

# Trip of Kerang – Wemen – Red Cliffs 220 kV line and Kiamal synchronous condenser transformer on 11 December 2022

May 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.

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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      |
| CB           | circuit breaker                       |
| CBM          | Circuit Breaker Management            |
| KGTS         | Kerang Terminal Station               |
| KMTS         | Kiamal Terminal Station               |
| KSF          | Kiamal Solar Farm                     |
| kV           | kilovolts                             |
| MW           | megawatts                             |
| NEM          | National Electricity Market           |
| NER          | National Electricity Rules            |
| PIT          | Permissive Inter Trip                 |
| RCTS         | Red Cliffs Terminal Station           |
| syncon       | Synchronous condenser                 |
| TNSP         | Transmission Network Service Provider |
| VFRB         | Very Fast Run Back                    |
| WETS         | Wemen Terminal Station                |

# Incident review

This reviewable operating incident<sup>1</sup> 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 AusNet<sup>2</sup>, Transgrid<sup>3</sup>, Powercor Australia<sup>4</sup>, Foresight Solar Australia Pty Ltd<sup>5</sup>, WIRSOL Australia<sup>6</sup>, Total Eren<sup>7</sup> and from AEMO systems.

**Table 1 Summary of event**

| Details                                   |  |
|---|--|
| <b>Reviewable operating incident type</b> | Non-credible contingency event impacting critical transmission elements.   |
| <b>Incident details</b>                   | This report relates to a reviewable operating incident <sup>8</sup> that occurred on 11 December 2022 in Victoria. The incident involved the simultaneous trip of the Kerang Terminal Station (KGTS) – Wemen Terminal Station (WETS) – Red Cliffs Terminal Station (RCTS) 220 kilovolts (kV) line, as well as the synchronous condenser (syncon) transformer at Kiamal Terminal Station (KMTS). See Appendix A1 for a simplified single line diagram of the impacted system elements.  |
| <b>Incident classification</b>            | Other causes – human error – incorrect algorithm applied to transformer differential protection causing protection to mal-operate.   |
| <b>Generation impact</b>                  | 55 megawatts (MW) of generation due to the correct operation of Wemen Solar Farm and Bannerton Solar Farm anti-islanding protection.   |
| <b>Customer load impact</b>               | 27 MW of load supplied from Wemen, Boundary Bend and Ouyen 66 kV substations was lost due to the disconnection of WETS.  |
| <b>Pre-incident conditions</b>            | There was an unplanned outage of the Kiamal syncon prior to this event which commenced at 0736 hrs on 21 September 2022, with an expected return to service date by 14 June 2023. The Kiamal syncon inter-trip scheme <sup>9</sup> was disabled and Kiamal Solar Farm (KSF) output was constrained to 50 MW due to unavailability of the Kiamal syncon.<br>Prior to the event, Wemen Solar Farm was generating 11 MW and Bannerton Solar Farm was generating 34 MW.  |
| <b>Incident key events</b>                | <ol style="list-style-type: none"> <li>At 1157 hrs on 11 December 2022: <ul style="list-style-type: none"> <li>The KGTS – WETS – RCTS 220 kV transmission line tripped and did not reclose.</li> <li>Simultaneously, the 7422B and RC2A circuit breakers (CBs) at KMTS opened, disconnecting the Kiamal syncon transformer.</li> <li>AEMO noted that there was lightning activity in the vicinity of this equipment.</li> </ul> </li> <li>At 1215 hrs on 11 December 2022, the KGTS – WETS – RCTS 220 kV line was returned to service.</li> <li>At 1310 hrs on 15 December 2022, the Kiamal syncon transformer was returned to service.</li> </ol> |
| <b>Incident cause</b>                     | <ul style="list-style-type: none"> <li>Post incident investigation by Total Eren has confirmed that:</li> <li>The Kiamal syncon transformer differential protection mal-operated in response to the trip of the KGTS – WETS – RCTS 220 kV line.</li> </ul>   |

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

<sup>2</sup> Ausnet is the Transmission Network Service Provider for Victoria.

<sup>3</sup> Transgrid is the owner of the Kiamal Terminal Station (KMTS) including 7422B and RC2A circuit breakers (CBs).

<sup>4</sup> Powercor Australia is an Australian electricity distribution service provider that operates throughout western Victoria and the western suburbs of Melbourne.

<sup>5</sup> Foresight Solar Fund Limited is the asset owner of the Bannerton Solar Park, located near Robinvale, Victoria.

<sup>6</sup> WIRSOL Australia is the asset owner of the Wemen Solar Farm, located near Mildura in Victoria.

<sup>7</sup> Total Eren is the majority owner of the Kiamal Solar Farm and the Kiamal syncon and the syncon transformer located north of Ouyen, Victoria.

<sup>8</sup> 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.

<sup>9</sup> An automated control scheme which monitors the Kiamal syncon CB status, and, if the CB is offline, will block the solar farm inverters, and stop all active and reactive power output of the KSF within 600 milliseconds (ms).

| Details  |   |
|--|---|
|  | <ul style="list-style-type: none"> <li>The Kiamal syncon transformer protection system comprises two Siprotec 4 protection relays (SIP4 and SIP5) for differential protection. The original equipment manufacturer (OEM), Siemens, concluded that only the SIP4 relay operated during this incident. Siemens has confirmed that the due to human error an incorrect algorithm had been applied to the calculation of the stabilisation current for the differential protection function. This error caused the relay to mal-operate in response to the KGTS – WETS – RCTS 220 kV line trip.</li> <li>Post incident investigation by AusNet has confirmed that:</li> <li>The trip of the KGTS – WETS – RCTS 220 kV line was due to a red-phase-to-ground fault caused by lightning. The X and Y<sup>10</sup> distance protection schemes correctly operated at all three ends of the line (KGTS, WETS and RCTS) via its Permissive Inter Trip (PIT) scheme. The fault was cleared after 59 milliseconds (ms), which is within in the NER maximum fault clearance time.</li> <li>The KGTS – WETS – RCTS 220 kV line did not successfully auto reclose, because the “dead voltage” threshold of the auto reclose scheme was set too low. This meant the auto reclose scheme could not reliably detect the de-energised line and initiate the auto reclose sequence.</li> </ul> |
| <b>Power system response (facilities and services)</b> | <p>The trip of the KGTS – WETS – RCTS 220 kV line disconnected the WETS and the downstream network (including Wemen, Boundary Bend and Ouyen 66 kV substations, and Wemen and Bannerton Solar Farms) supplied from WETS. In response to the island condition, Wemen Solar Farm’s and Bannerton Solar Farm’s anti-islanding protection operated correctly, tripping 55 MW of generation. See Appendix A1 for the single line diagram of the transmission system.</p> <p>There was no other material impact on the broader power system, load or generation following this incident</p>   |
| <b>Rectification</b>                                   | <p>Total Eren requested Siemens replace the incorrect SIP4 relay algorithm with the correct settings. Siemens completed the SIP4 relay protection remedial works on 3 May 2023.</p> <p>Ausnet rectified the “dead voltage” issue on 9 February 2023 by increasing the “dead voltage” setting of the relay. Ausnet has confirmed there is no requirement to conduct a broader review of other line auto reclose settings, because each relay’s settings are designed and tested individually at the time of installation and as part of normal maintenance.</p>  |
| <b>Power system security</b>                           | <p>The power system remained in a secure operating state throughout this incident and the Frequency Operating Standard<sup>11</sup> was met for this incident.</p>  |
| <b>Reclassification</b>                                | <p>AEMO assessed whether to reclassify this incident as a credible contingency event<sup>12</sup>.</p> <p>As the cause of the trip of the simultaneous trip of the KGTS – WETS – RCTS 220 kV line and the KSF syncon transformer could not be identified, AEMO correctly reclassified this contingency as credible at 1310 hrs on 15 December 2022.</p> <p>AEMO removed the reclassification of this event as a credible contingency at 1700 hrs on 15 May 2023 after Total Eren informed AEMO that the required SIP4 protection relay remedial works had been completed.</p>   |
| <b>Market information</b>                              | <p>For this incident, AEMO issued the following market notices (MNs) – all MNs for this incident were issued in accordance with NER requirements:</p> <ul style="list-style-type: none"> <li>MN104350 at 1214 hrs on 11 December 2022 to inform the market of the intra-regional transfer limit variation due to loss of KGTS – WETS – RCTS 220 kV line.</li> <li>MN104350 at 1238 hrs on 11 December 2022 to inform the marker of an update the intra-regional transfer limit variation following the KGTS – WETS – RCTS 220 kV line being returned to service.</li> <li>MN104353 at 1311 hrs on 11 December 2022 to provide advice of the non-credible contingency event.</li> <li>MN104481 at 1319 hrs on 15 December 2022 to advise reclassification of the simultaneous trip of the KGTS – WETS – RCTS 220 kV line and the KSF syncon transformer as a credible contingency event until further notice.</li> <li>MN107915 at 1700 hrs on 15 May 2023, cancellation of the reclassification (see MN104481) of the simultaneous trip of the KGTS – WETS – RCTS 220 kV line and the KSF syncon transformer as a credible contingency.</li> </ul>  |
| <b>Recommendations</b>                                 | <p>AEMO plans to discuss the findings from this event at the Power System Security Working Group by the end Q2 2023.</p>  |

<sup>10</sup> X and Y are the duplicate protection schemes installed in the Ausnet network in accordance with the NER S5.1.8 and S5.1.9 and Ausnet protection design standards.

<sup>11</sup> Please see <https://www.aemc.gov.au/sites/default/files/2020-01/Frequency%20operating%20standard%20-%20effective%201%20January%202020%20-%20TYPO%20corrected%2019DEC2019.PDF>.

<sup>12</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).

# A1. Single line diagrams

Figure 1 Single line diagram at Kiamal Terminal Station

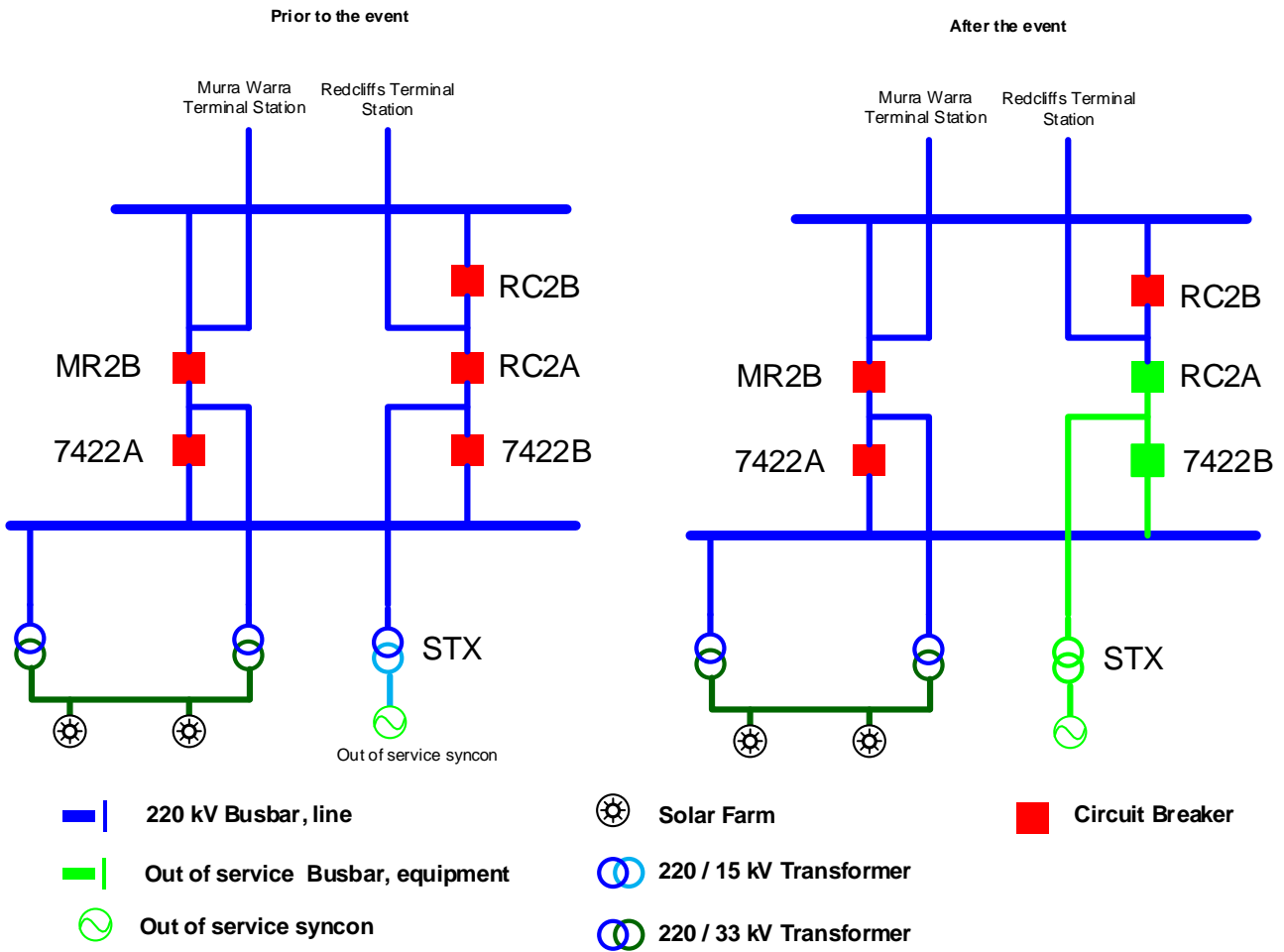


Figure 2 Network configuration prior to the event

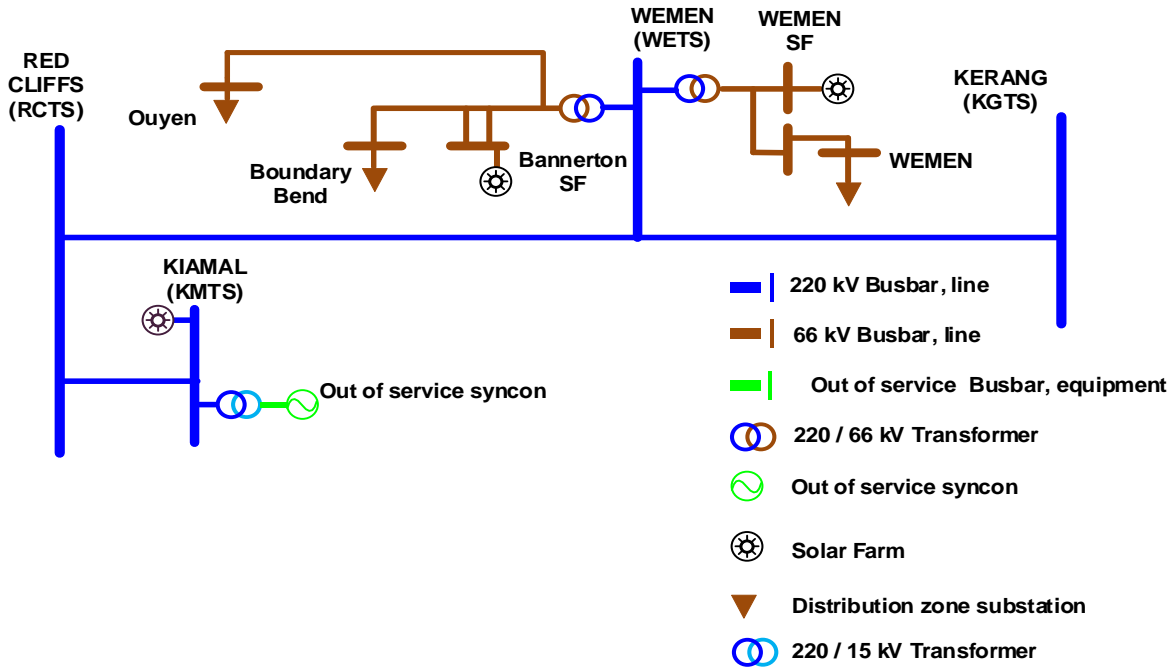


Figure 3 Network configuration after the event

