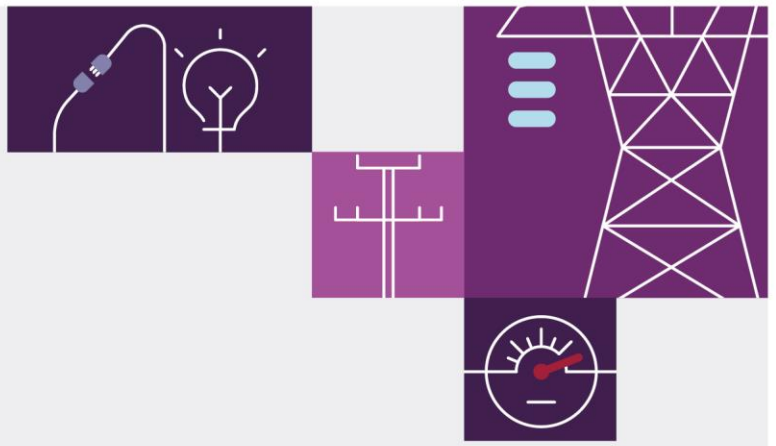


Trip of Liddell – Tomago 330 kV line and the Tamworth SVC on 7 April 2023

September 2023

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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Contact

If you have any questions or comments in relation to this report, please contact AEMO at system.incident@aemo.com.au.

The NEM operates on Australian Eastern Standard Time (AEST). All times in this report are in AEST.

Abbreviations

Abbreviation	Term
AEMC	Australian Energy Market Commission
AEMO	Australian Energy Market Operator
AEST	Australian Eastern Standard Time
kV	kilovolt/s
MW	megawatt/s
NEM	National Electricity Market
NER	National Electricity Rules
OOS	out of service
PTR	permission to restore
PSSWG	Power System Security Working Group
QNI	Queensland – New South Wales interconnector
SVC	static volt-ampere reactive compensator
TNSP	Transmission Network Service Provider

Incident review

This reviewable operating incident¹ report is prepared in accordance with clause 4.8.15(c) of the National Electricity Rules (NER). It has been prepared using information provided by Transgrid² and from AEMO systems.

Table 1 Summary of event

Details	
Reviewable operating incident type	Non-credible contingency event impacting critical transmission elements.
Incident details	This report relates to a reviewable operating incident ³ that occurred on 7 April 2023 in New South Wales. The incident involved the trip of the Liddell – Tomago 330 kilovolt (kV) No. 82 line and the Tamworth 1 330 kV static volt-ampere reactive compensator (SVC).
Incident classification	Transmission equipment failure – Failure of an insulator string and SVC Thyristor control card.
Generation impact	Nil
Customer load impact	Nil
Pre-incident conditions	<p>Tamworth 1 330 kV SVC was commissioned in September 2022, associated with the Queensland – New South Wales Interconnector (QNI) upgrade project.</p> <p>At the time of the incident, four Tamworth 1 330 kV SVC thyristor control cards had known errors which were planned to be cleared. Transgrid had engaged the manufacturer to identify and address the defect that was causing the errors.</p> <p>Immediately prior to the event, a lightning storm was present in the vicinity of Liddell and Tomago substations. This resulted in approximately 10 lightning strikes on or near the Liddell – Tomago 330 kV No. 82 line over a two-hour period.</p>
Incident key events	<ul style="list-style-type: none"> At 2257 hrs on 7 April 2023, the Liddell – Tomago 330 kV No. 82 line tripped. Approximately 3 seconds later, the Tamworth 1 330 kV SVC tripped (see Figure 1 for a post incident diagram of the network). At 1901 hrs on 8 April 2023, the Liddell – Tomago 330 kV No. 82 line returned to service. At 1532 hrs on 18 April 2023, the Tamworth 1 330 kV SVC was placed into service. AEMO had not provided Permission to Restore (PTR) at this time as Transgrid had not sought PTR from AEMO. At 1533 hrs on 18 April 2023, AEMO called Transgrid regarding energisation of Tamworth 1 330 kV SVC. Transgrid advised AEMO that the Tamworth 1 330 kV SVC was placed into service for testing. AEMO asked to be informed when testing was complete, and the Tamworth 1 330 kV SVC remained in service for testing. At 1648 hrs on 18 April 2023: <ul style="list-style-type: none"> Transgrid advised AEMO that Tamworth 1 330 kV SVC testing was completed, and trip of the Liddell – Tomago 330 kV No. 82 line and the Tamworth 1 330 kV SVC was unlikely given the current circumstances. AEMO provided Transgrid PTR for the Tamworth 1 330 kV SVC.
Incident cause	<p>Post incident investigation has confirmed:</p> <ul style="list-style-type: none"> On 7 April 2023 at 2257 hrs, the centre phase insulator string broke on a transmission tower supporting the Liddell – Tomago 330 kV No. 82 line. As a result, the centre phase conductor fell onto the bottom phase tower crossarm and conductors, causing the Liddell – Tomago 330 kV No. 82 line to trip due to a phase to phase fault. The Liddell – Tomago 330 kV No. 82 line protection system attempted to auto-reclose the line, in line with its expected operation. The line tripped again due to a phase to earth fault and the auto-reclose function correctly locked out. Transgrid has confirmed that the transmission tower centre phase insulator string broke due to corrosion of the insulator pin.

¹ Reviewable operating incidents are defined by NER clause 4.8.15(a) and the AEMC Reliability Panel Guidelines for Identifying Reviewable Operating Incidents.

² Transgrid is a Transmission Network Service Provider (TNSP) for New South Wales.

³ 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.

Details	
	<ul style="list-style-type: none"> At 2257 hrs on 7 April 2023, in response to the trip of the Liddell – Tomago 330 kV No. 82 line, the Tamworth 1 330 kV SVC internal control system unexpectedly initiated the SVC trip. Transgrid determined that this was most likely due to a thyristor card fault following cumulative errors in multiple thyristor control cards on a single thyristor stack.
Power system response (facilities and services)	<p>The Tamworth 1 330 kV SVC was placed into service (restoring the SVC's load carrying capability) for testing by Transgrid without obtaining PTR from AEMO. The Outage Assessment guidelines (SO_OP_3718)⁴ state that for out of service (OOS) work, a Transmission Network Service Provider (TNSP) must request PTR from AEMO immediately before carrying out high voltage switching which would restore the load carry capability of the equipment. Transgrid has reviewed the PTR process and has reminded all staff involved of the need to correctly follow PTR protocols.</p> <p>There were no material impacts on the broader power system, load or generation associated with the event.</p>
Rectification	<p>Liddell – Tomago 330 kV No. 82 line trip</p> <p>Soon after the event, on 27 April 2023, Transgrid advised AEMO that they had concluded that the trip of the Liddell – Tomago 330 kV No. 82 line was due to an insulator string failure. Transgrid noted that there was significant corrosion at the point of separation of the failed insulator string. At the failure location, the Liddell – Tomago 330 kV No. 82 line shares a double circuit tower with the Newcastle – Tomago 330 kV No. 95 line. Transgrid replaced the failed insulator string and inspected the remaining insulators on both circuits of the tower. Following inspection, Transgrid replaced insulators on 14 structures along the Liddell – Tomago 330 kV No. 82 line between 13 June 2023 and 18 June 2023 and on 12 structures along the Newcastle – Tomago 330 kV No. 95 line between 24 June 2023 and 30 June 2023.</p> <p>Transgrid also informed AEMO that it:</p> <ul style="list-style-type: none"> Has reviewed the collected asset information of the replaced insulators in accordance with its asset management strategy. Has inspected the failed insulator string in accordance with its asset management strategy and identified the potential failure modes and root cause. Transgrid's initial investigation suggested the corrosion was caused by trapped moisture because the transmission tower was in a low-lying riverine environment. Has undertaken additional sampling of insulator strings meeting similar installation and operating condition criteria to determine if there was an increased likelihood of failure and whether a change in transmission line maintenance plans is required. Has reviewed its asset management strategy, and concluded that it adequately covers the inspection, sampling and replacement of insulator strings and the failure mode observed in this incident. Planned to undertake a second round of sampling in approximately 12 months to monitor the progression of any observed corrosion. <p>Tamworth 1 330 kV SVC trip</p> <p>Later, on 14 June 2023, Transgrid advised AEMO that the Tamworth 1 330 kV SVC most likely tripped due to cumulative errors in multiple thyristor control cards on a single thyristor stack. Transgrid reviewed its network to identify any SVCs at risk of similar thyristor card failures, which identified the Dumaresq 1 330 kV SVC as at risk. Transgrid is managing the risk of future Tamworth 1 330 kV and Dumaresq 1 330 kV SVC trips due to cumulative errors by immediately dispatching staff to manually address the source of error alarms when they are first observed by Transgrid's control room. The intention is to keep the error count as low as possible to minimise the risk of further trips until the manufacturer can remediate the issue. Transgrid is continuing to work with the SVC manufacturer to replace the existing cards of the Tamworth 1 330 kV and Dumaresq 1 330 kV SVCs with newer manufacturer-tested cards and will return error-prone cards to the manufacturer for assessment.</p> <p>Transgrid is continuing to work with the manufacturer to identify the root cause of the thyristor control card errors.</p>
Power system security	<p>The power system remained in a secure operating state throughout this incident and the Frequency Operating Standard⁵ was met during this incident.</p>
Reclassification	<p>AEMO assessed whether to reclassify this incident as a credible contingency event⁶.</p> <p>Transgrid advised AEMO that the cause of this incident had been identified and rectified during the Tamworth No. 1 SVC outage between 7 April 2023 and the SVCs return to service for testing on 18 April 2023. At the time, Transgrid advised AEMO that it believed the trip of the Tamworth 1 330 kV SVC was not related to the trip of the Liddell – Tomago 330 kV No. 82 line. Additionally, when the Tamworth 1 330 kV SVC was returned to service for testing, Transgrid advised AEMO that it was possible for the Tamworth 1 330 kV SVC to trip again during the testing. Transgrid did not specify any external contingencies which could cause the SVC to trip at that time.</p> <p>Upon completion of the SVC testing, Transgrid confirmed to AEMO that the trip of the Liddell – Tomago 330 kV No. 82 line and the Tamworth 1 330 kV SVC was unlikely given the current circumstances.</p>

⁴ Available at https://aemo.com.au/-/media/files/electricity/nem/security_and_reliability/power_system_ops/procedures/so_op_3718-outage-assessment.pdf?la=en.

⁵ Frequency Operating Standard, effective 1 January 2020, available at <https://www.aemc.gov.au/media/87484>.

⁶ 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).

Details	
	<p>AEMO appropriately applied the reclassification criteria and determined the reclassification criteria were not met based on the information available to AEMO at the time.</p> <p>At 1727 hrs on 17 August 2023, the Tamworth 1 330 kV SVC tripped unexpectedly, with Transgrid confirming the trip was most likely due to a thyristor card error. In light of this trip (while Transgrid controls were in place following the previous incident), Transgrid's ongoing investigation and after further discussion with Transgrid, AEMO appropriately applied the reclassification criteria and determined the reclassification criteria were met based on the information available to AEMO at the time. On 23 August 2023, AEMO appropriately reclassified the simultaneous trip of the Liddell – Tomago 330 kV No. 82 line and the Tamworth 1 330 kV SVC as a credible contingency event until further notice.</p>
Market information	<p>For this incident, AEMO issued the following market notices (all market notices for this incident were issued in accordance with NER requirements):</p> <ul style="list-style-type: none"> • AEMO issued Market Notice 107334 at 1821 hrs on 7 April 2023 – Non-credible contingency event more likely to occur due to severe weather in New South Wales region. • AEMO issued Market Notice 107349 at 2310 hrs on 7 April 2023 – Advice of the trip of the Liddell – Tomago 330 kV No. 82 line and Tamworth 1 330 kV SVC. • AEMO issued Market Notice 107350 at 2330 hrs on 7 April 2023 – Advice of the inter-regional transfer limit variation (this market notice was issued in accordance with the Power System Security Guidelines SO_OP_3715⁷). • AEMO issued Market Notice 107351 at 2335 hrs on 7 April 2023 – Cancellation of advice of non-credible contingency event more likely to occur due to severe weather in New South Wales region. • AEMO issued Market Notice 107527 at 1751 hrs on 18 April 2023 – Advice of the return to service of the Tamworth 1 330 kV SVC. • AEMO issued Market Notice 109422 at 1402 hrs on 23 August 2023 – Notification that the trip of Liddell – Tomago 330 kV No. 82 line and the Tamworth 1 330 kV SVC had been reclassified as a credible contingency until further notice.
Conclusions	<p>AEMO has concluded that:</p> <ol style="list-style-type: none"> 1. On 7 April 2023, an insulator string broke due to corrosion of the insulator pin, causing the trip of the Liddell – Tomago 330 kV No. 82 line. Transgrid replaced the failed insulator string prior to the Liddell – Tomago 330 kV No. 82 line's return to service. 2. On 7 April 2023, three seconds after the Liddell – Tomago 330 kV No. 82 line trip, when power system voltages had stabilised, a thyristor card failed causing the Tamworth 1 330 kV SVC to trip unexpectedly. 3. The Outage Assessment (SO_OP_3718)⁸ states that for OOS work, a TNSP must request PTR from AEMO immediately before high voltage switching which would restore the load carry capability of the equipment. PTR was not given prior to return to service of Tamworth 1 330 kV SVC. 4. The cause of this incident was identified and rectified by Transgrid, and AEMO was initially satisfied that the incident was unlikely to re-occur and therefore determined that reclassification was not required. At 1727 hrs on 17 August 2023, the Tamworth 1 330 kV SVC tripped unexpectedly, with Transgrid confirming the trip was most likely due to a thyristor card error. In light of this trip and after further discussion with Transgrid, AEMO reclassified the simultaneous loss of the Liddell – Tomago 330 kV No. 82 line and the Tamworth 1 330 kV SVC as a credible contingency event until further notice. 5. The power system remained in a secure operating state and the Frequency Operating Standard was met during this incident.
Recommendations	<p>AEMO recommends that:</p> <ol style="list-style-type: none"> 1. AEMO and Transgrid share the findings of this incident with the Power System Security Working Group (PSSWG) by Q4 2023. 2. Transgrid continue to work with the SVC manufacturer to identify the root cause of the thyristor card failure and share this information with AEMO and the PSSWG. 3. Transgrid complete its planned replacement of error-prone thyristor cards for the Tamworth 1 330 kV SVC and the Dumaresq 1 330 kV SVC. 4. Transgrid undertake its planned second round of insulator string sampling in approximately 12 months.

⁷ See section 19 of the Power System Security Guidelines at https://aemo.com.au/-/media/files/electricity/nem/security_and_reliability/power_system_ops/procedures/so_op_3715-power-system-security-guidelines.pdf?la=en.

⁸ See sections 6.2.1 and 9.17 of the Outage Assessment at https://aemo.com.au/-/media/files/electricity/nem/security_and_reliability/power_system_ops/procedures/so_op_3718-outage-assessment.pdf?la=en

Figure 1 Post-incident diagram – Trip of Liddell – Tomago No. 82 Line and Tamworth 1 330 kV SVC

