Trip of the Coffs Harbour – Lismore 89 330 kV line and Koolkhan – Lismore 967 132 kV line on 8 October 2019

May 2020

Reviewable Operating Incident Report under the National Electricity Rules

INCIDENT CLASSIFICATIONS

Classification	Detail
Time and date of incident	1438 hrs on 8 October 2019
Region of incident	NSW
Affected regions	NSW
Event type	Bushfire
Generation impact	There was no loss of generation as a result of this incident
Customer load impact	86 MW of customer load was disconnected as a result of this incident
Associated reports	Nil

ABBREVIATIONS

Abbreviation	Term
AEMO	Australian Energy Market Operator
AEST	Australian Eastern Standard Time
kV	Kilovolt
NEM	National Electricity Market
NER	National Electricity Rules
SVC	Static Var Compensator
TNSP	Transmission Network Service Provider

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

AEMO has made every reasonable effort 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.

Accordingly, to the maximum extent permitted by law, AEMO and its officers, employees and consultants involved in the preparation of this report:

- make no representation or warranty, express or implied, as to the currency, accuracy, reliability or completeness of the information in this document; and
- are not liable (whether by reason of negligence or otherwise) for any statements or representations in this document, or any omissions from it, or for any use or reliance on the information in it.

COPYRIGHT

Contents

1. Overview

This report relates to a reviewable operating incident[1] that occurred on 8 October 2019 in New South Wales. The incident involved the trip of the:

- Coffs Harbour – Lismore 89 330 kilovolt (kV) line (89 line).
- Lismore – Koolkhan 967 132 kV line (967 line).
- Lismore No. 1 Static Var Compensator (SVC) (No. 1 SVC).
- Directlink.

This incident resulted in the disconnection of 86 megawatts (MW) of customer load for up to 36 minutes. There was no loss of generation.

As this was 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[2].

AEMO has concluded that:

1. The outages of 89 and 967 lines were the result of bushfires.
2. AEMO and TransGrid were aware of bushfire activity near 89 and 967 lines prior to this event, but were unaware of how close to the lines the fire was prior to the lines tripping. TransGrid has implemented processes to ensure more timely provision of information on bushfire activity.
3. While the majority of protection operated as expected to clear the line faults, the reason 967 line failed to trip at Lismore for the first fault could not be determined.
4. The outage of the No. 1 SVC was due to a loss of supply to the SVC cooling system. This was an expected outcome for this event.
5. There was a delay in restoring the No. 1 SVC due to control system problems. The control system is due to be replaced later in 2020.
6. The power system was not in a secure operating state for less than 30 minutes. AEMO took all reasonable actions to restore the power system to a secure operating state as soon as practicable.

This report is prepared in accordance with clause 4.8.15(c) of the National Electricity Rules (NER). It is based on information provided by TransGrid[3] and AEMO.

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

[1] See NER clause 4.8.15(a)(1)(i), as the event relates to a non-credible contingency event; and the AEMC Reliability Panel Guidelines for Identifying Reviewable Operating Incidents.

[2] See NER clause 4.8.15(b).

[3] TransGrid is a Transmission Network Service Provider (TNSP) in New South Wales.

2. The incident

2.1 Pre-incident conditions

Prior to this incident, the Lismore – Tenterfield 96L 132 kV line (96L line) was out of service for planned work. This outage had a recall time of three hours during the day and two hours overnight. Additionally, one of the three Directlink cables was unavailable for service. Refer to Appendix A2 for a diagram of the power system prior to the incident.

2.2 Incident

Commencing at around 1435 hrs on 8 October 2019, a series of events as listed in Table 1 occurred that resulted in the concurrent loss of 89 line, 967 line, and Directlink[4]. As a result of these events, there was the loss of around 86 MW of customer load in the area between Lismore and the Queensland/New South Wales border due to loss of network connection.

Table 1 Event summary

Event No.	Time	Event
1	14:35:30 – 14:35:45	89 line tripped at Coffs Harbour and Lismore.
		Directlink tripped.
		967 line tripped at Koolkhan end only.
		No. 1 SVC tripped.
		89 line auto-reclosed at Coffs Harbour and Lismore.
		967 line auto-reclosed at Koolkhan.
2	14:36:10 – 14:36:26	89 line tripped at Coffs Harbour and Lismore, auto-reclosed at both Coffs Harbour and Lismore, and then tripped again. The line remained out of service.
3	14:39:13 – 14:39:21	967 line tripped at Koolkhan and Lismore and auto-reclosed at the Lismore end only.
4	14:46:55	89 line was manually returned to service by TransGrid at Coffs Harbour.
	14:47:48	89 line was manually returned to service by TransGrid at Lismore.
	14:47:56	89 line tripped at Coffs Harbour and Lismore.

The 89 line and 967 line were returned to service at 1503 hrs and 1506 hrs respectively on 8 October 2019. All load was restored by 1515 hrs on the same day.

2.3 Investigation

At the time of these incidents, TransGrid was in contact with the New South Wales Rural Fire Service and was aware of a bushfire in the vicinity of 89 and 967 lines south-east of Lismore. These lines share a common

[4] Refer to Appendix A1 for a full sequence of events.

easement in this area. However, this fire[5] was not shown on the fire location systems used by TransGrid and AEMO. See below for further discussion on this.

Protection information indicates that the faults on both 89 line and 967 line were within the fire area but at different locations. The faults on 89 line were approximately 27.8 kilometres from Lismore and the faults on 967 line were approximately 15.8 kilometres from Lismore. TransGrid has advised that all faults were as a result of bushfires in the vicinity of the lines. TransGrid has further advised that all protection systems apart from the protection on 967 line at Lismore operated as designed during these events.

2.3.1 Event 1

At around 1435 hrs, 89 line tripped and auto-reclosed approximately 15 seconds later. While 89 line was out of service, Directlink tripped, due to the operation of the Directlink Emergency Control Scheme. This scheme operates to trip Directlink immediately whenever 89 line trips and flow on Directlink is greater than 20 MW into Queensland[6]. This is to prevent overloading on the parallel 132 kV network in northern New South Wales.

Shortly after the trip of 89 line and prior to the successful auto-reclose of the line, the 967 line tripped at the Koolkhan end only and auto-reclosed approximately four seconds later. This resulted in the loss of all load between Lismore and the Queensland border for approximately four seconds. The No. 1 SVC tripped at the same time, due to loss of auxiliary supply for the SVC cooling system. The loss of load and trip of the No. 1 SVC were expected outcomes for the system conditions at the time.

TransGrid was not able to provide a definitive reason why 967 line tripped only at Koolkhan, given the line did trip at both ends for a subsequent fault (as discussed in Section 2.3.3). TransGrid has advised protection maintenance will be conducted at Lismore in July 2020.

2.3.2 Event 2

At around 1436 hrs, 89 line again tripped and auto-reclosed and tripped again. There was no loss of load at this stage as all load in the area was supplied via the 967 line.

2.3.3 Event 3

At 1439 hrs, while 89 line was out of service, 967 line tripped, resulting in the loss of all load between Lismore and the Queensland border. This was an expected outcome under the system conditions at the time.

The auto-reclose scheme on 967 line is designed to close the Koolkhan end of the line three seconds after tripping, and when the line is energised from Koolkhan the Lismore end is also reclosed.

As per design, 967 line was successfully re-energised from Koolkhan. However, while the Lismore end was reclosing, the Koolkhan end tripped again in response to a transient fault not seen by protection systems at the Lismore end. This resulted in 967 line remaining closed at Lismore but open at Koolkhan.

2.3.4 Event 4

In accordance with its procedures, TransGrid waited 10 minutes before attempting a manual reclose of 89 line. At 1447 hrs, TransGrid disabled the auto-reclose on 89 line and successfully returned the line to service. This resulted in the restoration of all load between Lismore and the Queensland border. However, 89 line tripped again a few seconds later resulting in a further load interruption.

Prior to any further restoration attempt, loads in northern New South Wales were isolated by opening circuit breakers on the distribution network[7]. At 1503 hrs, 89 line was successfully returned to service, followed by 967 line at 1506 hrs. All load was restored by 1515 hrs on 8 October 2019.

One of the Directlink cables was returned to service at 1622 hrs on 8 October 2019.

---

[5] Part of the Bushby Flat Road fire.

[6] The flow on Directlink at the time was 30 MW into Queensland.

[7] This is to prevent large inrush currents through transformers with potential tripping of the transformers, and is normally considered as good work practice. AEMO notes this was not initiated by either AEMO or TransGrid prior to the first reclose attempt on 89 line.

2.3.5 Fire information

Both AEMO and TransGrid have bushfire monitoring/tracking applications available. These applications rely on information from passing satellites and information from the local fire services authorities.

While both AEMO and TransGrid were aware of a bushfire in the area, indications available showed the fire did not pose a threat to any transmission lines and reclassification was not necessary. However, due to the very fast movement of the fire at the time of the incident, the satellite information was out of date[8] and information from local fire authorities could not be updated quickly enough to provide real-time tracking of the fire.

As a result of recent changes to the way reclassifications in relation to bushfire risks are managed,[9] TransGrid will endeavour to have a representative on site at the local Rural Fire Service (RFS) Command Centre to ensure more timely and accurate information on fire movement can be provided. However this may not be possible for rapidly developing fires. For large state wide bushfires, TransGrid have access to the Energy Utilities Functional Area Coordinator at the state RFS Control Centre at Homebush providing direct contact between the RFS and TransGrid.

2.3.6 Lismore SVC

As noted above, the No. 1 SVC tripped in response to the loss of the auxiliary supply to the SVC cooling system when supply was lost to Lismore substation.

The No. 1 SVC was returned to service at 1505 hrs on 10 October 2019. The delayed return to service resulted from control system issues with the SVC. There have been several control system issues associated with the No. 1 SVC in recent times, and TransGrid has advised AEMO that this will be addressed as part of the project to upgrade the Queensland – New South Wales interconnector planned for 2020.

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[10].

The power system was in a secure operating state prior to these incidents.

To restore or maintain the power system in a secure operating state during these events, AEMO took the following actions.

3.1 Constraint sets invoked

AEMO invoked the constraint sets shown in Table 2.

There was a delay of approximately 60 minutes in invoking the constraint set for the No. 1 SVC outage. Ideally, this constraint should have been invoked shortly after the SVC tripped. However, the constraint equations within this constraint set relate to managing the potential for voltage collapse at Lismore, and as there was no load at Lismore from 1447 hrs to 1515 hrs, the constraint set would not have been required during this period. Even after the Lismore load had been restored and the constraint set was invoked at

[8]The intervals between satellite passes vary from a minimum of 30 minutes but may be up to 90 minutes.

[9] Refer to AEMOs Power System Security Guidelines (SO_OP 3715), Section 8 for details.

[10] 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.

1535 hrs, none of the associated constraint equations bound or violated in the dispatch system until 1610 hrs, 35 minutes after the constraint set was invoked.

Table 2 Constraint sets invoked

Constraint Set	Reason	Invoked	Revoked
N-X_MBTE_3	All 3 Directlink cables out of service	1450 hrs	1620 hrs
N-LS_VC1	Lismore SVC out of service	1535 hrs	1630 hrs
		1710 hrs[A]	1705 hrs (11/10/19)
N-X_LS_VC1_967_96L	Lismore SVC and either 967 or 96L line out of service	1630 hrs	1710 hrs

A. After both 967 and 96L lines had been returned to service.

3.2 Other actions

3.2.1 Recall of 96L line

At 1500 hrs on 8 October 2019, AEMO instructed TransGrid to restore the 96L line to service. As noted above, this line had been on a planned outage with a three hour recall time prior to this incident. The line was restored to service at 1700 hrs on 8 October 2019.

3.2.2 Response to Contingency Analysis and Constraint violations

At 1610 hrs, AEMO's Contingency Analysis (CA) application indicated high voltage levels in the Coffs Harbour/Koolkhan area if either the Armidale – Coffs Harbour 87 330 kV line (87 line) or 89 line were to trip. At the same time, constraint equations N^N-LS_SVC[11] and N>N-LSTN_TE_C1[12] were violating in the dispatch system. A constraint violating in the dispatch system is an indication that the power system is not in a secure operating state. In response, AEMO instructed TransGrid to take capacitors out of service at Koolkhan and Lismore. While this action resolved the CA violation, it did not resolve the constraint violations. At 1615 hrs, AEMO instructed TransGrid to take the 967 line out of service, leaving Lismore fed via 89 line only. Constraint equation N>N-LSTN_TE_C1 ceased violating at 1620 hrs.

Constraint equation N^N-LS_SVC continued to violate indicating potential voltage collapse at Lismore if 87 line were to trip. To resolve the constraint violation AEMO identified switching steps at Coffs Harbour to radialise 87 and 89 lines from Coffs Harbour, so that if 87 line tripped 89 line would be automatically de-energised. Before this could be implemented one of the Directlink cables was returned to service at 1622 hrs on 8 October 2019 and constraint equation N^N-LS_SVC ceased violating at 1630 hrs. The power system was not in a secure operating state for 20 minutes.

The 967 line was returned to service at 1700 hrs on 8 October 2019, shortly after 96L line had been returned to service.

3.3 Reclassification

AEMO assessed whether to reclassify these incidents as a credible contingency event[13].

At 1715 hrs on 8 October 2019, AEMO conducted an assessment to determine if reclassification of 89 line and 967 lines as a credible contingency event was required. This assessment was conducted in accordance with AEMO's Power System Security Guidelines in relation to reclassification due to bushfires. The assessment

[11] Avoid voltage collapse for trip of Armidale – Coffs Harbor 87 line.

[12] Avoid overload of 967 line on trip of 89 line.

[13] AEMO is required to assess whether to reclassify a non-credible contingency event as a credible contingency event – NER clause 4.2.3A(c) – and to report how the reclassification criteria were applied – NER clause 4.8.15(ca).

determined that the fire front had moved through the power line easement and was moving further away and therefore reclassification was not required.

Although a reclassification was not made at this stage, there was a further trip and auto-reclose of 967 line at 1715 hrs and 89 line at 1735 hrs.

Based on updated advice received from the New South Wales Rural Fire Service at 1921 hrs, AEMO conducted a further assessment in relation to reclassification of 89 and 967 lines. AEMO reclassified the simultaneous loss of both 89 and 967 lines as a credible contingency event at 1945 hrs on 8 October 2019. Constraint set N-NIL-89-967_N-2 was invoked at 1945 hrs in response to this reclassification. The reclassification was cancelled, and the associated constraint set revoked, at 1130 hrs on 9 October 2019.

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[14] over the course of this incident.

For this incident, AEMO informed the market on the following matters.

1. A non-credible contingency event – notify within two hours of the event[15].
   - AEMO issued Market Notice 70454 at 1616 hrs on 8 October 2019, 97 minutes after the event, to advise of the non-credible contingency event.
2. Reclassification, details, and cancellation of a non-credible contingency – notify as soon as practical[16].
   - AEMO issued Market Notice 70456 at 1800 hrs on 8 October 2019 to advise that the 89 and 967 lines had been returned to service and that AEMO would not reclassify the incident as a credible contingency.
   - AEMO issued Market Notice 70457 at 1954 hrs on 8 October 2019 to advise that the simultaneous loss of 89 and 967 lines had been reclassified as a credible contingency event.
   - AEMO issued Market Notice 70471 at 1133 hrs on 9 October 2019 to advise that the reclassification of 89 and 967 lines as a credible contingency event had been cancelled.
3. Constraints invoked with interconnector terms on left hand side (LHS)[17].
   - AEMO issued Market Notice 70451 at 1505 hrs on 8 October 2019 to advise it had invoked constraint set N-X_MBTE_3. This constraint set contains constraint equations with interconnector terms on the LHS.
   - AEMO issued Market Notice 70453 at 1720 hrs on 8 October 2019 to advise it had invoked constraint set N-X_LS_VC1_967_96L. This constraint set contains constraint equations with interconnector terms on the LHS.
   - AEMO issued Market Notice 70455 at 1641 hrs on 8 October 2019 to advise it had invoked constraint set N-X_LS_VC1. This constraint set contains constraint equations with interconnector terms on the LHS.

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

[15] AEMO is required to notify the Market of a non-credible contingency event within two hours of the event – AEMO, Power System Security Guidelines, Section 10.3, available at SO_OP 3715 Power System Security Guidelines.

[16] AEMO is required to notify the market of a reclassification – NER clause 4.2.3(g), details of the reclassification – 4.2.3(c), and when AEMO cancels the reclassification – 4.2.3(h).

[17] For short notice outages, AEMO is required to notify the Market of variances to interconnector transfer limits as per section 22 of AEMO's Power System Security Guidelines.

5. Conclusions

AEMO has assessed this incident in accordance with clause 4.8.15(b) of the NER. 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 has concluded that:

1. The outages of 89 and 967 lines were the result of bushfires.
2. AEMO and TransGrid were aware of bushfire activity near 89 and 967 lines prior to this event, but were unaware of how close to the lines the fire was prior to the lines tripping. TransGrid has implemented processes to ensure more timely provision of information on bushfire activity.
3. While the majority of protection operated as expected to clear the line faults, the reason 967 line failed to trip at Lismore for the first fault could not be determined.
4. The outage of the No. 1 SVC was due to a loss of supply to the SVC cooling system. This was an expected outcome for this event.
5. There was a delay in restoring the No. 1 SVC due to control system problems. The control system is due to be replaced later in 2020.
6. The power system was not in a secure operating state for less than 30 minutes. AEMO took all reasonable actions to restore the power system to a secure operating state as soon as practicable.

A1. Sequence of events

Table 3 Sequence of events on 8 October 2019

Time	Event
14:35:30	89 line tripped.
14:35:30	Directlink tripped.
14:35:41	967 line tripped at Koolkhan end only.
14:35:42	Lismore No1 132kV Static var Compensator tripped.
14:35:45	967 line reclosed at Koolkhan.
14:35:45	89 line auto-reclosed.
14:36:10	89 line tripped.
14:36:26	89 line auto-reclosed.
14:37:09	89 line tripped.
14:38:00	89 line auto-reclose disabled by TransGrid.
14:39:13	967 line tripped.
14:39:16	967 line auto-reclosed at Koolkhan.
14:39:18	967 line tripped at Koolkhan.
14:39:21	967 line auto-reclosed at Lismore.
14:46:55	89 line reclosed by TransGrid at Coffs Harbour.
14:47:48	89 line reclosed by TransGrid at Lismore.
14:47:56	89 line tripped.
14:50:00	Constraint set N-X_MBTE_3 invoked.
15:00:00	AEMO instructed TransGrid to return 96L line to service.
15:01:07	89 line reclosed by TransGrid at Coffs Harbour.
15:01:43	89 line reclosed by TransGrid at Lismore.
15:05:00	MN 70451 issued – Outage of 89 line. Revision to inter-regional transfer limits.
15:05:35	967 line reclosed by TransGrid at Koolkhan.
15:07:00	89 line auto-reclose enabled by TransGrid.
15:35:00	Constraint set N-LS_VC1 invoked.
16:10:00	Constraint equations N^N-LS_SVC and N>N-LSTN_TE_C1 violating.
16:14:00	CA violations for loss of 87 or 89 line.
16:14:46	967 line opened by TransGrid at Lismore

Time	Event
16:16:00	MN 70454 issued - Advice on non-credible contingency, 89 and 967 lines out of service.
16:20:00	Constraint equation N>N-LSTN_TE_C1 no longer violating.
16:20:00	Constraint set N-X_MBTE_3 revoked.
16:20:00	Constraint set N-X_MBTE_2 invoked.
16:22:00	Directlink returned to service.
16:30:00	Constraint equation N^N-LS_SVC no longer violating.
16:30:00	Constraint set N-LS_VC1 revoked.
16:30:00	Constraint set N-X_LS_VC1_967_96L invoked.
16:40:42	Circuit breaker 892A at Coffs Harbour opened by TransGrid.
16:41:00	MN 70453 issued – Outage of 967 line and Lismore SVC. Revision to inter-regional transfer limits.
17:00:21	967 line reclosed by TransGrid at Lismore.
17:00:30	96L line returned to service.
17:10:00	Constraint set N-LS_VC1 invoked.
17:10:00	Constraint set N-X_LS_VC1_967_96L revoked.
17:15:00	AEMO conducted an assessment to determine if reclassification of 89 & 967 lines as a credible contingency was required. A reclassification was not required.
17:15:00	Constraint equation N-LS_VC1 violating.
17:15:13	967 line tripped.
17:15:22	967 line auto-reclosed.
17:20:00	MN 70455 issued – Update eon non-credible contingency. Revision of inter-regional transfer limits.
17:29:19	Circuit breaker 892A reclosed by TransGrid at Lismore.
17:35:28	89 line tripped.
17:35:47	89 line auto-reclosed.
18:00:00	MN 70456 issued – Update on non-credible contingency. AEMO will not reclassify.
19:45:00	Based on updated advice from the New South Wales Rural Fire Service, AEMO reclassified the loss of 89 and 967 lines as a credible contingency.
19:45:00	Constraint set N-NIL-89-967_N-2 invoked.
19:54:00	MN 70457 – Reclassification of 89 and 967 lines as a credible contingency event.
11:33:00 (9/10/2019)	MN 70471 – Cancel reclassification of 89 and 967 lines.

A2. System diagram

The diagram below shows the transmission network in northern New South Wales immediately prior to the incidents discussed in this report.