AEMO
AUSTRALIAN ENERGY MARKET OPERATOR

Newport 220 kV Bus 1 and Fishermans Bend 220/66 kV Transformer B2 Trip on 14 May 2021

November 2021

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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CONTACT

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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
BLTS	Brooklyn Terminal Station
CB	Circuit breaker
CT	Current transformer
FBTS	Fisherman Bends Terminal Station
kV	Kilovolt
NEM	National Electricity Market
NPDS	Newport D Power Station
NER	National Electricity Rules
REF	Restricted Earth Fault
TNSP	Transmission Network Service Provider
WMTS	West Melbourne Terminal Station

Incident review

This reviewable operating incident[1] 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 Services (AusNet)[2] and from AEMO systems.

Table 1 Summary of event – Trip of Newport D Power Station No. 1 220 kV busbar and Fisherman Bend 220/66 kV transformer B2

	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 14 May 2021 in Victoria. The incident involved the trip of Newport D Power Station No. 1 220 kV busbar (NPSD No. 1 busbar) and Fisherman Bend 220/66 kilovolt (kV) transformer B2 (FBTS B2 transformer).
Incident classification	• Human error • Transmission equipment failure at NPSD. • Protection/control system mal-operation at FBTS.
Generation impact	Nil
Customer load impact	Nil
Pre-incident conditions	On 14 May 2021, prior to the incident, there was a planned outage of the NPSD No. 1 busbar and the Newport – Brooklyn (NPDS – BLTS) 220 kV line. Newport D Power Station was not operating prior to the incident and was disconnected from the power system.
Incident key events	1. At 1446 hrs, permission to restore was issued by AEMO for the planned outage of the NPSD No. 1 busbar and the NPDS – BLTS 220 kV line. 2. At 1458 hrs, the NPSD No. 1 busbar was energised from BLTS by closing the NPSD – BLTS 220 kV line Circuit Breaker (CB). 3. At 1501 hrs, the NPSD No. 1 busbar tripped due to operation of its X and Y high impedance busbar protection. This tripped the NPSD – BLTS 220 kV line CB (at the NPSD end), which was the only CB closed on to the NPSD No. 1 busbar at the time. 4. After the trip of the NPSD – BLTS 220 kV line CB, to ensure the correct operation of the CB, the NPSD – BLTS 220 kV line was deenergised and the CB at the NPSD end was test closed by the Ausnet controller. 5. At 1502 hrs, the NPSD tie bus CB 2 was closed. Then, after a few seconds, the NPSD – BLTS 220 kV line CB was again closed to energise the NPSD No. 1 busbar from BLTS and tripped immediately. 6. Similar to step 4, the NPSD – BLTS 220 kV line CB and tie bus CB 1 were test closed/opened to ensure correct operation and subsequently the busbar restoration continued. 7. At 1520 hrs, the NPSD – BLTS 220 kV line CB was closed for a third time to energise the NPSD No. 1 busbar from BLTS.

[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] AusNet Services is the Transmission Network Service Provider (TNSP) in the Victoria region.

[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
	8. At 1521 hrs, the tie bus CB 1 was closed and the NPSD No. 1 busbar was also supplied via the NPSD No. 2 busbar. This action placed the NPSD – BLTS 220 kV line and NPDS – FBTS 220 kV line on-load. 9. At 1521 hrs on 14 May 2021: 9.1. Approximately 14 seconds after the tie bus CB 1 was closed, the NPDS No. 1 busbar tripped due to its X and Y high impedance busbar protection. This tripped the NPSD – BLTS 220 kV line CB and tie bus CB 1. 9.2. The FBTS B2 220/66 kV transformer tripped from both low voltage and high voltage sides (the B1-B2 CB and B2-B3 CB) which resulted in the FBTS No. 2 busbar being de-energised. 10. At 1523 hrs on 14 May 2021, two minutes after trip of the FBTS B2 220/66 kV transformer, the FBTS B3 220/66 kV transformer, which is normally energised but kept out off load (shown in Figure 1), was placed in service by closing its low voltage CB to secure load in FBTS with three in service transformers. 11. At 1633 hrs on 14 May 2021: 11.1. The FBTS B2 220/66 kV transformer was isolated by opening its high voltage isolator. 11.2. The FBTS No. 2 busbar returned to service by closing the B1-B2 CB and B2-B3 CB. 12. At 2105 hrs on 14 May 2021, the FBTS B2 220/66 kV transformer returned to service with its Y REF protection out of service. 13. Following replacement of the NPSD No. 1 white phase chamber, at 1159 hrs on 1 June 2021, the NPSD No. 1 busbar returned to service.
Incident cause	• Post-incident investigation by AusNet concluded that an internal arc fault in the white phase busbar chambers at NPSD[4] occurred and triggered the X and Y high impedance busbar protection. • Coincident with the fault at NPSD at 1521 hrs, the FBTS B2 220/66 kV transformer Y REF protection operated for the fault at NPSD. This was not expected as the fault was outside the protection zone of the Y REF protection.
Power system response (facilities and services)	Post incident investigation by AusNet has concluded that: • The Y REF protection of the FBTS B2 220/66 kV transformer had the correct settings. • The cause of operation of the Y REF protection was linked to the current transformer (CT) of the B1-B2 CB, which was likely saturated before the REF protection operation. • The CT of the B2-B3 CB was not saturated for the same fault at NPSD. • The CT specifications were correct and the test results of both CTs were consistent. The saturation of CT of B1-B2 CB was likely caused by an uneven CT remanence[5]. • The FBTS B2 220/66 kV transformer X REF protection did not operate for the same fault at NPSD. AusNet advised that during an equipment restoration process, if any equipment is identified as tripping due to a protection operation, the restoration process would stop, and the cause of trip investigated. However, during restoration of the NPSD No. 1 busbar, AusNet attempted restoration of the NPSD No. 1 busbar three separate times. Post incident investigation has confirmed that: • When the first trip of the NPSD No. 1 busbar happened (Step 3, Incident key events), the AusNet controller did not notice SCADA alarms indicating the trip was initiated by protection operation. In addition, given that the NPSD No. 1 busbar remained energised for around 3 minutes and 36 seconds, from 1458 hrs to 1501 hrs, the controller incorrectly assumed that the NPSD – BLTS 220 kV line CB tripped mechanically. After testing the CBs operation (Step 4, Incident key events), a second attempt to restore the NPSD No. 1 busbar was made. As described earlier, if the SCADA alarms were noticed at Step 3, Incident key events, the restoration process would have stopped, and the cause of trip would be investigated. • After the first trip of the NPSD No. 1 busbar, the SCADA alarms reset while the protection relays had not been reset and their output signals remained active. The second trip of the NPSD No. 1 busbar happened immediately after the NPSD – BLTS 220 kV line CB was closed (Step 5, Incident key events) as the bus protection relay trip outputs were still active. There were no new SCADA alarms indicating a fault caused the trip of the NPSD – BLTS 220 kV line CB. • Therefore, a third attempt to restore the NPSD – BLTS 220 kV line CB was made. This resulted in simultaneous trip of the NPSD No. 1 busbar and the FBTS B2 220/66 kV transformer. At this point the AusNet controller

[4] NPSD has Gas Insulated Switchgear (GIS) on site. The busbars on site are in chambers filled with SF6 gas for insulation.

[5] A magnetic flux which remains in the magnetic circuit when there is no current on the primary side is called Residual Flux Density or Remanence. A CT with high remanence in its magnetic circuit can reach CT saturation earlier when a fault current produces a flux in the CT's magnetic circuit with same sign of the CT's remanence.

	Details
	identified protection operation alarms in the SCADA system and ceased attempts to re-energise the affected equipment.
Rectification	To prevent the recurrence of this type of incident, the following actions were completed by AusNet: • The NPSD No. 1 busbar white phase chambers were replaced, and high voltage testing was carried out. • The FBTS B2 220/66 kV transformer Y REF protection setting was modified, as recommended by the relay manufacturer. • In order to raise awareness and prevent multiple attempts to restore equipment following protection operation, details of this incident have been discussed at AusNet's controller working group.
Power system security	The power system remained in a secure operating state throughout this incident.
Reclassification	AEMO assessed whether to reclassify this incident as a credible contingency event[6]. AusNet advised AEMO that the cause of the trip of the NPDS No. 1 busbar and the FBTS B2 220/66 kV transformer had been identified and the incident was unlikely to reoccur. Based on this advice, AEMO determined the incident was unlikely to reoccur and therefore correctly determined that reclassification as a credible contingency event was not required.
Market information	For this incident, AEMO issued the following market notices (all market notices for this incident were issued in accordance with NER requirements): • AEMO issued Market Notice 85442 at 1611 hrs on 14 May 2021 advising of the non-credible contingency event. • AEMO issued Market Notice 86378 at 1209 hrs on 1 June 2021 advising that AEMO will not reclassify the event as a credible contingency event.
Conclusions	AEMO has concluded that: 1. The trip of the NPDS No. 1 busbar and the FBTS B2 220/66 kV transformer was likely caused by the internal arc fault at the NPSD white phase chambers. 2. The NSPD No. 1 busbar protection operated as expected and as designed to clear the fault at NSPD. 3. AusNet controller failed to identify SCADA alarms related to busbar protection operation after the first attempt. AusNet have confirmed that, in line with their procedures, if the protection operations had been identified the restoration process would have stopped, and the cause of trip would be investigated. 4. The FBTS B2 220/66 kV transformer Y REF protection operated unexpectedly at FBTS for a fault outside the protection zone. 5. Based on information provided by AusNet at the time of the incident, AEMO was satisfied that the reason had been identified and a reoccurrence of this incident was unlikely, therefore the incident was correctly not reclassified as a credible contingency. 6. The power system remained in a secure operating state throughout this incident. 7. AusNet subsequently implemented revised FBTS B2 220/66 kV transformer Y REF protection settings as recommended by the relay manufacturer.
Recommendation	AEMO will share details of this event with Transmission Network Service Providers at Power System Security Working Group and Operational Planning Working Group meetings in Q4 2021 to enable them to consider any implications during an equipment restoration process.

[6] 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).

Figure 1 Configuration for NPSD and FBTS immediately after the incident