

# Multiple events involving the trip of Buronga synchronous condensers between 11 November 2020 and 30 March 2022

November 2022

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 operational events and the performance of equipment and processes leading up to, during, and after the incidents described. In addition, AEMO has collated information from its own observations, records and systems. Any views expressed in this report 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.

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## Incident classifications

Classification	Detail
Time and date of incident	11 November 2020 to 30 March 2022
Region of incident	New South Wales
Affected regions	New South Wales
Event type	Multiple separate events – protection-control system failure and mal-operation
Generation impact	Multiple separate events – some incidents included generation tripping or operation of generator trip/fast trip/transfer trip schemes (see Table 1 for details)
Customer load impact	None
Associated reports	<i>Trip of Red Cliffs – Kiamal 220 kV line, Kiamal synchronous condenser, Buronga No. 2 and No. 3 synchronous condensers on 1 March 2022<sup>1</sup></i>

## Abbreviations

Abbreviation	Term
AEMC	Australian Energy Market Commission
AEMO	Australian Energy Market Operator
AEST	Australian Eastern Standard Time
CB	circuit breaker
EMI	electromagnetic interference
hrs	hours
KMTS	Kiamal Terminal Station
kV	kilovolt/s
MW	megawatt/s
NEM	National Electricity Market
NER	National Electricity Rules
OEM	original equipment manufacturer
PLC	Programmable Logic Controller
RCTS	Red Cliffs Terminal Station
SC	synchronous condenser
SF	solar farm
TTS	Transfer Tripping Scheme

<sup>1</sup> At [https://aemo.com.au/-/media/files/electricity/nem/market\\_notices\\_and\\_events/power\\_system\\_incident\\_reports/2022/trip-of-red-cliffs-kiamal-220-kv-line.pdf?la=en](https://aemo.com.au/-/media/files/electricity/nem/market_notices_and_events/power_system_incident_reports/2022/trip-of-red-cliffs-kiamal-220-kv-line.pdf?la=en).



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# 1 Overview

This report relates to a series of incidents that occurred between 11 November 2020 and 30 March 2022 involving the Buronga No. 1, No. 2, and No. 3 Synchronous Condensers (SCs) in New South Wales. During this period, there were 20 events where Buronga SCs tripped, along with the associated solar farms (SFs) for which the SCs provide system strength remediation.

AEMO considers that these recurring incidents may involve systemic issues of significance to overall power system operation and has therefore conducted a review under clause 4.8.15(a)(3) of the National Electricity Rules (NER)<sup>2</sup> to identify the root causes of the SC trips.

Through this review AEMO has assessed the adequacy of the provision and response of facilities and services and the appropriateness of actions taken to restore or maintain power system security<sup>3</sup>.

AEMO has concluded that:

1. Faulty logic in the Programmable Logic Controller (PLC) control program was the root cause in five of seven events involving the Buronga No. 1 SC. The SC original equipment manufacturer (OEM) has implemented code corrections to rectify the issues caused by the faulty logic in the PLC.
2. Octopus Investments (owner of the Buronga No. 2 and No. 3 SCs) confirmed that the maloperation of the stator differential protection and vibration protection caused 11 of 13 events involving the Buronga No. 2 and No. 3 SCs. Octopus Investments has identified that the stator differential protection of the Buronga No. 2 and No. 3 SCs is sensitive to external events, which can cause it to operate erroneously. Octopus Investments also confirmed that the Buronga No. 2 and No. 3 SCs have tripped five times on vibration protection due to electromagnetic interference (EMI) from lightning. Octopus Investments and Transgrid (transmission network service provider [TNSP] for New South Wales) are currently investigating these protection maloperation issues.
3. The root causes of the stator differential protection and vibration protection maloperation issues of the Buronga No. 2 and No. 3 SCs are yet to be determined. As such, there is a risk of recurrence of these events resulting from protection issues until the root causes are identified and resolved. Testing and further investigation into the root cause of these protection maloperations is planned during the next scheduled SC outage.
4. Following the event on 1 March 2022, AEMO reclassified the trip of the Kiamal SF – Red Cliffs 220 kilovolt (kV) transmission line at Kiamal. After consulting with Transgrid, AEMO included the Buronga No. 2 and No. 3 SCs in the reclassification from 1536 hrs on 1 March 2022 until further notice. The reclassification of the Buronga No. 2 and No. 3 SCs will remain in place in accordance with NER 4.2.3A until Octopus Investments confirms to AEMO the findings of the site investigation and that the incident is unlikely to re-occur.
5. Inadvertent trips of SCs could present an increasing risk as progressively more SCs are installed across the National Electricity Market (NEM) to manage system strength requirements. As such, defining technical requirements for new SC connections and ensuring that SCs meet these technical requirements is critical for safe and reliable operation of the power system.

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<sup>2</sup> AEMO may review any power system events that it considers of significance to the operation of the power system, including recurring minor incidents of this type, consistent with the Reliability Panel Guidelines for identifying reviewable operating incidents, 1 April 2013, paragraph 6(f). Available at <https://www.aemc.gov.au/sites/default/files/2018-02/Final-revised-guidelines.pdf>

<sup>3</sup> See NER clause 4.8.15(b).



Based on the findings, AEMO makes the following recommendations:

1. AEMO recommends ESCO Pacific (principal representative for owners of the Buronga No. 1 SC) and Octopus Investments review ongoing compliance monitoring programs for Buronga No. 1, No. 2, and No. 3 SCs to ensure these remain fit for purpose.
2. AEMO recommends Transgrid review whether the recent performance of the Buronga No. 1, No. 2, and No. 3 SCs met the technical requirements and, if applicable, review relevant limit advice.
3. AEMO recommends ESCO Pacific and Octopus Investments undertake a full protection relay settings and equipment audit for Buronga No. 1, No. 2, and No. 3 SCs to assess suitability of protection settings and potential for other issues to occur.

ESCO Pacific confirmed that it has taken the following actions to address this recommendation:

- Development of ESCO Pacific SC Availability Improvement Strategy, which is a review of issues impacting availability as well as suggestions to mitigate those issues.
  - Setting up an OEM support contract, which is an agreement with the OEM that includes proactive maintenance to ensure continued SC availability.
  - A general site inspection by an external consultant to confirm compliance with as-built design and relevant Australian Standards.
4. Through these events, AEMO identified issues with assessing the technical performance of the Buronga No. 1, No. 2, and No. 3 SCs due to how their performance standards are defined<sup>4</sup>. AEMO is currently reviewing how best to define performance standards for new synchronous condenser connections as part of the current access standard review<sup>5</sup>. AEMO intends to consult on the recommendations from this review in Q1 2023.
  5. AEMO will share this report directly with other NEM synchronous condenser operators.

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 ESCO Pacific, Octopus Investments and Transgrid and available through AEMO systems.

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

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<sup>4</sup> See AEMO's submission in response to the AEMC's draft determination for the 'Efficient management of system strength on the power system' rule change: [aemo\\_4.pdf \(aemc.gov.au\)](#). In this submission, AEMO recommended that there would be benefit in system strength services establishing performance standards as part of the NER to ensure there is an appropriate regime in place for performance standards and compliance monitoring for system strength services.

<sup>5</sup> See NER clause 5.2.6A(a)

## 2 The incidents

### 2.1 Summary

There are three SCs at Buronga (see Appendix A1):

- ESCO Pacific is the principal representative for the Buronga No. 1 SC, which provides system strength remediation for the Finley 162 megawatts (MW) SF.
- Buronga No. 2 and No. 3 SCs are owned by Octopus Investments and provide system strength remediation for the Darlington Point 275 MW SF.

Buronga SCs are included in Transfer Tripping Schemes (TTS). These schemes are designed to prevent instability during unplanned outages of transmission lines or SCs as follows:

- When the Finley SF TTS is armed, the 33 kV circuit breakers (CBs) at Finley substation are opened to trip Finley SF if the Buronga No. 1 SC trips.
- When the Darlington Point SF TTS is armed, the Darlington Point SF TTS is enabled to open the 33 kV CBs at Darlington Point SF following trip of the Buronga No. 2 and No. 3 SCs.

Between 11 November 2020 and 30 March 2022, there was a total of 20 events involving trip of SCs at Buronga, with root causes related to protection-control system maloperation and failure:

- Buronga No. 1 SC tripped seven times between 15 September 2021 and 30 March 2022.
- Buronga No. 2 SC tripped 13 times between 11 November 2020 and 1 March 2022.
- Buronga No. 3 SC tripped five times between 11 November 2020 and 1 March 2022.

Further details are provided in Appendix A2.

### 2.2 Analysis


This section provides a breakdown of causes of the incident involving the tripping of Buronga No. 1, No. 2, and No. 3 SCs based on the information provided by ESCO Pacific, Octopus Investments, and Transgrid.

#### 2.2.1 Buronga No. 1 SC

The Buronga No. 1 SC tripped seven times in the period 15 September 2021 to 30 March 2022.

##### PLC logic fault

The Buronga No. 1 SC tripped five times due to an overpressure alarm. ESCO Pacific confirmed that the overpressure alarm was triggered due to a pressure surge in the SC bearing oil. The Buronga No. 1 SC lubrication oil system is set up to automatically swap the active and standby oil pumps every seven days. Each time, these pressure surges were observed during this automatic lubrication oil pump changeover process (upon starting the new pump). The control PLC identified the overpressure alarm and a trip signal was sent to the SC protection relay to open the SC CB.



Following the SC OEM's detailed investigation, a logic fault in the PLC was identified as the root cause for these trips. A PLC code correction was carried out on 19 May 2022. Further testing after the code correction work was also completed to confirm the issue was resolved.

### Faulty ethernet switch

On one occasion, the Buronga No. 1 SC tripped due to the maloperation of rotor vibration protection. ESCO Pacific confirmed that a faulty unmanaged ethernet switch caused the maloperation of the rotor vibration protection. This ethernet switch was removed from the control network to prevent this maloperation from occurring in the future.

### Metal shards in the filter element

The Buronga No. 1 SC tripped once due to a lube oil filter alarm. ESCO Pacific confirmed that metal shards in the filter element triggered the lube oil filter alarm. ESCO Pacific confirmed that the filter element has been replaced at the last oil change. Since then, no further lube oil filter alarms/trips have been identified.

## 2.2.2 Buronga No. 2 and No. 3 SCs

There were 13 events involving the Buronga No. 2 and No. 3 SCs in the period 11 November 2020 to 1 March 2022. The sections below provide an analysis into the cause of these incidents, showing that 11 out of 13 events involving the Buronga No. 2 and No. 3 SC were due to the maloperation of stator differential protection or the maloperation of vibration protection.

### Maloperation of the stator differential protection

The Buronga No. 2 and No. 3 SCs tripped six times due to the maloperation of stator differential protection. Octopus Investments confirmed that the stator differential protection was triggered due to external factors in all events. The external factors that caused the maloperation of the stator differential protection were:


- Energisation and restoration of the Buronga – Red Cliffs OX1 220 kV line.
- Transformer energisation at Buronga substation.
- Voltage disturbance due to the tripping of the Karadoc SF.
- Network restoration activities in the area near to the SCs.
- Reclosure of one of the CBs at Kiamal.

Genuine faults that cause the stator differential protection to operate would likely cause damage to the SCs. As such, after each incident, Octopus Investments inspected the SCs thoroughly (inspecting both electrical and mechanical parts) and found no signs of damage. Transgrid has reviewed trip-related information supplied by Octopus Investments. Testing and investigation of the root cause of these incidents is planned during the next scheduled outage of the SCs.

### Maloperation of the vibration protection

The Buronga No. 2 and No. 3 SCs tripped five times due to the maloperation of vibration protection. Octopus Investments confirmed that stormy weather and thunder was present near the site of the Buronga 220 kV substation prior to each of these incidents. Therefore, Octopus Investments suspects that EMI from lightning





caused the vibration protection to maloperate. Transgrid has reviewed trip related information supplied by Octopus Investments. Testing and investigation of the root cause of these incidents is planned during the next scheduled outage of the SCs.

#### Faulty cable

The Buronga No. 2 SC tripped once due to a faulty cable. Octopus Investments confirmed that the faulty cable has been replaced to resolve the issue. Since then, sporadic vibration spikes on the SCs have not been observed.

#### Faulty analogue input card

A faulty analogue input card may have caused the maloperation of the vibration protection in the Buronga No. 2 SC, which tripped the SC once over the considered period. Octopus Investments and the SC OEM are currently investigating the root cause of this incident.

## 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<sup>6</sup>.

The power system remained in a secure operating state throughout these incidents and the Frequency Operating Standard<sup>7</sup> was met.

### 3.1 Reclassification

AEMO assessed whether to reclassify these incidents as credible contingency events<sup>8</sup>.

In relation to the incidents discussed in this report, reclassification was required and issued for one incident. The other incidents were all credible contingencies and as such required no reclassification.

- AEMO correctly reclassified the contingency event involving the trip of the Kiamal SF – Red Cliffs 220 kV transmission line at Kiamal from 0840 hrs on 1 March 2022 until further notice. After consulting with Transgrid, AEMO correctly included the Buronga No. 2 and No. 3 SCs in the reclassification from 1536 hrs on 1 March 2022 until further notice. AEMO made this change due to insufficient evidence at the time that the tripping of the Buronga No. 2 and No. 3 SCs was a separate event from the tripping of Kiamal SF – Red Cliffs 220 kV line and Kiamal SC.
- The reclassification of the Buronga No.2 and No.3 synchronous condensers will remain in place until Octopus Investments confirms to AEMO the outcome of the site investigation and that the incident is unlikely to re-occur.

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<sup>6</sup> 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.

<sup>7</sup> Frequency Operating Standard, effective 1 January 2020, [https://www.aemc.gov.au/sites/default/files/2020-01/Frequency\\_operating\\_standard\\_-\\_effective\\_1\\_January\\_2020\\_-\\_TYPO\\_corrected\\_19DEC2019.PDF](https://www.aemc.gov.au/sites/default/files/2020-01/Frequency_operating_standard_-_effective_1_January_2020_-_TYPO_corrected_19DEC2019.PDF).

<sup>8</sup> AEMO is required to assess whether or not 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).



## 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<sup>9</sup> over the course of these incidents.

As discussed in the event report relating to the event on 1 March 2022<sup>1</sup>, AEMO informed the market of the following matters:

1. A non-credible contingency event – notify within two hours of the event<sup>10</sup>.
  - AEMO issued Market Notice 94972 at 0637 hrs on 1 March 2022, to advise that the Red Cliffs Terminal Station (RCTS) – Kiamal Terminal Station (KMTS) 220 kV line and the Buronga No. 2 and No. 3 SCs had been returned to service.
2. Reclassification, details, and cancellation of a non-credible contingency – notify as soon as practical<sup>11</sup>.
  - AEMO issued Market Notice 94989 at 1536 hrs on 1 March 2022 to update advice that AEMO had added the Buronga No. 2 and No. 3 SCs to the reclassification as a credible contingency until further notice.

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<sup>9</sup> AEMO generally informs the market about operating incidents as they progress by issuing Market Notices – see <https://www.aemo.com.au/Market-Notices>.

<sup>10</sup> 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 7.3.

<sup>11</sup> 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).

## 5 Conclusions

AEMO has assessed these incidents 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. Faulty logic in the PLC control program was the root cause in five of seven events involving the Buronga No. 1 SC. The SC OEM has implemented code corrections to rectify the issues caused by the faulty logic in the PLC.
2. Octopus Investments confirmed that the maloperation of the stator differential protection and vibration protection caused 11 of 13 events involving the Buronga No. 2 and No. 3 SCs. Octopus Investments has identified that the stator differential protection of the Buronga No. 2 and No. 3 SCs is sensitive to external events, which can cause it to operate erroneously. Octopus Investments also confirmed that the Buronga No. 2 and No. 3 SCs have tripped five times on vibration protection due to EMI from lightning. Octopus Investments and Transgrid are currently investigating these protection maloperation issues.
3. The root causes of the stator differential protection and vibration protection maloperation issues of the Buronga No. 2 and No. 3 SCs are yet to be determined. As such, there is a risk of recurrence of these events resulting from protection issues until the root causes are identified and resolved. Testing and further investigation into the root cause of these protection maloperations is planned during the next scheduled SC outage.
4. Following the event on 1 March 2022, AEMO reclassified the trip of the Kiamal SF – Red Cliffs 220 kV transmission line at Kiamal. After consulting with Transgrid, AEMO included the Buronga No. 2 and No. 3 SCs in the reclassification from 1536 hrs on 1 March 2022 until further notice. The reclassification of the Buronga No. 2 and No. 3 SCs will remain in place in accordance with NER 4.2.3A until Octopus Investments confirms to AEMO the findings of the site investigation and that the incident is unlikely to re-occur.
5. Inadvertent trips of SCs could present an increasing risk as progressively more SCs are installed across the NEM to manage system strength requirements. As such, defining technical requirements for new SC connections and ensuring that SCs meet these technical requirements is critical for safe and reliable operation of the power system.

## 6 Recommendations

As a result of this incident review, AEMO has identified a number of issues that require further investigations and potential opportunities to improve operation and processes related to SCs with the intention of enhancing the reliability of the NEM power system. AEMO's recommendations on these matters are set out in this section.

AEMO envisages that the learnings, outcomes, and recommendations of this report will be considered in future to mitigate the risks associated with the high-criticality dynamic assets of the power system including but not limited to SCs.

1. AEMO recommends ESCO Pacific and Octopus Investments review ongoing compliance monitoring programs for Buronga No. 1, No. 2, and No. 3 SCs to ensure these remain fit for purpose.
2. AEMO recommends Transgrid review whether the recent performance of the Buronga No. 1, No. 2, and No. 3 SCs met the technical requirements and, if applicable, review relevant limit advice.
3. AEMO recommends ESCO Pacific and Octopus Investments undertake a full protection relay settings and equipment audit for Buronga No. 1, No. 2, and No. 3 SCs to assess suitability of protection settings and potential for other issues to occur.

ESCO Pacific confirmed that it has taken the following actions to address this recommendation:

- Development of ESCO Pacific SC Availability Improvement Strategy, which is a review of issues impacting availability as well as suggestions to mitigate those issues.
  - Setting up an OEM support contract, which is an agreement with the OEM that includes proactive maintenance to ensure continued SC availability.
  - A general site inspection by an external consultant to confirm compliance with as-built design and relevant Australian Standards.
4. Through these events, AEMO identified issues with assessing the technical performance of the Buronga No. 1, No. 2, and No. 3 SCs due to how their performance standards are defined<sup>12</sup>. AEMO is currently reviewing how best to define performance standards for new synchronous condenser connections as part of the current access standard review<sup>13</sup>. AEMO intends to consult on the recommendations from this review in Q1 2023.
  5. AEMO will share this report directly with other NEM synchronous condenser operators.

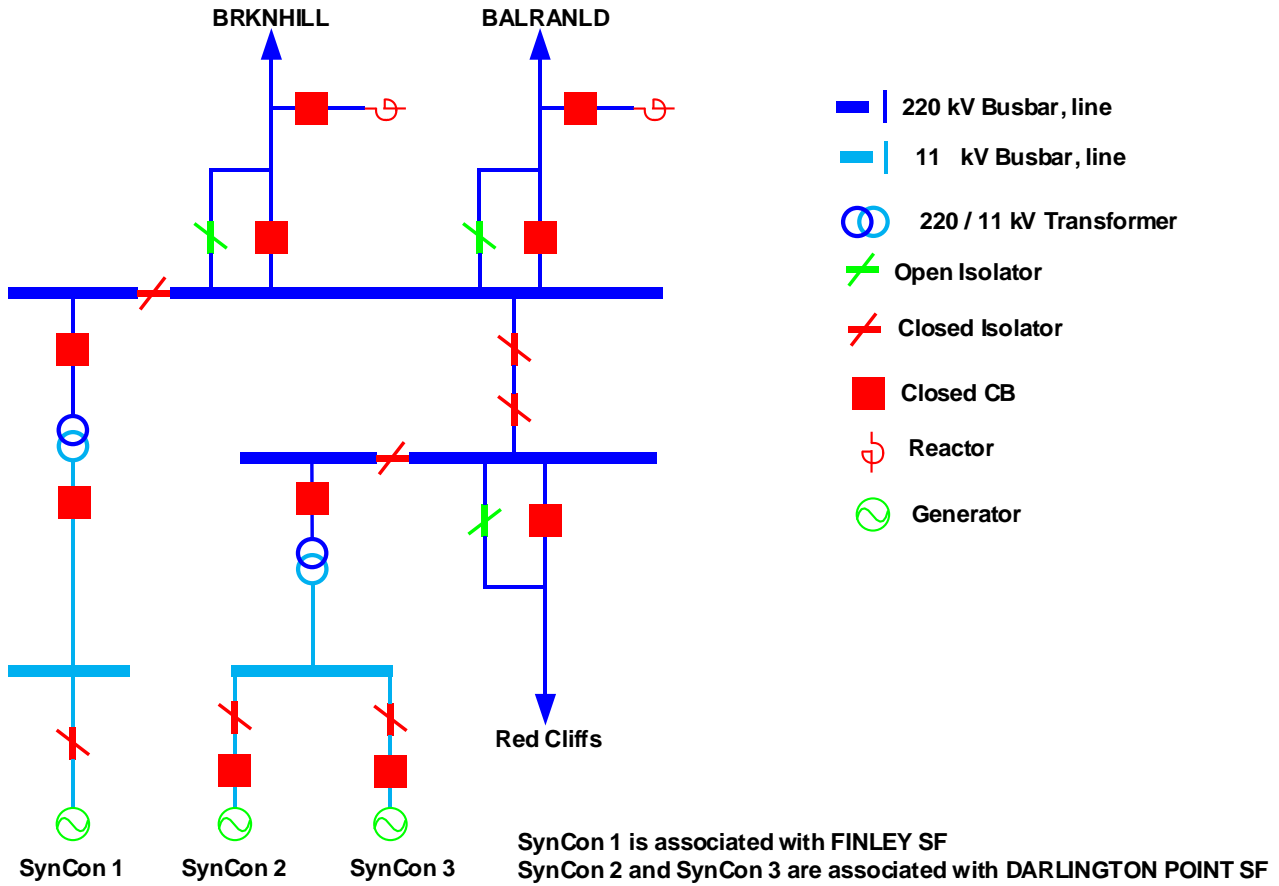
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<sup>12</sup> See AEMO's submission in response to the AEMC's draft determination for the 'Efficient management of system strength on the power system' rule change, at [https://www.aemc.gov.au/sites/default/files/documents/aemo\\_4.pdf](https://www.aemc.gov.au/sites/default/files/documents/aemo_4.pdf). In this submission, AEMO recommended that there would be benefit in system strength services establishing performance standards as part of the NER to ensure there is an appropriate regime in place for performance standards and compliance monitoring for system strength services.

<sup>13</sup> See NER clause 5.2.6A(a)

# A1. System diagram

Figure 1 SCs No. 1, No. 2, and No. 3 at Buronga substation



## A2. The incidents

Table 1 provides details of the incidents involving the tripping of Buronga SC No. 1, No. 2, and No. 3 from 11 November 2020 to 30 March 2022.

**Table 1 Details of the incidents involving the tripping of Buronga SC No. 1, No. 2, and No. 3 from 11 November 2020 to 30 March 2022**

Date	Tripped SC No.	Incident key events	Incident category	Incident cause	Status
<b>11 November 2020</b>	2 and 3	The Buronga No. 2 and No. 3 SCs tripped at approximately 1305 hrs.	Protection-control system maloperation – Maloperation of stator differential protection.	The SCs tripped due to the maloperation of stator differential protection.	Under investigation
<b>25 May 2021</b>	2 and 3	The Buronga No. 2 and No. 3 SCs tripped at approximately around 1645 hrs while restoring Buronga-Redcliffs OX1 220 kV line.	Protection-control system maloperation – Maloperation of stator differential protection.	Octopus Investments confirmed that the SCs tripped during the restoration of the Buronga — Redcliffs OX1 220 kV line due to maloperation of stator differential protection.	Under investigation
<b>17 July 2021</b>	2	The Buronga No. 2 SC tripped at approximately 2120 hrs due to maloperation of the vibration protection. The SC was restarted and successfully re-synchronised at approximately 2320 hrs.	Protection-control system maloperation – Maloperation of vibration protection.	The SC tripped due to the maloperation of the vibration protection.	Under investigation
<b>23 July 2021</b>	2	The Buronga No. 2 SC tripped at approximately 1912 hrs. The SC was re-synchronised at approximately 2111 hrs.	Protection-control system failure - Faulty cable caused large errors in the analogue values.	Octopus Investments confirmed that the issue was identified as a faulty cable, which was later replaced. The faulty cable had caused large errors in the analogue values that were fed into the control system of the SC.	Resolved
<b>19 August 2021</b>	2	The Buronga No. 2 SC tripped at approximately 1648 hrs. The SC was re-synchronised with the network at approximately at 2250 hrs.	Protection-control system maloperation – Maloperation of stator differential protection.	Octopus Investments confirmed that the Buronga No. 2 SC tripped due to the maloperation of the stator differential protection while Transgrid was energising the Redcliffs — Buronga OX1 220 kV line at the Buronga substation. The cause of this protection maloperation is currently unknown.	Under investigation
<b>15 September 2021</b>	1	The Finley SF tripped approximately at 0624 hrs as the Buronga No. 1 SC failed to start.	Protection-control system failure – Small shards of metal in the service filter element.	ESCO Pacific confirmed that the lube oil filter alarm was triggered, which caused the pre-start conditions to timeout and prevented the SC from starting. Transgrid have reported to ESCO Pacific that small shards of metal were found in the	Resolved

Date	Tripped SC No.	Incident key events	Incident category	Incident cause	Status
				service filter element after it was removed for inspection. ESCO Pacific confirmed that the SC lubrication system had experienced metal contamination from the piping system during commissioning. ESCO Pacific also confirmed that the residual metal left in the system was caught in the filter element and triggered the lube oil filter alarm.	
<b>18 September 2021</b>	2 and 3	The Buronga No. 2 and No. 3 SCs tripped at approximately 1619 hrs during planned restoration of Buronga No. 1 SC. The Buronga No. 2 and No. 3 SCs were re-synchronized with the grid at approximately 1631 hrs.	Protection-control system maloperation – Maloperation of stator differential protection.	Octopus Investments confirmed the trip occurred during planned restoration of the Buronga No. 1 SC. The Buronga No. 1 SC transformer energisation at the Buronga substation caused the maloperation of the stator differential protection in the Buronga No. 2 and No. 3 SCs.	Under investigation
<b>25 September 2021</b>	2 and 3	On 25 September 2021 at approximately 0745 hrs, following the trip of Karadoc SF, the Buronga No. 2 and No. 3 SCs tripped due to maloperation of the stator differential protection. The Darlington Point SF TTS tripped the Darlington Point SF from 61 MW. Octopus Investments confirmed that SC restoration took longer than anticipated due to issues with an automatic voltage regulator fault alarm which can sometimes trigger when the SC gets up to speed and initiates its synchronisation procedure. During the SC restoration, Karadoc SF reportedly attempted re-energisation at around 1045 hrs, which led to the trip of Karadoc SF. At the same time, the Buronga No. 2 and No. 3 SCs tripped again due to maloperation of the same stator differential protection. The Buronga No. 3 and No. 2 SCs were synchronised at approximately 1303 hrs and 1451 hrs, respectively.	Protection-control system maloperation – Maloperation of stator differential protection.	Prior to the trip of the Buronga No. 2 and No. 3 SCs, Karadoc SF in Victoria had been tripped due to a fault. Octopus Investments confirmed that the trip of the Karadoc SF resulted in a voltage disturbance that caused the maloperation of the stator differential protection in the SCs.	Under investigation
<b>28 October 2021</b>	2	The Buronga No. 2 SC tripped at approximately 0123 hrs due to maloperation of vibration protection. The Buronga No. 2 SC was re-synchronised at approximately 1736 hrs.	Protection-control system failure – Faulty analogue input card.	Octopus Investments confirmed that a faulty analogue input card may have caused the maloperation of the vibration protection.	Under investigation
<b>06 November 2021</b>	2	Trip of Buronga No. 2 SC.	Protection-control system maloperation – Maloperation of stator differential protection.	Octopus Investments confirmed the trip occurred during planned network restoration activities conducted by Transgrid following a significant number of planned outages in the area. Octopus Investments also confirmed that the network restoration activities caused the maloperation of the stator differential protection in the SC.	Under investigation



Date	Tripped SC No.	Incident key events	Incident category	Incident cause	Status
17 December 2021	1	Since 13 December 2021, Transgrid were working on a communications issue. This work was between the SC remote terminal unit and Transgrid's SCADA system. At approximately 0905 hrs, the Buronga No. 1 SC protection relay tripped the SC due to a vibration fault. Consequently, the Finley SF TTS tripped Finley SF from 123 MW. At approximately 1240 hrs, the SC was restored back to service with the SC OEM's assistance.	Protection-control system failure – Faulty unmanaged ethernet switch.	ESCO Pacific confirmed that an investigation team, which included ESCO Pacific, SC OEM, and Transgrid, identified a faulty unmanaged ethernet switch as the cause for the maloperation of the vibration protection. The faulty unmanaged ethernet switch was removed from the control network. Following the removal of the faulty ethernet switch, Transgrid confirmed that all monitoring signals were restored and indicating as healthy.	Resolved
19 December 2021	2	The Buronga No. 2 SC tripped approximately at 0234 hrs due to maloperation of its vibration protection. The Buronga No. 2 SC was re-synchronised with the network at approximately 0515 hrs.	Protection-control system maloperation – EMI from lightning led to the maloperation of the vibration protection.	Prior to the trip, stormy weather and thunder was reported near to the Buronga 220 kV substation. Octopus Investments suspects that EMI from lightning caused the maloperation of vibration protection in the SC.	Under investigation
13 January 2022	1	The Buronga No. 1 SC tripped. Transgrid was able to restart the Buronga No. 1 SC.	Protection-control system maloperation – Logic fault in the PLC control program.	Transgrid notified ESCO Pacific that the Buronga No. 1 SC was tripped due to over pressure in the bearings. ESCO Pacific confirmed that a pressure surge was detected in the bearings on starting a new pump. This triggered an overpressure alarm to trip the Buronga No. 1 SC.	Resolved
26 January 2022	1	The trip of Buronga No. 1 SC. The Finley SF TTS tripped the Finley SF from 35 MW.	Protection-control system maloperation – Logic fault in the PLC control program.	ESCO Pacific confirmed that the SC was tripped on a bearing oil pressure D-End alarm. SC OEM and Transgrid identified that the Bearing Oil Pressure D-End alarm logic was incorrectly enabled in the PLC control program (as an older version of the program was stored in the PLC).	Resolved
26 January 2022	2	At approximately 1453 hrs, the SC protection relay tripped the Buronga No. 2 SC due to maloperation of the vibration protection. The Darlington Point SF TTS tripped the Darlington Point SF from 260 MW. The Buronga No. 2 SC was initially restored to service that afternoon at approximately 1617 hrs. However, the Buronga No. 2 SC tripped again later in the evening at approximately 2059 hrs. The Buronga No. 2 SC was left de-energised (with the Buronga No. 3 SC remaining in service) throughout the rest of 26 January 2022 until local storm activity had been passed. The Buronga No. 2 SC was restored to service on the morning of 27 January 2022 at approximately 0924 hrs.	Protection-control system maloperation – EMI from lightning led to the maloperation of the vibration protection.	Prior to the trip, stormy weather and thunder was reported near to the Buronga 220 kV substation. Octopus Investments suspects that EMI from lightning caused the maloperation of vibration protection in the SC.	Under investigation

Date	Tripped SC No.	Incident key events	Incident category	Incident cause	Status
28 February 2022	2	The SC No. 2 tripped approximately at 1044 hrs due to the maloperation of vibration protection. The Darlington Point SF TTS tripped the Darlington Point SF from 34 MW.	Protection-control system maloperation –EMI from lightning led to the maloperation of the vibration protection.	Prior to the trip, stormy weather and thunder was reported near to the Buronga 220 kV substation. Octopus Investments suspects that EMI from lightning caused the maloperation of vibration protection in the SC.	Under investigation
01 March 2022	2 and 3	The Buronga No. 2 and No. 3 SCs tripped at 0423 hrs. The Buronga No. 2 and No. 3 SCs were successfully reclosed at 0616 hrs and 0626 hrs, respectively*.	Protection-control system maloperation – Maloperation of stator differential protection.	The Kiamal SF – Red Cliffs 220 kV transmission line was tripped at around 0423 hrs due to a three-phase fault. Immediately following the successful reclosure of one of the breakers at Kiamal, the Buronga No. 2 and No. 3 SCs tripped due to the maloperation of stator differential protection.	Under investigation
10 March 2022	1	The Buronga No. 1 SC tripped due to overpressure in the bearings. Transgrid was able to reset the fault and restart the Buronga No. 1 SC.	Protection-control system maloperation –Logic fault in the PLC control program.	ESCO Pacific confirmed that a pressure surge was detected in the bearings on starting a new pump. This triggered an overpressure alarm, which tripped the Buronga No. 1 SC.	Resolved
17 March 2022	1	The Buronga No. 1 SC tripped due to overpressure in the bearings. Transgrid was able to reset the fault and restart the Buronga No. 1 SC.	Protection-control system maloperation –Logic fault in the PLC control program.	ESCO Pacific confirmed that a pressure surge was detected in the bearings on starting a new pump. This triggered an overpressure alarm, which tripped the Buronga No. 1 SC.	Resolved
30 March 2022	1	The Buronga No. 1 SC tripped due to overpressure in the bearings. Transgrid was able to reset the fault and restart the Buronga No. 1 SC.	Protection-control system maloperation –Logic fault in the PLC control program.	ESCO Pacific confirmed that a pressure surge was detected in the bearings on starting a new pump. This triggered an overpressure alarm, which tripped the Buronga No. 1 SC.	Resolved