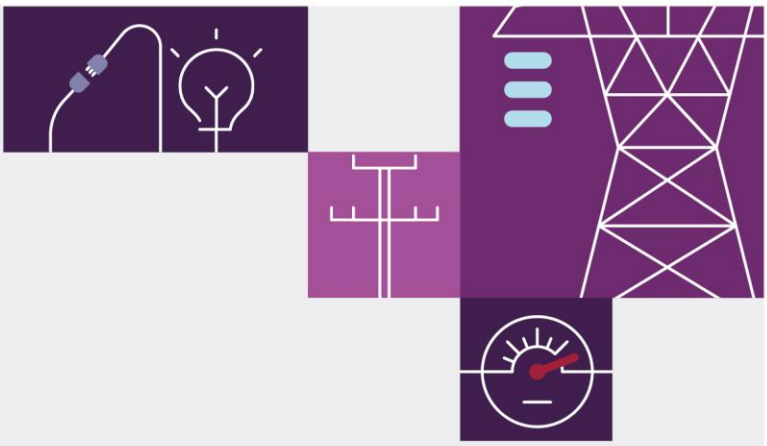
Trip of Ross 275 kV No. 2 busbar on 21 October 2023

June 2024

Reviewable Operating Incident Report under the National Electricity Rules



Important notice

Purpose

AEMO has prepared this report in accordance with clause 4.8.15(c) of the National Electricity Rules, using information available as at the date of publication, unless otherwise specified.

Disclaimer

To inform its review and the findings expressed in this report, AEMO has been provided with data by registered participants as to the status or response of some facilities before, during and after the reviewable incident, and has also collated information from its own observations, records and systems. Any views expressed in this report are those of AEMO unless otherwise stated, and may be based on information given to AEMO by other persons. AEMO has made reasonable efforts to ensure the quality of the information in this report but cannot guarantee its accuracy or completeness. Any views expressed in this report may be based on information given to AEMO by other persons.

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Incident classifications

Classification	Detail
Time and date of Incident	0133 hrs on 21 October 2023
Region of incident	Queensland
Affected regions	Queensland
Event type	Protection or control system – incorrect relay setting/configuration
Generation impact	0 MW
Load impact	213 MW
Associated report	Trip of Ross 275 kV No. 1 SVC during planned switching of Ross No. 4 275/132 kV transformer on 13 September 2023[1].

Abbreviations

Abbreviation	Term
A	amperes
AEMC	Australian Energy Market Commission
AEMO	Australian Energy Market Operator
AEST	Australian Eastern Standard Time
CB	Circuit Breaker
CBF	Circuit Breaker Failure
CQ	Central Queensland
DUID	Dispatchable Unit Identifier
FOS	Frequency Operating Standard
kV	Kilovolt/s
MW	Megawatts
MVA	Megavolt-amperes
NEM	National Electricity Market
NER	National Electricity Rules
NQ	Northern Queensland
NOFB	Normal Operating Frequency Band
NSP	Network Service Provider
OOS	Out of service
PTR	Permission to restore
SQ	Southern Queensland
SVC	static volt-ampere reactive (Var) compensator
TNSP	Transmission Network Service Provider
QNI	Queensland – New South Wales Interconnector

[1] Available at https://aemo.com.au/-/media/files/electricity/nem/market_notices_and_events/power_system_incident_reports/2023/trip-of-ross-no1-275-kv-svc-13-september-2023.pdf?la=en.

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1 Overview

This report relates to a reviewable operating incident[2] that occurred in Queensland on 21 October 2023 at 0133 hrs. The incident involved the trip of Ross 275 kilovolt (kV) No. 2 busbar and the subsequent trip at 0141 hrs of Clare South – Townsville South 132 kV 7131 line.

At 0133 hrs on 21 October 2023, a trip of Ross 275 kV No. 2 busbar occurred when the 275 kV 5812 circuit breaker (CB) was closed during the restoration of the No. 1 275 kV static volt-ampere reactive (Var) compensator (SVC). The Ross 275 kV busbar tripped due to the unexpected operation of 275 kV 5812 CB circuit breaker fail (CBF) X protection. The Ross busbar trip resulted in 213 megawatts (MW) of load no longer being supplied by the Ross No. 2 and No. 8 transformers, instead leaving it supplied from Strathmore 275/132 kV substation via the 132 kV network through 132 kV 7131 line as the parallel 132 kV 7130 line was out of service for refurbishment works.

As a result of 132 kV 7131 line being the only remaining supply for the Ross 132 kV load, 132 kV 7131 line exceeded its emergency rating of 167 megavolt-amperes (MVA) for approximately eight minutes, and tripped due to a phase-to-phase fault at 0141 hrs. The trip of 132 kV 7131 line disconnected the 132 kV network between Clare South and Tully substations, resulting in the loss of 213 MW of connected load.

At 0208 hrs, the Ross 275 kV No. 2 busbar was energised, and all the load was restored by 0346 hrs on 21 October 2023.

Prior to this incident, at 0104 hrs on 21 October 2023, the Ross No. 4 275/132 kV transformer tripped due to a high voltage (HV) fault within the No. 4 275/132 kV transformer protection zone. This was followed a short time later by the trip of Ross 275 kV No. 1 SVC due to the loss of cooling system alternating current (AC) auxiliary supplies which had been provided by the No. 4 275/132 kV transformer. This event had already been reclassified as credible, following a similar event on 13 September 2023, as per Market Notice (MN) 109794.

At the time of the Ross No. 4 275/132 kV transformer and 275 kV No. 1 SVC incident, the Ross No. 3 275/132 kV transformer was out of service as part of a planned outage. Due to this planned outage, the trip of the Ross No. 4 275/132 kV transformer resulted in all Ross 132 kV load being supplied by the Ross No. 2 and No. 8 275/132 kV transformers which are single switched onto the Ross 275 kV No. 2 busbar.

During this incident, the power system was not operating in a satisfactory state for approximately eight minutes between 0133 hrs to 0141 hrs while the 132 kV 7131 line loading exceeded the line rating. The 132 kV 7131 line tripped prior to Powerlink being able to intervene to re-secure the power system.

As this is a reviewable operating incident, AEMO is required to assess the adequacy of the provision and response of facilities and services and the appropriateness of actions taken to restore or maintain power system security[3].

AEMO's conclusions findings, recommendations and actions arising from its review are summarised in Table 1.

[2] See NER clause 4.8.15(a)(1)(i), as the event relates to a non-credible contingency event; and the Australian Energy Market Commission (AEMC) Reliability Panel Guidelines for Identifying Reviewable Operating Incidents, at https://www.aemc.gov.au/sites/default/files/2022-09/Final%20guidelines.pdf.

[3] See NER 4.8.15(b).

Table 1 Summary of findings, conclusions and recommendations

Findings	Recommendations and Actions
Trip of Ross No. 4 275/132 kV transformer and 275 kV No. 1 SVC	
The trip of Ross No. 4 275/132 kV transformer at 0103 hrs on 21 October 2023 from its X and Y differential protection systems was due to an HV fault on the transformer tertiary bushings consistent with wildlife contact. The trip of Ross 275 kV No. 1 SVC at 0104 hrs on 21 October 2023 was due to the loss of the thyristor cooling system AC auxiliary supplies from the No. 4 275/132 kV transformer. The event had already been reclassified by AEMO as a credible contingency event as per MN 109794. The trip of Ross No. 4 275/132 kV transformer resulted in the Ross 132 kV load being supplied by No. 2 and No. 8 transformers which are single switched onto the 275 kV No. 2 busbar.	• On 11 December 2023, Powerlink temporarily replaced the supply to Ross 275 kV No. 1 SVC AC auxiliaries from Ross No. 3 transformer with the supply from a mobile diesel generator, which runs continuously. • Powerlink advised AEMO that the Ross 275 kV No. 1 SVC was now configured to remain in service for any outage (planned or unplanned) of Ross No. 4 275/132 kV transformer because of the AC supply redundancy. Powerlink advised AEMO that this arrangement will remain in place until the Ross No. 3 transformer is returned to service. • No further action recommended.
Trip of Ross 275 kV No. 2 busbar	
The trip of Ross 275 kV No. 2 busbar at 0133 hrs on 21 October 2023 was due to the operation of CBF X protection of 275 kV CB 5812 when the CB 5812 was closed to restore 275 kV No. 1 SVC to service. The operation of CB 5812 CBF X protection was not expected. The post-incident investigation by Powerlink found a trip output design issue with CB 5812 CBF X protection system. The CBF X protection was found to have an un-enunciated latched trip output signal which operated when CB 5812 was closed.	• Immediately following the incident, Powerlink reset CB 5812 CBF X protection to prevent reoccurrence of incident and to allow the 275 kV No. 1 SVC and 275 kV No. 2 busbar to be returned to service. • Powerlink completed a modification of CB 5812 CBF X protection trip output design on 26 October 2023. • No further action recommended.
Trip of 132 kV 7131 line and loss of 213 MW load	
The trip of Ross 275 kV No. 2 busbar resulted in all the Ross 132 kV load no longer being supplied by No. 2 and No. 8 transformers and instead being supplied by the Strathmore 275/132 kV substation via the 132 kV network and 132 kV 7131 line. The 132 kV 7131 line immediately became overloaded carrying 263 MVA, compared to its dynamic rating of 167 MVA (60% overload). During the period that 132 kV 7131 line was overloaded, the power system was not operating in a satisfactory state.	
The 132 kV 7131 line tripped as a result of X differential protection and Y distance protection at 0141 hrs on 21 October 2023. The protection operated as expected for an A phase to B phase fault on the line conductors.	• AEMO recommends Powerlink assess all the equipment subjected to the overloading to confirm elements have not suffered permanent damage which may affect equipment serviceability or ratings.
The trip of 132 kV 7131 line caused the 132 kV network between Clare South and Tully substations to be disconnected resulting in the loss of 213 MW of load.	
The power system did not operate in a satisfactory state for approximately eight minutes between 0133 hrs and 0141 hrs. To reduce the 132 kV 7131 line overload, AEMO contacted Yabulu Power Station at 0137 hrs to confirm its ability to synchronise a unit and ramp up to full load. AEMO subsequently called the Yabulu Power Station trader at 0140 hrs to initiate the process of issuing a direction. AEMO also contacted Powerlink 0140 hrs to discuss whether 132 kV 7131 line should be offloaded to secure the power system. However, 132 kV 7131 line tripped during this phone call. Powerlink had considered closing the 132 kV network between Ross and Woree substations which was operating with an open point south of Tully substation on the Cardwell – Tully 132 kV 7389 line. However, this option was not progressed as the open point was in place to manage system security on the contingent loss of either Chalumbin – Tumoulin 275 kV 8932 line or Woree – Tumoulin 275 kV 877 line. The trip of 132 kV 7131 line at 0141 hrs, eight minutes after the line became overloaded, was due to a phase-to-phase fault on the line.	• AEMO plans to present to the Transmission Network Service Provider (TNSP) planners on the need to consider the implementation of control schemes when using asset ratings of less than 15 minutes and for the control schemes to provide facilities to automatically disconnect overloaded assets, including the use of load shedding, to allow the power system to return to a satisfactory operating without the need for operator intervention. It is noted that there is an increasing use of dynamic ratings and five-minute ratings in the power system and this event confirms that coordination between control rooms exceeds this timeframe. • AEMO recommends refresher training of TNSP control room staff to reinforce the need to consider manual interruption of load under some power system topologies. This will be included in the AEMO – Network Service Provider (NSP) Load Shedding and System Restart training.

Findings	Recommendations and Actions
The line trip occurred before Powerlink, AEMO and Ergon[4] control room operators could intervene to return the power system to a satisfactory state.	
Load restoration commenced at 0208 hrs on 21 October 2023. The majority of load was restored by 0318 hrs and all load was restored by 0346 hrs on 21 October 2023.	

This report is prepared in accordance with National Electricity Rules (NER) 4.8.15(a)(1)(i) (non-credible contingency event) and NER 4.8.15(a)(3) in accordance with Reliability Panel guideline 6.a) (power system not in a satisfactory operating state for more than five minutes). It is based on information provided by Powerlink[5] and information gathered from AEMO systems.

National Electricity Market (NEM) time (Australian Eastern Standard Time [AEST]) is used in this report.

[4] Ergon is the Distribution Network Service Provider (DNSP) for North Queensland

[5] Powerlink is a Transmission Network Service Provider (TNSP) for Queensland.

2 The incident

2.1 Pre-event conditions

2.1.1 Generation dispatch and demand

A summary of Queensland operational conditions at 0133 hrs on 21 October 2023, just prior to the non-credible trip of Ross 275 kV No. 2 busbar, is shown in Table 2.

Table 2 Queensland key system conditions at 0130 hrs on 21 October 2023

Quantity description	Value (MW)
Queensland operational demand	5,471
Queensland scheduled and semi scheduled generation	5,595
Southern Queensland (SQ) – Central Queensland (CQ) flow	235
CQ – Northern Queensland (NQ) flow	27
Directlink interconnector flow into New South Wales	13
Queensland – New South Wales Interconnector (QNI) flow into New South Wales	141
132 kV 7131 line	14
Ross 275 kV network – Ross 132 kV network flow	185

Table 3 provides a summary of North Queensland generator dispatch at 0130 hrs on 21 October 2023.

Table 3 North Queensland generator dispatch at 0130 hrs on 21 October 2023

Station name	Dispatched generation (MW)	Station name	Dispatched generation (MW)
Barron Gorge Power Station Unit 1	31	Kareeya Power Station Unit 3	18
Kaban Wind Farm	108	Kareeya Power Station Unit 4	18
Kareeya Power Station Unit 1	18	Kennedy Energy Park	30
Kareeya Power Station Unit 2	18	Mt Emerald Wind Farm	127

2.1.2 Prior planned outages

The following transmission elements were on planned outages prior to the Ross 275 kV No. 2 busbar trip at 0133 hrs on 21 October 2023:

- Ross No. 3 275/132 kV transformer.
- Clare South – Invicta Mill Tee 132 kV 7130 line.
- Ross – Woree 275 kV 8905 line.

2.1.3 North Queensland 132 kV coastal network configuration

Due to the planned outage of 275 kV 8905 line, the 132 kV network between Ross and Woree substations was operating with an open point south of Tully substation on the Cardwell – Tully 132 kV 7389 line to manage system security on the contingent loss of either Chalumbin – Tumoulin 275 kV 8932 line or Woree – Tumoulin 275 kV 877 line.

Consequently, Cardwell and Ingham South substations were supplied by the Ross 132 kV network, while Tully, El Arish, Innisfail and Edmonton substations were supplied from the Woree 132 kV network.

Due to the planned outage of 132 kV 7130 line, the 132 kV network between Ross substation and Strathmore substation were connected only by 132 kV 7131 line.

2.1.4 Prior unplanned outage Ross No. 4 275/132 kV transformer and 275 kV No. 1 SVC

At 0104 hrs on 21 October 2023, there was a credible trip of the Ross No. 4 275/132 kV transformer and 275 kV No. 1 SVC. This event was previously reclassified by AEMO as a credible contingency event as per MN 109794 issued at 1450 hrs on 13 September 2023. At the time of the Ross No. 4 275/132 kV transformer and 275 kV No. 1 SVC trip on 21 October 2023, the Ross No. 3 transformer was on a planned outage. The trip of No. 4 275/132 kV transformer resulted in all the Ross 132 kV load being supplied by No. 2 and No. 8 transformers which are supplied by the Ross 275 kV No. 2 busbar (see Figure 4 and Figure 5).

2.2 The incident

At 0133 hrs on 21 October 2023, the Ross 275 kV No. 2 busbar tripped when the 275 kV 5812 CB was closed during the restoration of 275 kV No. 1 SVC. The busbar trip was caused by the operation of 5812 CB CBF X protection, which was unexpected. This protection operation resulted in all the Ross 132 kV load no longer being supplied by No. 2 and No. 8 275/132 kV transformers, leaving load supplied from the Strathmore 275/132 kV substation via the 132 kV network and 132 kV 7131 line (see Figure 6 and Figure 7).

Subsequently, 132 kV 7131 line was thermally overloaded for approximately eight minutes between 0133 hrs and 0141 hrs, at which time the line tripped due to a phase-to-phase fault. This disconnected the 132 kV network between Clare South and Tully substations (see Figure 8) with the resultant loss of 213 MW of load.

Table 4 provides the detailed sequence of events.

Table 4 Sequence of events

Time (hhmm or hhmm.ss)	Time since Ross 132 kV network trip (hh:mm)	Event	Comment
Prior trip of Ross No. 4 275/132 kV transformer and 275 kV No. 1 SVC			
0103.57	-0:37	• Ross No. 4 275/132 kV transformer tripped.	Powerlink found that the fault was consistent with wildlife breaching the insulation between the No. 4 275/132 kV transformer tertiary bushings.
0104.07	-0:37	• Ross 275 kV No. 1 SVC tripped.	The 275 kV No. 1 SVC tripped due to the loss of AC auxiliary supply provided by the tertiary of No. 4 275/132 kV transformer. The trip of Ross No. 4 275/132 kV transformer and 275 kV No. 1 SVC was

Time (hhmm or hhmm.ss)	Time since Ross 132 kV network trip (hh:mm)	Event	Comment
			previously reclassified as a credible event under AEMO MN 109794 which was still current.
0115	-0:26	• AEMO invoked the following constraint sets: – Q-H13RS_SVC – Q-X_RS_TX_TX_0	
Trip of Ross 275 kV No. 2 busbar, thermal overload, and trip of 132 kV 7131 line.			
0132.41	-0.08	• Powerlink initiated Ross 275 kV No. 1 SVC start sequence via SCADA to close 275 kV CB 5812 at Ross substation.	
0133.01	-0:08	• The CBF X protection for 275 kV 5812 CB unexpectedly operated. • The CBF X operation tripped the Ross 275 kV No. 2 busbar.	Following the No. 2 busbar trip, all 132 kV load supplied by Ross substation between Clare South and Tully substations was being supplied via Strathmore 275/132 kV substation 132 kV network and 132 kV line 7131.
0134	-0:07	• AEMO attempted to call Powerlink to advise that 132 kV 7131 line was overloaded but Powerlink was unable to be contacted.	
0135	-0:06	• AEMO again attempted to call Powerlink, but Powerlink was unable to be contacted.	
0135	-0:06	• AEMO contacted Powerlink and advised them that 132 kV 7131 line was overloaded. • Powerlink contacted Ergon to discuss the Ross 275 kV No. 2 busbar trip and the thermal overload on 132 kV 7131 line.	
0136	-0:05	• AEMO called Yabulu Power Station to confirm an ability to come online and ramp up to full load[6]. • Yabulu Power Station could supply up to 160 MW of generation.	
0140	-0:01	• AEMO called the Yabulu trader to initiate a direction associated with the phone call at 0136 hrs. 132 kV 7131 line tripped before the direction could be issued.	
0140	-0:01	• AEMO called Powerlink to recommend offloading 132 kV 7131 line and shed load in the Ross area. However, 132 kV 7131 line tripped during this phone call.	
132 kV 7131 line trip and loss of 213 MW load			
0141.02	0:00	• 132 kV 7131 line tripped. • The 132 kV network between Clare South and Tully substations disconnected.	132 kV 7131 line tripped by its line X and Y protection due to a phase-to-phase fault on the line conductors. The 132 kV 7131 line trip resulted in the loss of 213 MW of load.
0141.12	0:00.10	• 132 kV 7131 line reclose at Townsville South operated and closed 132 kV CB 71562. • 132 kV 7131 line reclose at Clare South is designed to block reclose for a dead-line and did not close CB 71312.	As the Townsville South 132 kV busbar was already de-energised from the Ross 132 kV network, 132 kV 7131 line reclose sequence operated as designed but could not restore load automatically.
Network and load restoration			

[6] It would take Yabulu Power Station 11 minutes to ramp up to full load based off its dispatch inflexibility profile (T1=5min, T2 = 6min); see https://aemo.com.au/-/media/files/electricity/nem/security_and_reliability/dispatch/policy_and_process/fast-start-unit-inflexibility-profile.pdf.

Time (hhmm or hhmm.ss)	Time since Ross 132 kV network trip (hh:mm)	Event	Comment
0208	0:27	• Ross 275 kV No. 2 busbar was energised.	
0211	0:30	• Ross 275 kV No. 1 SVC returned to service.	
0216	0:35	• Ross 132 kV busbar No. 1, 2, 3 and 4 were energised via Ross No. 2 and 8 transformers.	
0219	0:38	• AEMO granted Powerlink permission to restore (PTR) all load.	
0310	1:29	• Powerlink advised AEMO that the Ross 275 kV No. 2 busbar trip occurred during the restoration of Ross 275 kV No. 1 SVC.	
0318	1:37	• Powerlink advised AEMO that most of the 132 kV network had been restored except for the following: – 132 kV 7131 line had not yet been restored. Powerlink was waiting for clearance to restore the line as it likely tripped on overloading. It was unknown if there was any damage to the line at this stage. – Dan Gleeson substation was only partially restored with the connection to 132 kV 7141 line remaining out of service (OOS) due to an issue with Ergon's 66 kV busbar. – Invicta was not yet restored but was progressing to restore load at this time.	
0346	2:05	• Yabulu Power Station was not yet restored. Powerlink was waiting for clearance from the power station. • Powerlink reported that all load was restored.	
0435	2:54	• Supplies to Yabulu Power Station were restored via Townsville – Yabulu Power Station 132 kV 7241 line. • Powerlink confirmed a total of 213 MW of load lost due to incident.	
0451	3:10	• Dan Gleeson No.2 66 kV busbar was restored.	

2.3 Analysis

Based on information provided by registered participants and available from AEMO systems, AEMO has outlined its findings in the following section.

2.3.1 Trip of Ross 275 kV No. 2 busbar

At 0132 hrs on 21 October 2023, Powerlink initiated the Ross 275 kV No. 1 SVC start sequence via SCADA to close 275 kV CB 5812 at Ross substation.

At 0133 hrs on 21 October 2023, when 275 kV 5812 CB closed, the Ross 275 kV No. 2 busbar tripped due to the unexpected operation of 5812 CB CBF X protection. Immediately after the incident, Powerlink applied a manual

intervention on-site to prevent any re-occurrence and to allow the Ross No. 4 busbar and the 275 kV No. 1 SVC to be returned to service.

The post-incident investigation by Powerlink identified an issue with the CBF X protection relay trip output design which resulted in an un-enunciated latched trip signal that led to the operation of the CBF X protection when 275 kV 5812 CB was closed.

Powerlink informed AEMO on 4 December 2023 that the 5812 CB CBF X protection relay trip output design had been corrected on 26 October 2023.

2.3.2 Thermal overload of 132 kV 7131 line

Prior to the Ross 275 kV No. 2 busbar trip, the load on 132 kV 7131 line was approximately 15 MVA and increased to approximately 263 MVA following the trip of the Ross 275 kV No. 2 busbar.

The applicable line rating for 132 kV 7131 line at the time was 167 MVA. The initial overload of 132 kV 7131 line was almost 60% above the dynamic line rating. The 132 kV 7131 line is protected by current differential and distance protection. Neither line protection could detect the line overloading condition. The line protection operated correctly later when a phase-to-phase fault occurred on the overhead conductors.

The overloading of 132 kV 7131 line resulted in the power system operating in an unsatisfactory state between 0133 hrs and 0141 hrs.

Following the Ross 275 kV No. 2 busbar trip, AEMO contacted Powerlink to discuss the overload on the 132 kV 7131 line. The Powerlink network controller worked to establish situational awareness through the review of the available information, including the alarms being presented. When the 132 kV 7131 line was identified as being overloaded, the network controller engaged with the Ergon control room to identify options to reduce the loading on 132 kV 7131 line. The Powerlink network controller's attention was also focused on several operational conditions resulting from the event, including the event's impact to the 132 kV changing voltage profile in the Townsville area.

2.3.3 Trip of line 7131and disconnection of Ross 132 kV network

At 0141 hrs on 21 October 2023, the 132 kV 7131 line tripped due to the operation of its X differential and Y distance line protection systems following an A phase – B phase HV fault on the line conductors. The line protection operated as expected. The 132 kV 7131 line fault was cleared within 66 milliseconds. Townsville South 132 kV 71312 CB successfully auto reclosed at 0141 hrs, however as the Townsville South 132 kV busbar was already de-energised from the Ross 132 kV network, auto reclose did not operate at Clare South as the line was not in an energised state, preventing any load being restored.

The trip of the 132 kV 7131 line, approximately eight minutes after the Ross 275 kV No. 2 busbar trip, resulted in the disconnection of the 132 kV network between Clare South and Tully substations and the loss of 213 MW of load interrupting the following 132 kV substations:

- Ross.
- Townsville South.
- Garbutt.

- Dan Gleeson.
- Cardwell.
- Alan Sherriff.
- Ingham South.

2.3.4 Restoration of load

At 0208 hrs on 21 October 2023, the Ross 275 kV No.2 busbar returned to service, followed by the restoration of the Ross 132 kV No. 1, No. 2, No. 3, and No. 4 busbars at 0216 hrs.

At 0219 hrs on 21 October 2023, AEMO gave Powerlink permission to restore (PTR) the interrupted load. Powerlink reported that most of the customer load was restored by 0319 hrs and all the load was restored at 0346 hrs on 21 October 2023. Refer to Table 4 for restoration details.

3 Power system security

AEMO is responsible for power system security in the NEM. This means AEMO is required to operate the power system in a secure operating state to the extent practicable and take all reasonable actions to return the power system to a secure state following a contingency event in accordance with the NER[7].

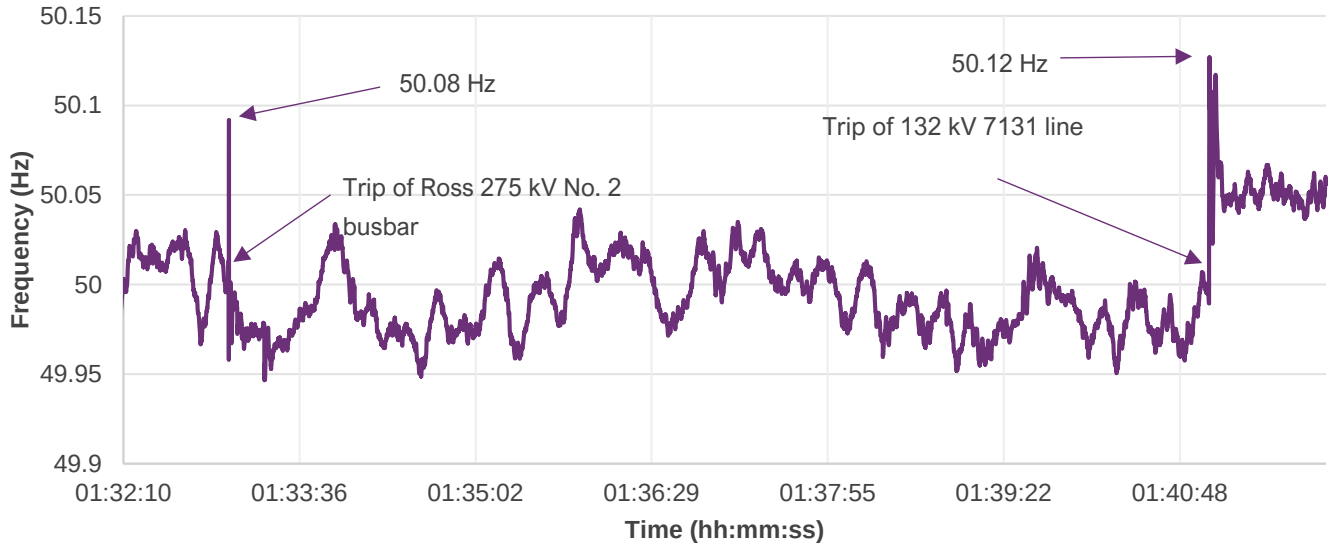
3.1 Frequency

The frequency remained within the Normal Operating Frequency Band (NOFB) and the Frequency Operating Standard (FOS)[8] was met throughout the incident.

Figure 1 shows a trend of the power system frequency performance during this event.

As a result of the trip of the Ross 275 kV No. 2 busbar at 0133 hrs, the frequency reached a maximum of 50.08 Hz before immediately returning to normal levels. The trip of the 132 kV 7131 line and the loss of 213 MW of load at 0141 hrs resulted in a maximum frequency of 50.12 Hz before immediately returning to approximately 50.05 Hz.

Figure 1 Power system frequency on 21 October 2023



3.2 Voltage

Figure 2 shows the voltage performance of the 132 kV network connected to Ross 275/132 kV and Strathmore 275/132 kV substations during this event.

[7] Refer to AEMO's functions in section 49 of the National Electricity Law and the power system security principles in clause 4.2.6 of the NER.

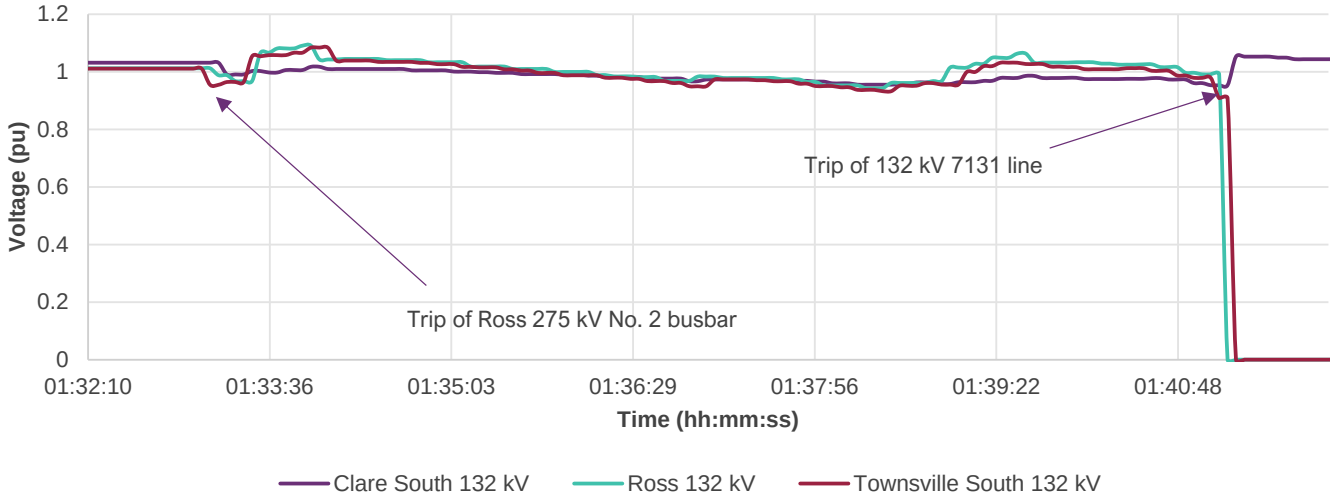
[8] Frequency Operating Standard, effective 9 October 2023, available at https://www.aemc.gov.au/media/87484.

Following the trip of Ross 275 kV No. 2 busbar at 0133 hrs, and until 0141 hrs when the 132 kV 7131 line tripped, the voltages on the 132 kV network remained within the voltage limits defined in the NER[9] and as specified by Network Service Providers (NSPs) in limits advice to AEMO.

At 0141 hrs, the 132 kV 7131 line tripped and disconnected all load on the 132 kV network between Clare South and Tully substations.

Clare South remained connected to Strathmore 275/132 kV substation and Tully remained connected to Woree 275/132 kV substation.

Figure 2 Voltage on 132 kV network 21 October 2023



Note: pu= per unit

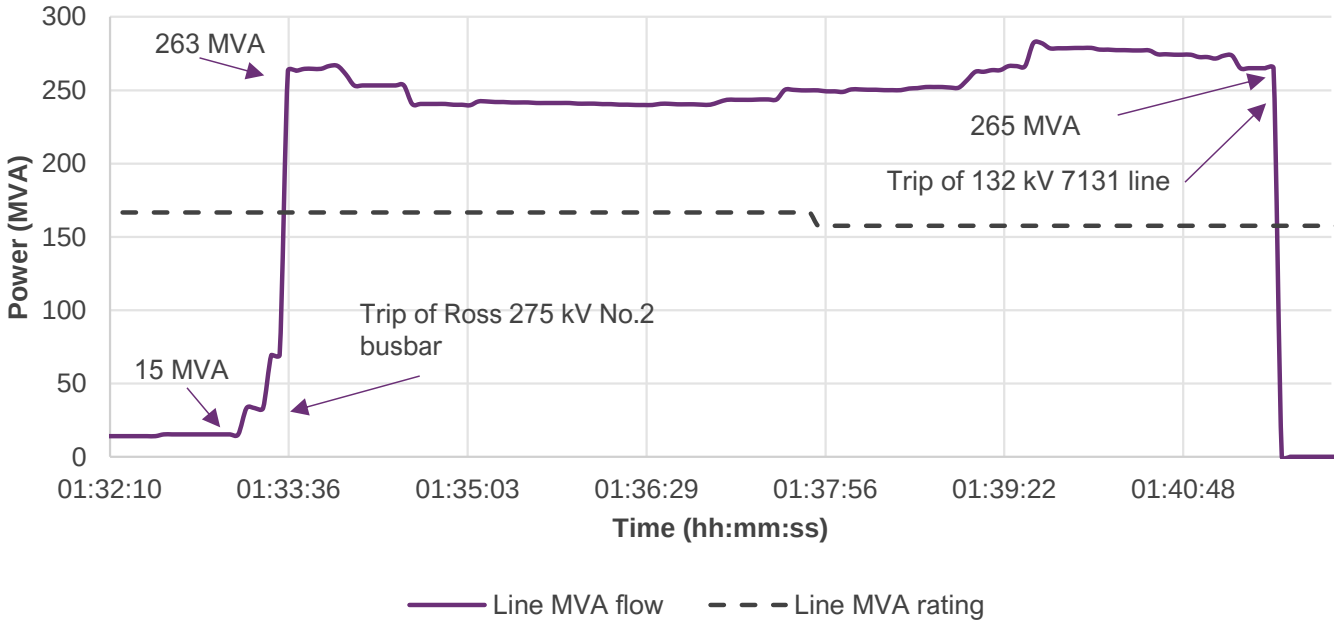
3.3 Loading on 132 kV 7131 line

Immediately following the Ross 275 kV No. 2 busbar trip at 0133 hrs on 21 October 2023, the 132 kV 7131 line load flow increased from 15 MVA to 263 MVA. The initial overload of the 132 kV 7131 line was almost 60% above the line rating of 167 MVA.

Figure 3 shows the load on 132 kV 7131 line during the event.

[9] See https://energy-rules.aemc.gov.au/ner/502/320130#4.5.

Figure 3 Load flow on 132 kV 7131 line on 21 October 2023



AEMO and Powerlink control room responses

At 0135 hrs, the AEMO control room established contact with the Powerlink control room and advised Powerlink that the 132 kV 7131 line was overloaded. Powerlink then contacted Ergon to discuss the scenario in the Townsville network area.

At 0136 hrs, AEMO contacted Yabulu Power Station to confirm an ability to bring a unit online and provided a verbal request to synchronise a unit and ramp up to full load.

At 0140 hrs, AEMO contacted the Yabulu Power Station trader to initiate the process for issuing a direction. However, the 132 kV 7131 line tripped prior to the direction being issued.

At 0140 hrs, AEMO called Powerlink to ask whether 132 kV 7131 line should be offloaded to secure the power system**.** This is an action which would shed load in the Ross area, however, the 132 kV 7131 line tripped during this phone call.

At 0141 hrs, the 132 kV 7131 line tripped due to a phase-to-phase fault and disconnected the 132 kV network between Clare South and Tully substations with the loss of 213 MW load.

The network events at Ross 275 kV substation commencing at 0103 hrs on 21 October 2023 were cumulative and complex in nature. The Powerlink network controller required time after each event to review available information to regain situational awareness and then establish and take appropriate actions.

For this type of non-credible event, there is inadequate time available to coordinate between the AEMO, Powerlink and Distribution Network Service Provider (DNSP) control rooms to reduce a line overload condition within five minutes of the event. Ordinarily, the return to a satisfactory state would be following a protection operation. In the case of 132 kV 7131 line, its line protection does not detect the overload condition, that is, does not have overcurrent protection elements. The line current differential protection and distance protection did not detect the line overload as a condition for tripping the line.

3.4 Reclassification

AEMO assessed whether to reclassify this incident as a credible contingency event[10].

Powerlink advised AEMO, following the Ross 275 kV No. 2 busbar trip at 0133 hrs on 21 October 2023, that the cause of the busbar trip was identified. Based on this information, AEMO assessed whether to reclassify the incident and was satisfied that another occurrence of this event was unlikely under the current circumstances.

Therefore, AEMO appropriately identified that reclassification was not required.

[10] AEMO is required to assess whether or not to reclassify a non-credible contingency event as a credible contingency event – NER 4.2.3A(c) – and to report how the reclassification criteria were applied – NER 4.8.15(ca).

4 Market information

AEMO is required by the NER and operating procedures to inform the market about incidents as they progress. This section assesses how AEMO informed the market[11] over the course of this incident.

For this incident, AEMO issued the following market notices in accordance with NER requirements:

- AEMO issued MN 110339 at 0218 hrs on 21 October 2023 – Advice of a non-credible contingency event in Queensland, that at 0133 hrs on 21 October 2023, the Ross 275 kV No. 2 busbar had tripped.
- AEMO issued MN 110340 at 0256 hrs on 21 October 2023 – Advice of the disconnection 213 MW of load and that the cause of the non-credible contingency was not known at this stage.
- AEMO issued MN 110341 at 0340 hrs on 21 October 2023 – Advice that the cause of the non-credible contingency event had been identified and AEMO was satisfied that another occurrence of this event is unlikely under the current circumstances.

[11] AEMO generally informs the market about operating incidents as they progress by issuing Market Notices – see https://www.aemo.com.au/Market-Notices.

5 Conclusions and recommendations

AEMO has assessed this incident in accordance with NER 4.8.15(b). In particular, AEMO has assessed the adequacy of the provision and response of facilities or services, and the appropriateness of actions taken to restore or maintain power system security.

AEMO's conclusions, recommendations, and actions arising from its review are summarised in Table 5.

Table 5 Summary of conclusions and recommendations

Findings	Recommendations and Actions
The trip of Ross No. 4 275/132 kV transformer at 0103 hrs on 21 October 2023 was due to an HV fault on the transformer tertiary bushings consistent with wildlife contact. The trip of Ross 275 kV No. 1 SVC at 0104 hrs on 21 October 2023 was due to the loss of the thyristor cooling system AC auxiliary supplies from the No. 4 275/132 kV transformer. The event had already been reclassified by AEMO as a credible contingency event as per MN 109794.	• On 11 December 2023, Powerlink temporarily replaced the supply to Ross 275 kV No. 1 SVC AC auxiliaries from Ross No. 3 transformer with the supply from a mobile diesel generator, which runs continuously. • Powerlink advised AEMO that the Ross 275 kV No. 1 SVC was now configured to remain in service for any outage (planned or unplanned) of Ross No. 4 275/132 kV transformer because of the AC supply redundancy. Powerlink advised AEMO that this arrangement would remain in place until the Ross No. 3 transformer was returned to service. • No further action recommended.
The trip of Ross 275 kV No. 2 busbar at 0133 hrs on 21 October 2023 was due to the operation of CBF X protection of 275 kV CB 5812 when the CB 5812 was closed to restore 275 kV No. 1 SVC to service. The operation of CB 5812 CBF X protection was not expected. The post-incident investigation by Powerlink found a trip output design issue with CB 5812 CBF X protection system. The CBF X protection was found to have an un-enunciated latched trip output signal which operated when CB 5812 was closed.	• Immediately following the incident, Powerlink reset CB 5812 CBF X protection to prevent reoccurrence of incident and to allow the 275 kV No. 1 SVC and 275 kV No. 2 busbar to be returned to service. • Powerlink completed a modification of CB 5812 CBF X protection trip output design on 26 October 2023. • No further action recommended.
The trip of Ross 275 kV No. 2 busbar resulted in all the Ross 132 kV load no longer being supplied by No. 2 and No. 8 transformers and instead being supplied by the Strathmore 275/132 kV substation via the 132 kV network and 132 kV 7131 line. The 132 kV 7131 line immediately became overloaded. After eight minutes, a phase-to-phase fault developed on the line conductors.	• The 132 kV 7131 line current differential and distance protection is not designed to detect line overload conditions. The line overload continued for eight minutes until a phase-to-phase fault developed on the line conductors. The line protection operated correctly to disconnect the power system fault. • No further action recommended.
The 132 kV 7131 line tripped as a result of X differential protection and Y distance protection at 0141 hrs on 21 October 2023. The protection operated as expected for an A phase to B phase fault on the line conductors.	• AEMO recommends Powerlink assess all the equipment subjected to the overloading to confirm elements have not suffered permanent damage which may affect equipment serviceability or ratings.
During the period between 0133 hrs and 0141 hrs on 21 October 2023 when 132 kV 7131 line was overloaded, the power system did not operate in a satisfactory state for approximately eight minutes. For this type of non-credible event, there is inadequate time available to coordinate between the AEMO, Powerlink and DNSP control rooms to reduce a line overload condition.	• AEMO plans to present to the TNSP planners on the need to consider the implementation of control schemes when using asset ratings of less than 15 minutes and for the control schemes to provide facilities to automatically disconnect overloaded assets, including the use of load shedding, to allow the power system to return to a satisfactory operating without the need for operator intervention. It is noted that there is an increasing use of dynamic ratings and five-minute ratings in the power system and this event confirms that coordination between control rooms exceeds this timeframe. • AEMO recommends refresher training of TNSP control room staff to reinforce the need to consider manual interruption of load under some power system topologies. This will be included in the AEMO – NSP Load Shedding and System Restart training.

A1. System diagram

The diagram below provides an overview of part of the power system immediately prior to and after the incident.

Figure 4 Ross substation at 0104 hrs on 21 October 2023, following the trip of Ross No. 4 275/132 kV transformer and 275 kV No. 1 SVC

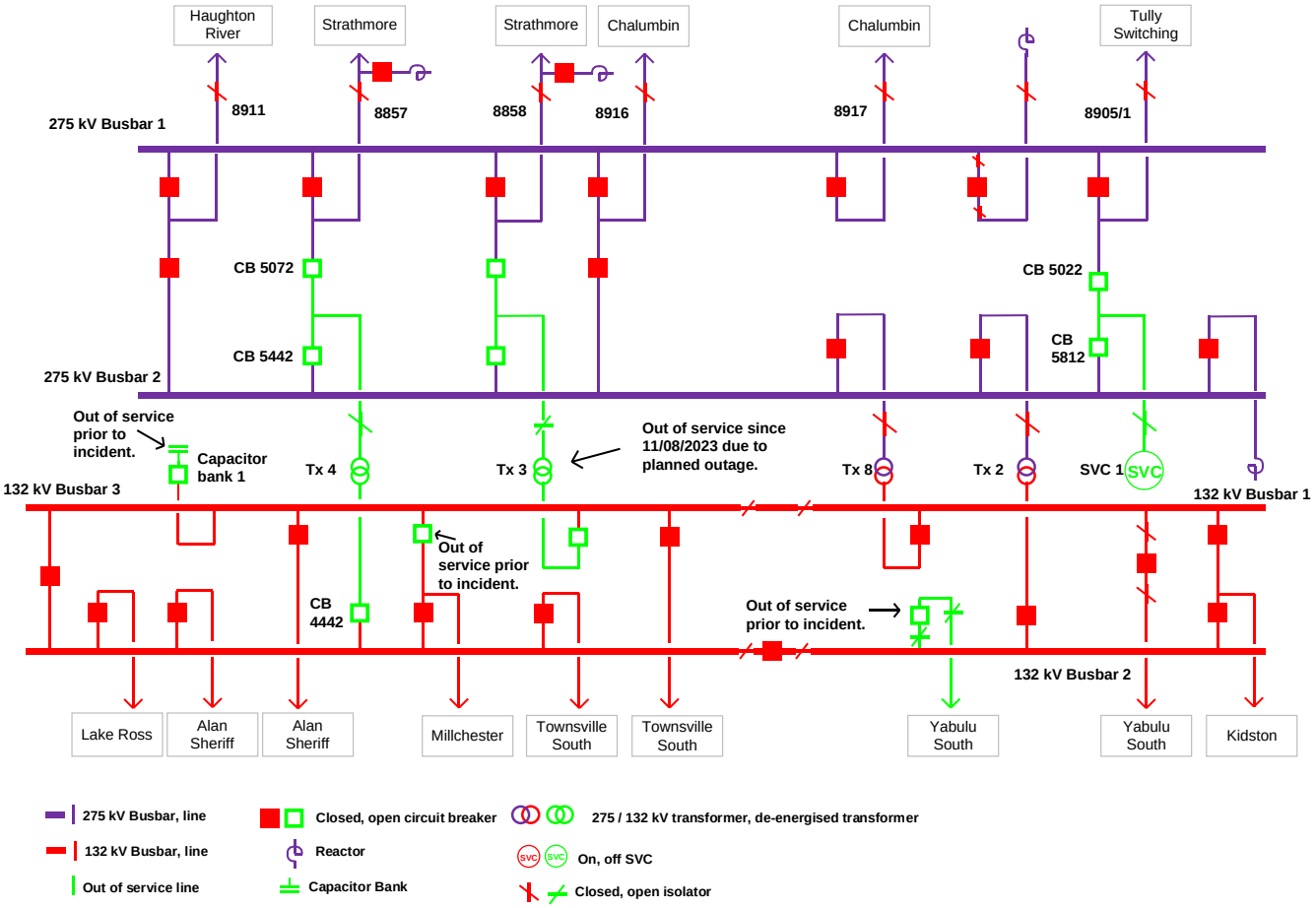


Figure 5 Ross 132 kV network following the trip of Ross No. 4 275/132 kV transformer and 275 kV No. 1 SVC

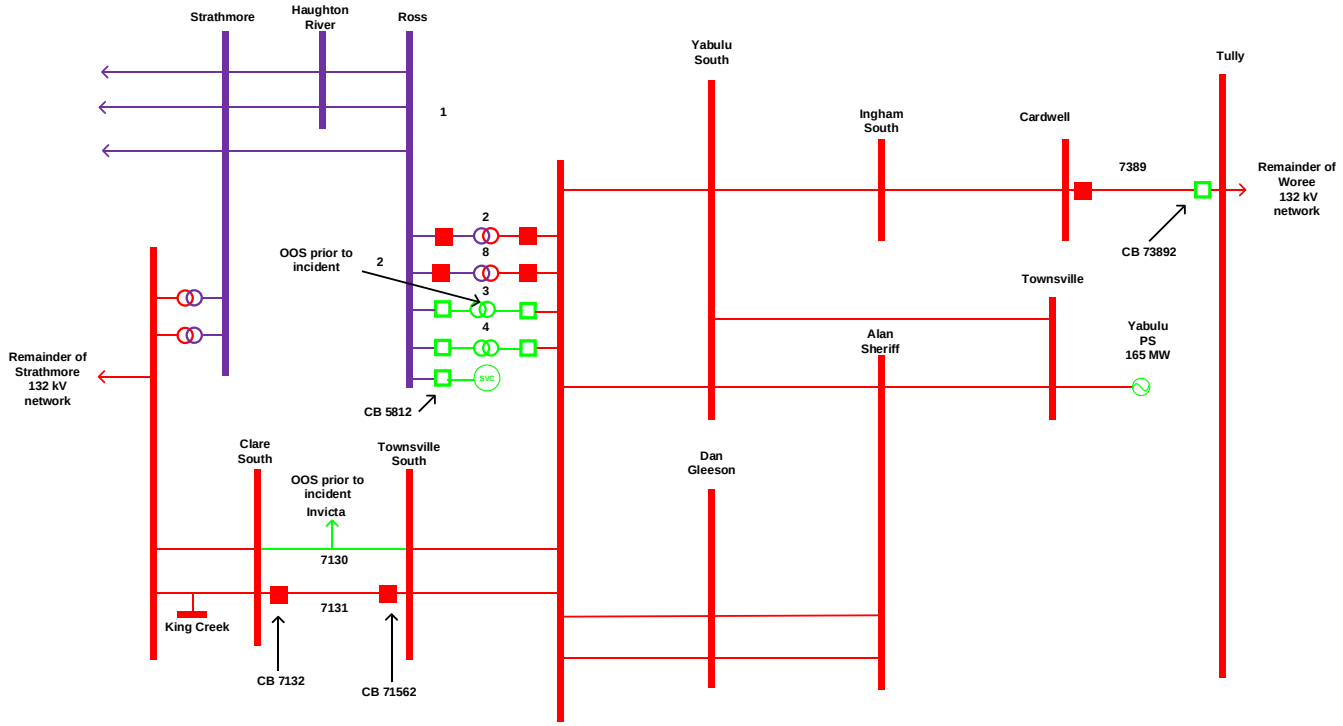


Figure 6 Ross substation at 0133 hrs on 21 October 2023, following the trip of Ross 275 kV No. 2 busbar

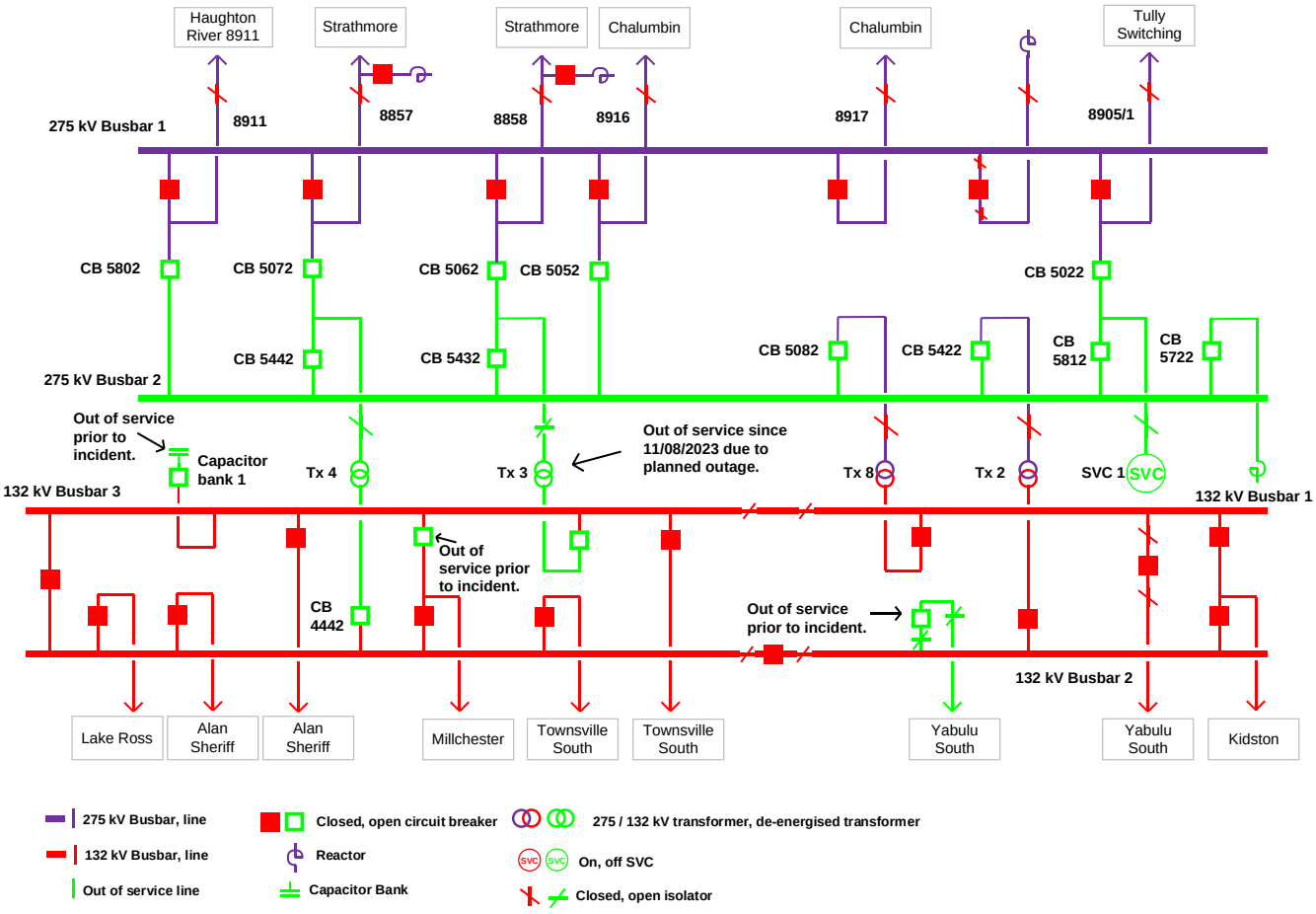


Figure 7 Ross 132 kV network following the trip of Ross 275 kV No. 2 busbar

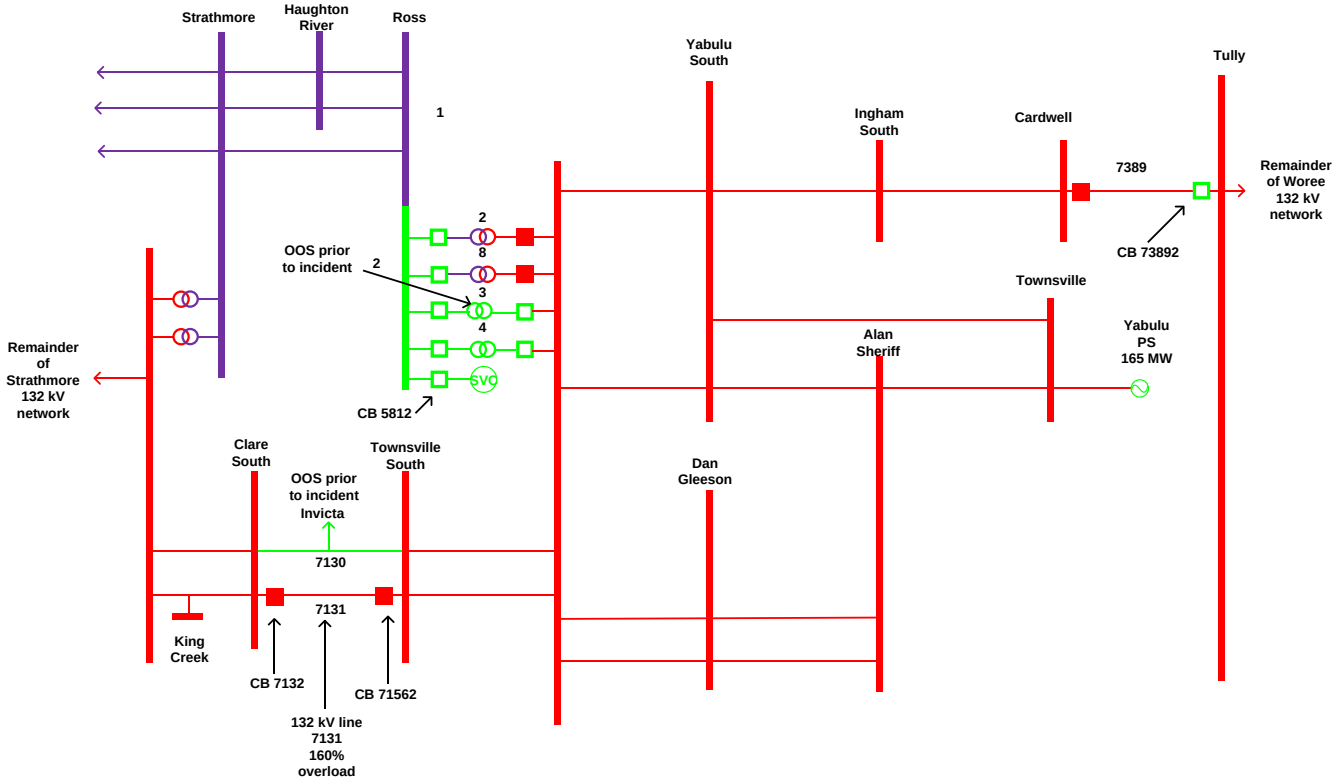


Figure 8 Ross 132 kV network at 0141 hrs on 21 October 2023, following the trip of 132 kV 7131 line