POWER SYSTEM INCIDENT REPORT: TROPICAL CYCLONE YASI – 02 AND 03 FEBRUARY 2011

PREPARED BY: Electricity System Operations Planning and Performance

FINAL

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1 Introduction

Between 0000 hrs and 0100 hrs on Thursday 3 February 2011 category 5 Tropical Cyclone (TC) Yasi crossed the north Queensland coast. Twelve 132 kV transmission lines tripped out of service resulting in the disconnection of the Tully, Cardwell, Ingham South and El Arish 132kV substations from the power system.

Restoration of the high voltage transmission network began at 1049 hrs on 3 February 2011 and was completed on 11 February 2011.

The power system remained in a secure operating state for the duration of the incident.

All references to time in this report refer to market time (Australian Eastern Standard Time).

Powerlink has provided relevant information to AEMO for this power system incident investigation. Data from AEMO's energy management and market systems has also been used in investigating the incident.

2 Pre-Contingent System Conditions

On 2 February 2011 TC Yasi, a category 5 severe tropical cyclone, was approaching the north Queensland Coast. The Bureau of Meteorology had forecast that the cyclone would cross the north Queensland coast in the Innisfail area south of Cairns at approximately 0000 hrs on 3 February 2011.

On 2 February 2011, to protect equipment from a possible cyclone-generated tidal surge, Powerlink took the following precautionary measures:

- At 0846 hrs the H39 Woree 132 kV static VAr compensator (SVC) was taken out of service and electrical components removed
- At 1158 hrs the T94 Townsville East 132 kV substation was taken out of service

There was no loss of supply as a result of these actions.

On 2 February 2011 the following power stations were progressively shut down, also as precautionary measures, prior to the arrival of TC Yasi:

- Mount Stuart Power Station (by 1045 hrs; 400 MW unavailable)
- Yabulu Power Station (by 1100 hrs; 164 MW unavailable)
- Kareeya Power Station (by 2010 hrs; 88 MW unavailable)
  Barron Gorge Power Station (by 2015 hrs; 63 MW unavailable)

No reserve deficits resulted due to the unavailability of these power stations.

At 1210 hrs on 2 February 2011 AEMO issued Electricity Market Notice No.34324 informing the market that it was monitoring the progress of the cyclone and would use the contingency reclassification process[1] as appropriate to maintain power system security.

[1] Power System Operating Procedure SO_OP 3715 "Power System Security Guidelines", on the AEMO website: www.aemo.com.au/electricityops/so_op3715v027.pdf

The status of the north Queensland power system immediately prior to the TC Yasi crossing the coast is shown in Figure 1.

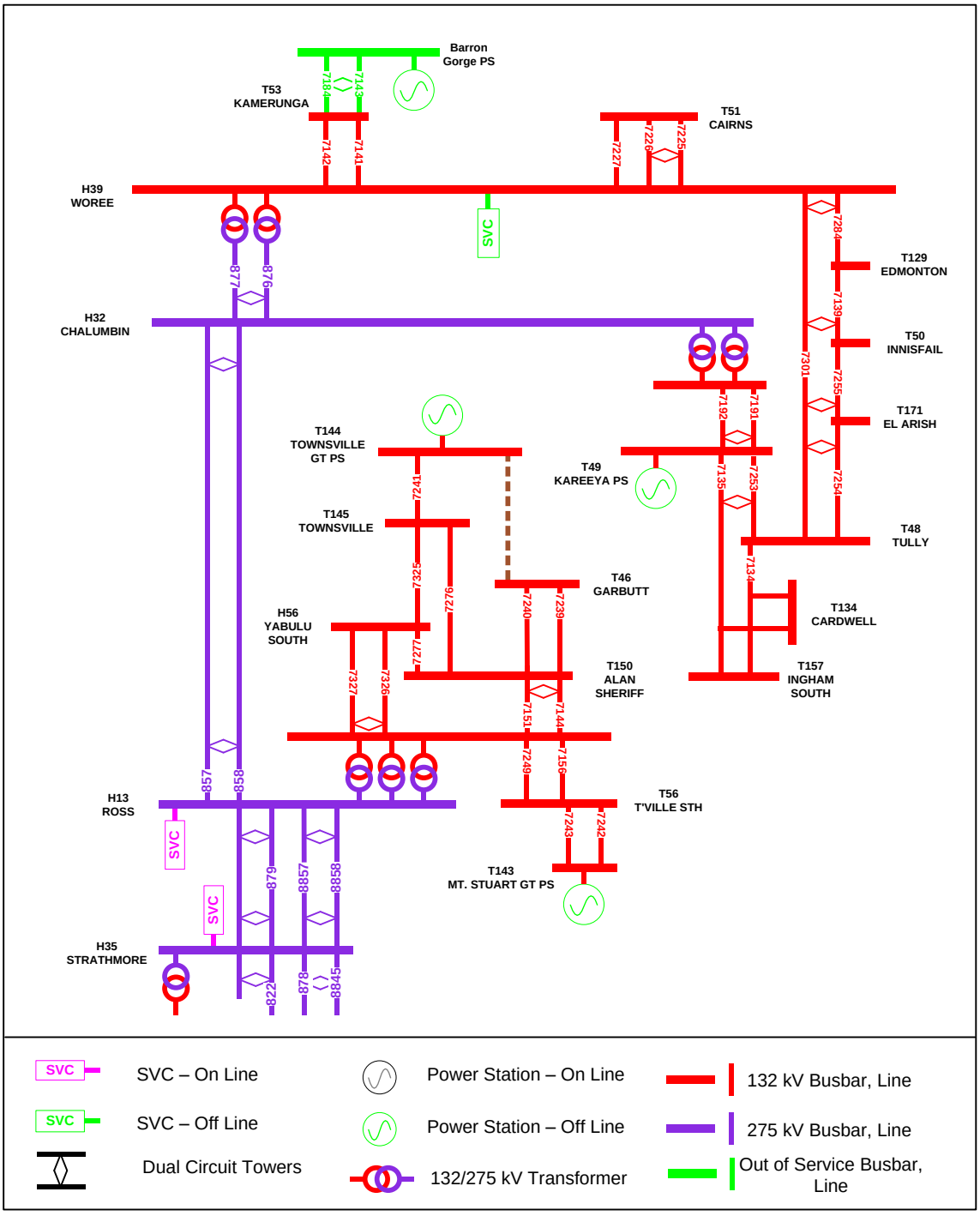

Figure 1 - North Queensland high voltage transmission network prior to the arrival of TC Yasi

3 Summary of Events

TC Yasi crossed the north Queensland coast near Mission Beach between 0000 hrs and 0100 hrs on 3 February 2011. Wind speeds of up to 285 kph were predicted close to the eye of the cyclone. TC Yasi maintained a strong core with damaging winds and heavy rain, tracking westwards across northern Queensland and finally weakened to a tropical low near Mount Isa around 2000 hrs on 3 February 2011[2].

As a result of damage wrought by the cyclone twelve 132 kV transmission lines tripped out of service, and four bulk supply 132 kV substations and one power station were automatically disconnected from the power system. The sequence of events on the transmission network associated with crossing of TC Yasi can be seen in Table 1 of Appendix A.

The following 132 kV transmission lines were disconnected from the power system due to damage caused by TC Yasi:

- No.7135 Kareeya – Ingham South Tee Cardwell 132 kV line (two transmission lines)
- No.7143 Barron Gorge – Kamerunga 132 kV line
- No.7184 Barron Gorge – Kamerunga 132 kV line
- No.7134 Tully – Ingham South Tee Cardwell 132 kV line (two transmission lines)
- No.7254 Tully – El Arish 132 kV line
- No.7255 Innisfail – El Arish 132 kV line
- No.7301 Woree – Tully 132 kV line
- No.7253 Kareeya – Tully 132 kV line
- No.7191 Kareeya – Chalumbin 132 kV line
- No.7156 Ross – Townsville South 132 kV line

The No.857 Ross – Chalumbin 275 kV line tripped and auto-reclosed at 1839 hrs on 2 February 2011, again at 2314 hrs that day (single-pole only), and at 0103 hrs on 3 February 2011 the line tripped auto-reclosed, tripped and locked-out. At 0112 hrs Powerlink placed the line in service and it remained in service for the remainder of the incident. There were no load interruptions as a result of these events.

The following bulk supply 132 kV substations were disconnected from the power system:

- T48 Tully 132 kV substation
- T134 Cardwell 132 kV substation
- T157 Ingham South 132 kV substation
- T171 El Arish 132 kV substation

The Barron George Power Station was also disconnected due to the loss of the Nos 7143 and 7184 Barron Gorge – Kamerunga 132 kV lines.

At 2137 hrs on 2 February 2011 the No.876 Woree – Chalumbin 275 kV line was taken out of service and at 2320 hrs the No.8858 Strathmore – Ross 275 kV line was also taken out of service, both for voltage management reasons caused by reduced demand in north Queensland..

[2] From the Australian Government Bureau of Meteorology website:
http://www.bom.gov.au/cyclone/history/yasi.shtml

The status of the north Queensland power system immediately after TC Yasi crossed the coast is shown in Figure 2.

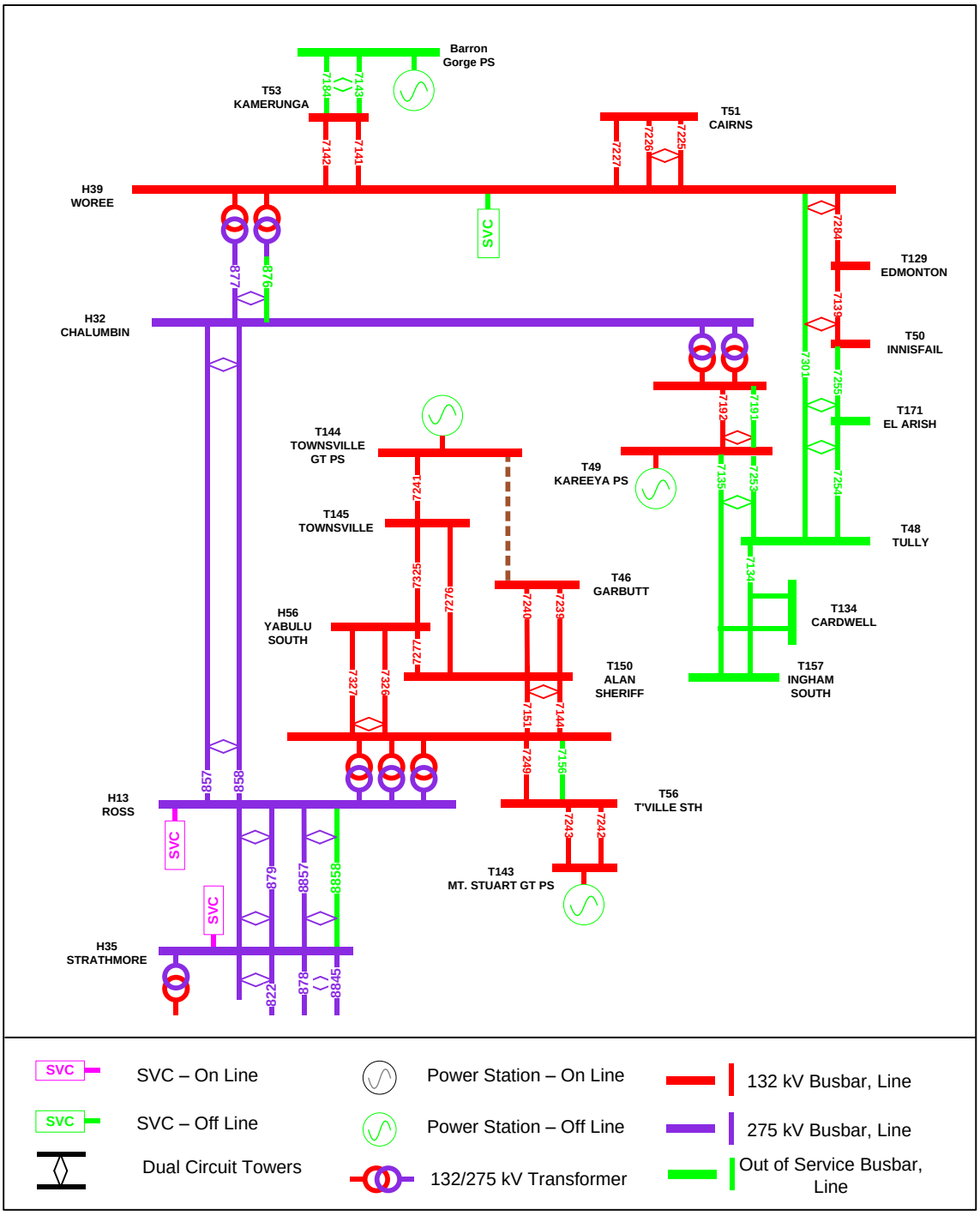

Figure 2 - North Queensland high voltage transmission network after the arrival of TC Yasi

4 Power System Security Assessment

During the incident the 275 kV transmission network in north Queensland experienced higher than normal voltage levels. The high voltage was caused by the reduced demand in north Queensland, through customers switching off loads, load being interrupted due to damage to the distribution network, and the deactivation of the Woree 132 kV SVC. In order to ensure that the voltage on the

275 kV lines in north Queensland remained at satisfactory levels the No.876 Woree – Chalumbin 275 kV line and the No.8858 Strathmore – Ross 275 kV lines were taken out of service[3].

The No.857 Ross – Chalumbin 275 kV line tripped and auto-reclosed at 1839 hrs on 2 February 2011, again at 2314 hrs that day (single-pole only), and at 0103 hrs on 3 February 2011 the line tripped auto-reclosed, tripped and locked-out. After investigation and analysis, Powerlink have concluded that the line trips were due to wind-borne debris blown onto the lines by the cyclone. The lock-out of No.857 line was caused by debris not being cleared from the line by the time that the auto-reclose occurred after the initiating trip (1 second after the trip). Powerlink were successfully able to manually reclose the line at 0112 hrs on 3 February 2011.

The reduction of load in north Queensland while TC Yasi was active is illustrated in Figure 3. As shownFigure 3, the majority of load was reduced prior to the cyclone crossing the north Queensland coast, due to interruptions caused by damage to the distribution network as the cyclone approached the coast and due to customers pre-emptively reducing demand, closing businesses and evacuating residences.

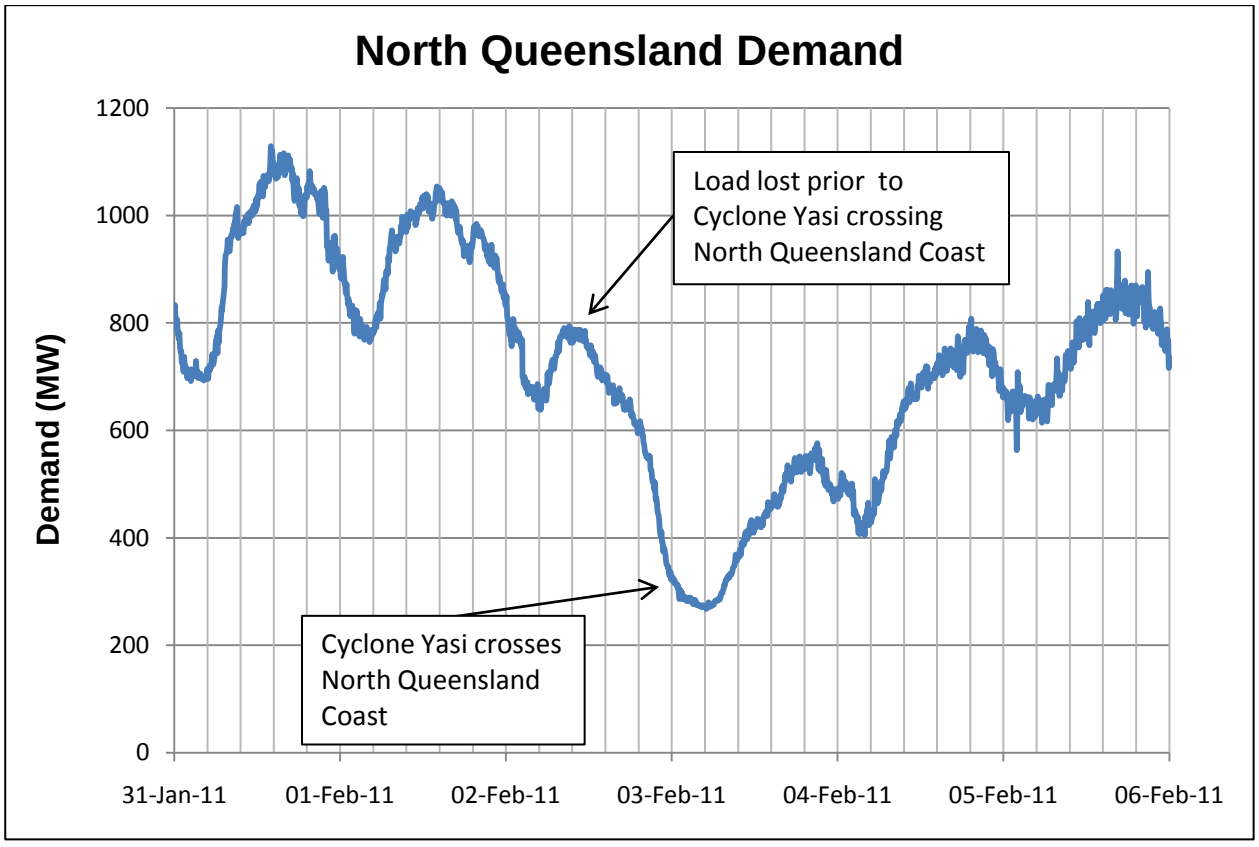

Figure 3 – North Queensland power system demand prior, during and after the crossing of TC Yasi

At 0129 hrs on 3 February 2011, as TC Yasi continued westward, AEMO reclassified the simultaneous loss of the Nos 857 and 858 Chalumbin – Ross 275 kV lines as a credible contingency event. Earlier, at 0120 hrs, AEMO issued Electricity Market Notice No.34342 informing the market of the reclassification. At 0117 hrs AEMO invoked constraint set Q-FNQ_120 to

[3] Due to their capacitive nature lightly loaded transmission lines cause increased voltage levels. By taking lines out of service the capacitive load in the area is reduced.

manage power system security over the period from 0120 hrs to 0500 hrs. The constraint equation within that constraint set did not bind in Dispatch and so did not affect market outcomes over the period concerned.

At 0500 hrs on 3 February 2011, AEMO determined that the simultaneous loss of Nos 857 and 858 Chalumbin – Ross 275 kV lines was no longer a credible contingency event. At 0501 hrs AEMO issued Electricity Market Notice No.34343 informing the market that the previous reclassification was no longer necessary.

Throughout the incident there was adequate operational coordination between AEMO and Powerlink.

The power system remained in a secure operating state for the duration of the incident.

5 Follow-up Actions

At 0514 hrs on 3 February 2011 AEMO issued Electricity Market Notice No.34345 informing the market that TC Yasi was no longer a threat to the north Queensland transmission network.

Restoration of the transmission network began on 3 February 2011 and was completed on 11 February 2011. The sequence of power system restorations is shown in Table 2 of Appendix A.

6 Conclusions

TC Yasi caused extensive damage to the north Queensland 132 kV transmission and distribution networks. Supply was lost to the Tully, Cardwell, Ingham South and El Arish 132 kV substations. However the 275 kV transmission network was left intact and the power system remained in a secure operating state.

Restoration of the 132 kV transmission network was completed by 11 February 2011.

7 Recommendations

There are no recommendations arising from this incident.

Appendix A – Sequence of Transmission Events

Table 1 - Sequence of events on the transmission network associated with the crossing of TC Yasi

Date	Time	Event	Comment
02/02/2011	08:46:49	H39 Woree 132 kV SVC switched out of service	SVC taken out of service due to threat of storm surge
02/02/2011	11:58:47	T94 Townsville East 132 kV substation switched out of service	Substation taken out of service due to threat of storm surge
02/02/2011	18:39:38	857 Ross – Chalumbin 275 kV line protection trip (single pole)	
02/02/2011	18:39:39	857 Ross – Chalumbin 275 kV line auto-reclose	
02/02/2011	21:37:24	876 Woree – Chalumbin 275 kV line switched out of service	Removed from service to manage high system volts
02/02/2011	21:47:09	7135 Kareeya – Ingham South Tee Cardwell 132 kV line protection trip	
02/02/2011	21:47:19	7135 Kareeya – Ingham South Tee Cardwell 132 kV line auto-reclose	
02/02/2011	21:47:19	7135 Kareeya – Ingham South tee Cardwell 132 kV line protection trip	Line out of service
02/02/2011	22:09:50	7143 Barron Gorge – Kamerunga 132 kV line Intertrip received from Barron George Power Station	No high voltage fault on feeder. Intertrip received from power station
02/02/2011	22:09:50	7184 Barron Gorge – Kamerunga 132 kV line Intertrip received from Barron George Power Station	No high voltage fault on feeder. Intertrip received from power station
02/02/2011	22:23:07	7135 Kareeya – Ingham South Tee Cardwell 132 kV line manual close	
02/02/2011	22:23:07	7135 Kareeya – Ingham South Tee Cardwell 132 kV line protection trip	
02/02/2011	23:14:49	857 Ross – Chalumbin 275 kV line protection	

Date	Time	Event	Comment
		trip (single pole)	
02/02/2011	23:14:50	857 Ross – Chalumbin 275 kV line auto-reclose	
02/02/2011	23:20:32	8858 Strathmore – Ross 275 kV line switched out of service	Removed from service to manage high system volts
02/02/2011	23:45:15	7134 Tully – Ingham South Tee Cardwell 132 kV line protection trip	
02/02/2011	23:45:20	7134 Tully – Ingham South Tee Cardwell 132 kV line auto-reclose	
02/02/2011	23:45:28	7134 Tully – Ingham South Tee Cardwell 132 kV line protection trip	Loss of 132 kV supply to Ingham South and Cardwell. Feeder out of service
02/02/2011	23:56:42	7254 Tully – El Arish 132 kV line protection trip	
02/02/2011	23:56:47	7254 Tully – El Arish 132 kV line auto-reclose	
03/02/2011	00:01:02	7255 Innisfail – El Arish 132 kV line protection trip	
03/02/2011	00:01:07	7255 Innisfail – El Arish 132 kV line auto-reclose	
03/02/2011	00:01:18	7254 Tully – El Arish 132 kV line protection trip	
03/02/2011	00:01:24	7254 Tully – El Arish 132 kV line auto-reclose	
03/02/2011	00:02:33	7301 Woree – Tully 132 kV line protection trip	
03/02/2011	00:02:43	7301 Woree – Tully 132 kV line auto-reclose	
03/02/2011	00:02:59	7301 Woree – Tully 132 kV line protection trip	Line out of service

Date	Time	Event	Comment
03/02/2011	00:03:04	7254 Tully – El Arish 132 kV line protection trip	
03/02/2011	00:03:09	7254 Tully – El Arish 132 kV line auto-reclose	
03/02/2011	00:03:26	7254 Tully – El Arish 132 kV line protection trip	Line out of service
03/02/2011	00:06:27	7253 Kareeya – Tully 132 kV line protection trip	Loss of 132 kV supply to Tully
03/02/2011	00:06:37	7253 Kareeya – Tully 132 kV line auto-reclose	Auto-reclose at Kareeya end only
03/02/2011	00:06:42	7255 Innisfail – El Arish 132 kV line protection trip	Loss of 132 kV supply to El Arish
03/02/2011	00:06:47	7255 Innisfail – El Arish 132 kV line auto-reclose	Auto-reclose at El Arish end only onto dead bus. Line out of service
03/02/2011	00:21:30	7253 Kareeya – Tully 132 kV line protection trip : Line out of service	
03/02/2011	00:59:26	7191 Kareeya – Chalumbin 132 kV line protection Trip	
03/02/2011	00:59:27	7191 Kareeya – Chalumbin 132 kV line auto-reclose	
03/02/2011	00:59:27	7191 Kareeya – Chalumbin 132 kV line protection trip	Line out of service
03/02/2011	01:03:35	857 Ross – Chalumbin 275 kV line protection trip	
03/02/2011	01:03:36	857 Ross – Chalumbin 275 kV line auto-reclose	
03/02/2011	01:03:37	857 Ross – Chalumbin 275 kV line protection trip	
03/02/2011	01:12:01	857 Ross – Chalumbin 275 kV line manual	

Date	Time	Event	Comment
		close	
03/02/2011	01:42:37	7156 Ross – Townsville South 132 kV line protection trip	
03/02/2011	01:42:47	7156 Ross – Townsville South 132 kV line auto-reclose	
03/02/2011	01:53:23	7156 Ross – Townsville South 132 kV line protection trip	
03/02/2011	01:53:33	7156 Ross – Townsville South 132 kV line auto-reclose	
03/02/2011	02:00:34	7156 Ross – Townsville South 132 kV line protection trip	
03/02/2011	02:00:45	7156 Ross – Townsville South 132 kV line auto-reclose	
03/02/2011	02:00:47	7156 Ross – Townsville South 132 kV line protection trip	
03/02/2011	02:22:06	7156 Ross – Townsville South 132 kV line manual close	
03/02/2011	02:54:02	7156 Ross – Townsville South 132 kV line protection trip	
03/02/2011	02:54:12	7156 Ross – Townsville South 132 kV line auto-reclose	
03/02/2011	02:54:15	7156 Ross – Townsville South 132 kV line protection trip	
03/02/2011	03:26:50	7156 Ross – Townsville South 132 kV line manual close	
03/02/2011	03:28:05	7156 Ross – Townsville South 132 kV line protection trip	
03/02/2011	03:28:15	7156 Ross – Townsville South 132 kV line auto-reclose	

Date	Time	Event	Comment
03/02/2011	03:28:27	7156 Ross – Townsville South 132 kV line protection trip	Line out of service

Table 2 – Restoration of the north Queensland transmission network

Date	Time	Equipment restored	Comment
03/02/2011	10:49:01	7143 Barron Gorge – Kamerunga 132 kV line	Barron Gorge Power Station reconnected to the power system
03/02/2011	10:49:44	7184 Barron Gorge – Kamerunga 132 kV line	
03/02/2011	14:09:19	7156 Ross – Townsville South 132 kV line	
03/02/2011	14:14:55	T94 Townsville East 132 kV substation	Power supply restored to T94 Townsville East 132 kV substation
03/02/2011	14:20:48	Woree 132 kV SVC	SVC returned to service
03/02/2011	15:05:10	876 Chalumbin – Woree 275 kV line	
04/02/2011	10:41:42	8858 Strathmore – Ross 275 kV line	
05/02/2011	12:28:35	7191 Kareeya – Chalumbin 132 kV line	
05/02/2011	13:46:18	7301 Woree – Tully 132 kV line	Power supply restored to T48 Tully 132 kV substation
05/02/2011	13:59:09	7255 Innisfail – El Arish 132 kV line	Power supply restored to T171 El Arish 132 kV substation
05/02/2011	14:22:01	7254 Tully – El Arish 132 kV line	
06/02/2011	16:22:32	7253 Kareeya – Tully 132 kV line	
08/02/2011	20:42:09	7134 Tully – Ingham South tee Cardwell 132 kV line	Power supply restored to T157 Ingham South and T134 Cardwell 132 kV substations
11/02/2011	14:07:20	7135 Kareeya – Ingham South Tee	

Date	Time	Equipment restored	Comment
		Cardwell 132 kV line	