POWER SYSTEM INCIDENT REPORT FARRELL “A” 220KV BUS TRIP ON 29 APRIL 2010

PREPARED BY: Electricity System Operations Planning and Performance

FINAL

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1 Introduction

On 29 April 2010 at 1450hrs, during switching activities for pre-commissioning checks of a new bus protection scheme, the Farrell “A” 220kV bus tripped resulting in the loss of load and generation on the West Coast of Tasmania. A total of approximately 62MW of customer load, 163MW of industrial load and 488MW of generation was lost as a result of this incident. All tripped circuits were restored by 1547hrs.

This report has been prepared under clause 4.8.15 of the National Electricity Rules (NER) 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.

Information for this report has been supplied to AEMO by Transend. Data from AEMO’s Network Outage Scheduler (NOS), Energy Management Systems (EMS) and Market Management Systems (MMS) has also been used in analysing the event.

All references to time in this report refer to Market time (Australian Eastern Standard Time).

2 Summary of Events

On 29 April 2010 at 1450hrs, during switching activities for pre-commissioning checks of a new bus protection scheme, the Farrell “A” 220kV bus tripped due to mal-operation of the existing “A” bus protection system. The network topology at Farrell substation just before the bus trip is shown in Figure 1. The bus trip occurred as the isolator D129A transitioned from the open state to the closed state. The isolator completed the transition to the closed state a few seconds after the bus trip, and this resulted in the Farrell “A” 220kV bus being re-energised. The network topology at Farrell substation just after the bus trip is shown in Figure 2. John Butters, Tribute, Bastyan and Reece 2 generators tripped as they were connected to 220kV bus “A” prior to the incident. Throughout the incident, the Farrell substation remained connected to Sheffield substation via the two Farrell-Sheffield 220kV lines. The Farrell-Reece 1 220kV line also remained in service.

The 220/110kV transformers T1 and T2 tripped along with 220kV bus “A” separating the 220kV and 110kV buses, and islanding the Farrell local load with the Mackintosh generator. This is because the Farrell-Hampshire 110kV line was open at Hampshire substation as per normal operating practice. Under normal operating conditions, the isolators are switched so that T1 and T2 are not connected to a single 220kV bus in order to prevent the trip of both transformers for the loss of one 220kV bus. However, as this incident occurred during a sequence of switching operations, T1 and T2 were connected to a single 220kV bus. Approximately 60ms after the 220kV bus “A” tripped, the Mackintosh generator tripped and power to the Farrell local load was interrupted. Subsequent analysis showed that the most probable cause for the generator tripping was the activation of the Farrell Contingency Arming Scheme which was enabled at the time.

A total of approximately 62MW of customer load and 488MW of generation was lost as a result of this incident. About 163MW of industrial load was also interrupted due to the action of Under Frequency Load Shedding (UFLS). The lowest frequency measured at George Town 220kV bus was 47.89Hz. Basslink was transferring 247MW from Tasmania to Victoria just prior to the incident and reduced to 47MW in response to the trip.

Preliminary investigations soon after the incident revealed that no actual fault had occurred, and AEMO gave permission to restore all industrial load at 1507hrs, and West Coast customer load at 1513hrs. All tripped circuits were restored by 1547hrs. Based on advice from Transend, AEMO was satisfied that the event did not require classifying the loss of the 220kV bus as a credible contingency, and market notice 31602 was issued to that effect.

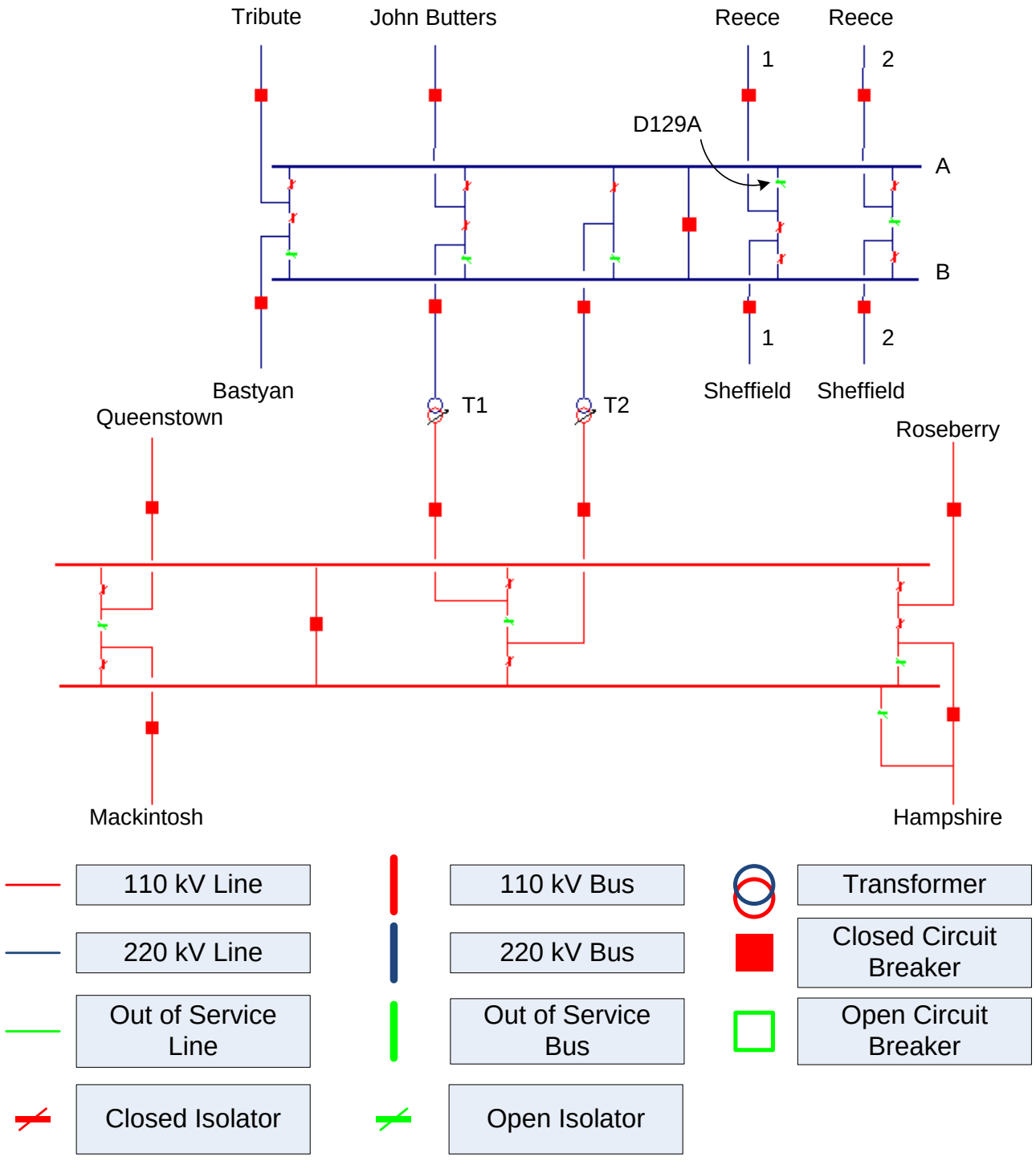

Figure 1: Network Topology at Farrell before the “A” 220kV Bus Trip

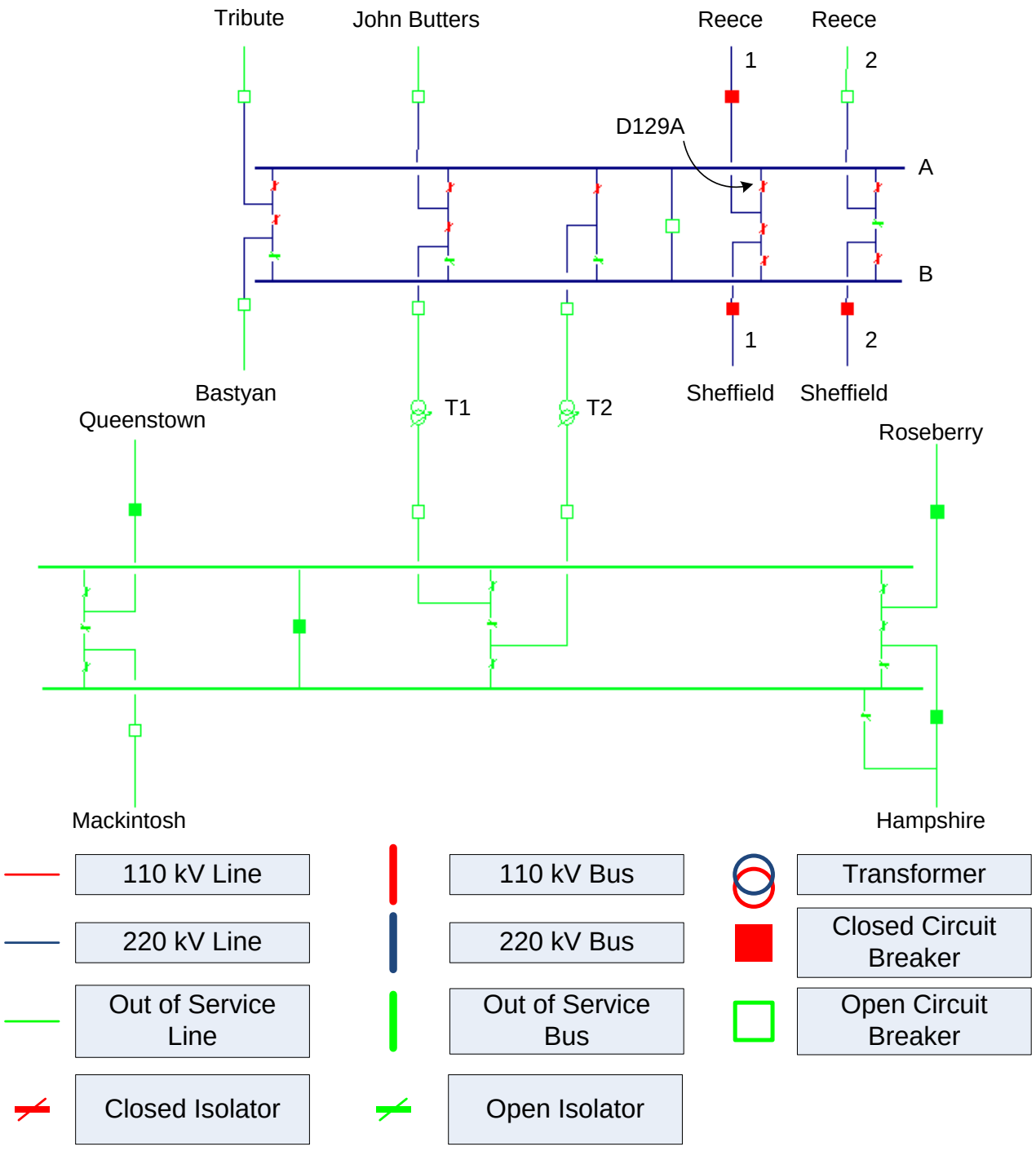

Figure 2: Network Topology at Farrell after the "A" 220kV Bus Trip, and Subsequent Closure of Isolator D129A

3 Analysis of Protection Operations

3.1 Bus Protection

Investigation into the incident revealed that the 220kV bus “A” trip was triggered by the operation of the existing bus zone “A” protection during the closing of the D129A isolator. The relay in question was an obsolete model that had reached the end of its useful life. This relay did not have a check zone feature and relied on there being no discrepancy between the isolator statuses indicated by the auxiliary contacts. It is believed that such a discrepancy may have occurred during the closing of the D129A isolator. It was confirmed that switching operations on the day were consistent with operational procedures.

3.2 Farrell Contingency Arming Scheme

The Farrell Contingency Arming Scheme is used to facilitate a planned outage of a single Farrell 220/110kV transformer. The scheme ensures that Mackintosh, if online, is not islanded to the West Coast load on the trip of the remaining 220/110kV transformer. In the event that the second transformer trips, the Farrell-Mackintosh 110kV line is tripped, thereby disconnecting Mackintosh.

The scheme was found to be enabled despite both Farrell 220/110kV transformers being in service. While it is believed to have tripped Mackintosh on the loss of both T1 and T2 transformers, no alarms were recorded for the operation of the scheme.

3.3 UFLS

Due to the loss of 488MW of generation, Tasmania experienced an under-frequency condition. The lowest frequency measured at George Town 220kV bus was 47.89Hz. The design criteria were met for UFLS relays to operate, resulting in the disconnection of approximately 163MW of industrial load.

4 System Security

4.1 Frequency Excursion and Basslink Response

The frequency excursion experienced in Tasmania and consequent Basslink response, as measured at the Georgetown 220kV bus, are shown in figure 3. The incident met the Frequency Operating Standard for a multiple contingency event in Tasmania.

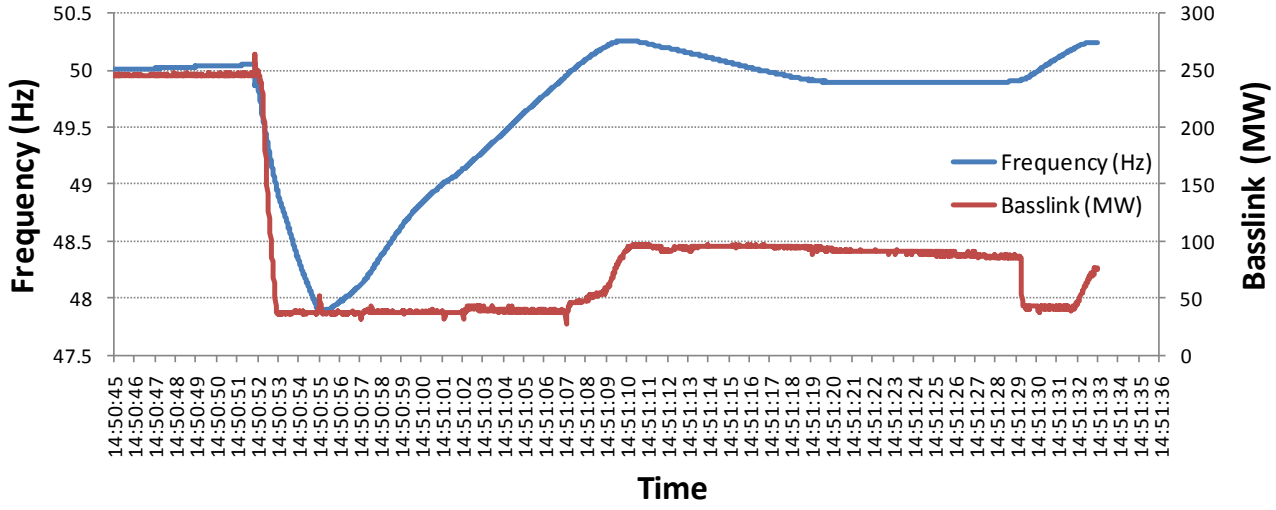

Figure 3: Measured Frequency at Georgetown 220kV Bus

4.2 Voltage

During the incident, the transient voltages resulting from this event were within limits as defined by Schedule S5.1a.4 of the NER.

4.3 Constraint Set invocations by AEMO

In response to the event, AEMO invoked appropriate constraint sets to ensure that tripped generators were taken into account in the dispatch process. No other constraint sets were deemed necessary to be invoked for this incident.

4.4 Load Restoration and Generator Reconnection

AEMO granted permission to restore industrial load at 1507hrs and West Coast load at 1513hrs. Load was gradually reconnected and all circuits where energised by 1547hrs. The duration of load loss was approximately 22 minutes for industrial load and 53 minutes for West Coast load. By 1600hrs, Tribute, Reece1, Mackintosh and Bastyan generators were online.

5 Operational Data Monitoring

The following issues related to operational data monitoring were noted during the investigation of the incident:

- There was no status and alarm information recorded for the operation of the Farrell Contingency Arming Scheme.
- High speed data was not available at Farrell substation.
- The frequency readings from the Georgetown data recorder for the Georgetown-Sheffield No. 1 220kV transmission line was offset by one second with respect to other high speed data readings from the station.

6 Follow-up Actions

The existing bus protection was replaced by a new and enhanced bus protection scheme with check zone features. The old relay model is no longer in use in Transend’s network.

7 Conclusion

During the commissioning of a new bus protection scheme at Farrell substation, the existing bus protection operated and tripped Farrell “A” 220kV bus. This resulted in the loss of approximately 62MW of customer load, 163MW of industrial load and 488MW of generation. The exact cause of the faulty protection operation has not been established. The relay in question was replaced by a new model with additional features to enhance system security.

8 Recommendations

AEMO makes the following recommendations:

- Transend should review its procedures to ensure that the Farrell Contingency Arming Scheme is enabled only for the duration of the appropriate planned outage. This action is to be completed by 31/12/2010.
- Transend should make suitable changes to the Farrell Contingency Arming Scheme to enhance historical data recording. This action is to be completed by 31/12/2010.
- Transend should investigate the reasons for the lack of high speed data from Farrell substation and report to AEMO on its findings and any remedial measures. This action is to be completed by 31/12/2010.
- Transend should investigate the reasons for the misalignment of high speed data from the Georgetown data recorder for the Georgetown-Sheffield No. 1 220kV transmission line and report to AEMO on its findings and any remedial measures. This action is to be completed by 31/12/2010.