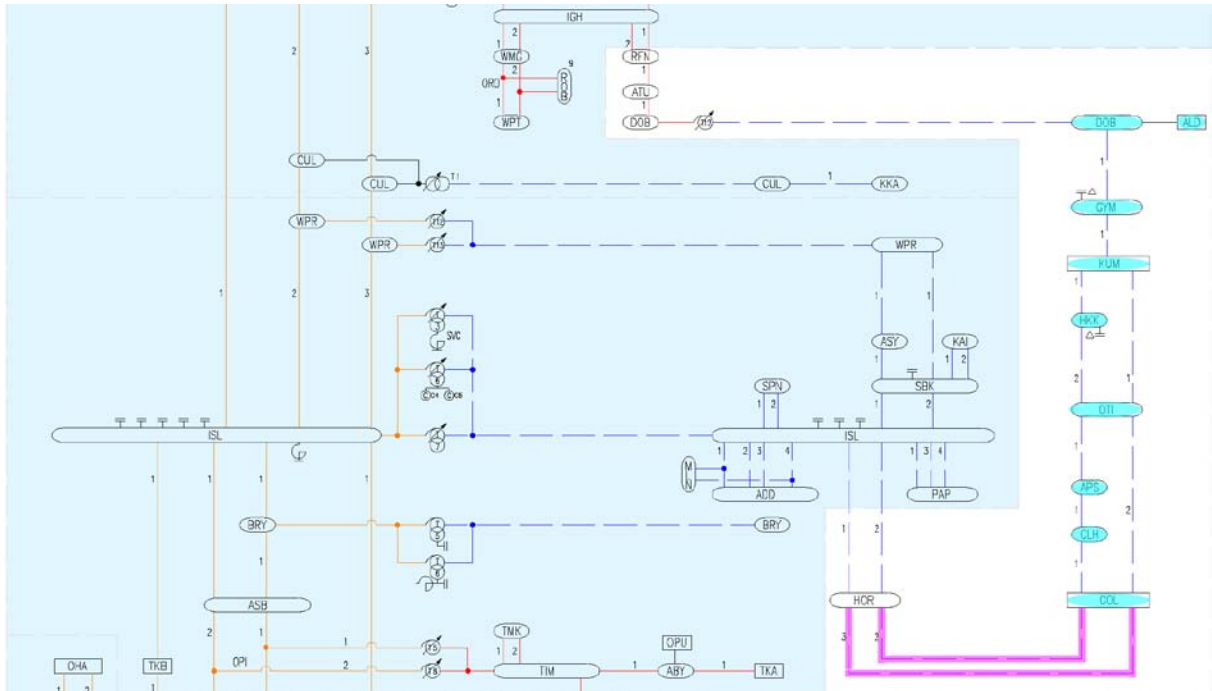
An outage of Hororata-Islington-1 or 2 66 kV circuit and the loss of the other circuit resulted in West Coast region relying on north infeed via a single 75 MVA 110/66 kV transformer at Dobson to supply the entire regional load (pre grid upgrade scenario).

The completion of the 14 Mvar capacitor bank at Hokitika removes low voltage issues in the region and the implementation of the West Coast Grid Upgrade project in 2012 improves the ability to supply West Coast load demand via north infeed through two circuits.

However it is important to note, the outage of one Hororata-Islington 66 kV circuit with the loss of the parallel Hororata-Islington 66 kV circuit during a low Coleridge generation scenario may cause power system issues in the region. This may require a grid reconfiguration to manage the issue.

2.2.4 OUTAGE OF A COLERIDGE-HORORATA 66 kV CIRCUIT AND LOSS OF THE OTHER CIRCUIT

Grid Exit Point	Power System Issue	Causing Factor	Indicative Limit	Operational Measures	Back to Limit Group
West Coast (excluding Hororata)	Transient stability in the West Coast region	Outage of a Coleridge-Hororata 66 kV circuit and loss of the other circuit	n/a	Special Protection Scheme Load management	1.5.1





An outage of a Coleridge-Hororata 66 kV circuit and the loss of the remaining Coleridge-Hororata circuit may cause transient stability problems in the West Coast region.

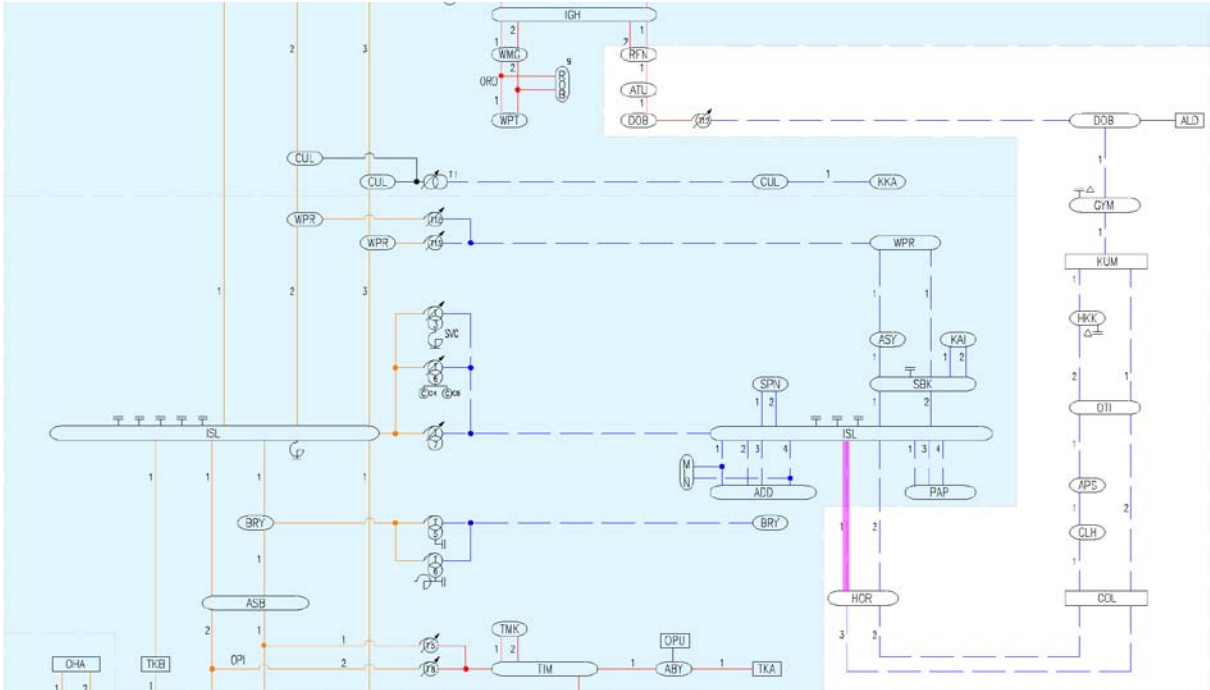
To manage this power system issue, a special protection scheme is offered to trip all but one of the large units at Coleridge (Constraint Coleridge generation at maximum of 15 MW). This level of generation requires power system capability limits on the West Coast load (excluding Hororata) to avoid voltage at Hokitika to fall below the advised capability limit.

Operational measures to manage the power system issue are the use of available local generation and load management. With the implementation of West Coast Grid Upgrade Project, the link to the Grid System from the north is enhanced. Transient stability issue will be reviewed as a separate study.

2.3 LOCAL ISSUES DURING NORMAL OPERATION

2.3.1 LOSS OF A HORORATA-ISLINGTON 66 kV CIRCUIT

Grid Exit Point	Power System Issue	Causing Factor	Indicative Limit	Operational Measures	Back to Limit Group
Hororata			n/a		1.5.1



The installation of 14 Mvar capacitor bank at Hokitika has removed the low voltage and asset reaching stated capability limit issue following the loss of a Hororata-Islington 66 kV circuit.

2.4 LOCAL ISSUES DURING OUTAGES

They are no local issues.