POWER SYSTEM INCIDENT REPORT TRIP OF MULTIPLE TRANSMISSION LINES IN THE VICINITY OF BRAEMAR 275 KV SUBSTATION 13 NOVEMBER 2009

PREPARED BY: Electricity System Operations Planning and Performance

FINAL

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1. Introduction

On 13 November 2009, multiple transmission network elements in the vicinity of Braemar 275 kV substation and generating units at Braemar 2 Power Station were disconnected during two separate faults on the transmission network. The first fault occurred during a thunderstorm in the area and the second fault resulted due to a failure of a surge arrestor at Braemar 275 kV substation.

This report has been prepared under clause 4.8.15 of the National Electricity Rules 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 Powerlink and ERM Power. Data from AEMO's Energy Management and Market Systems 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 13 November 2009 the following transmission elements were disconnected during two separate transmission network faults:

- Braemar - Tarong (8815) 275 kV transmission line;
- Braemar - Braemar 2 Power Station (8841) 275 kV transmission line tripped disconnecting Braemar 2 Power Station generating unit 3 (generating unit 3 was not in service when transmission line 8841 tripped at 19:28 hours);
- Bulli Creek - Millmerran (9903) 330 kV transmission line opened at Millmerran; and
- Braemar - Braemar 2 Power Station (8840) 275 kV transmission line tripped and disconnected Braemar 2 Power Station generating units 1 and 2, removing approximately 305 MW of generation from the power system.

The single line diagram representation of the transmission network relevant to the power system incident is shown in Figure 1. The status of circuit breakers prior to the event is also shown.

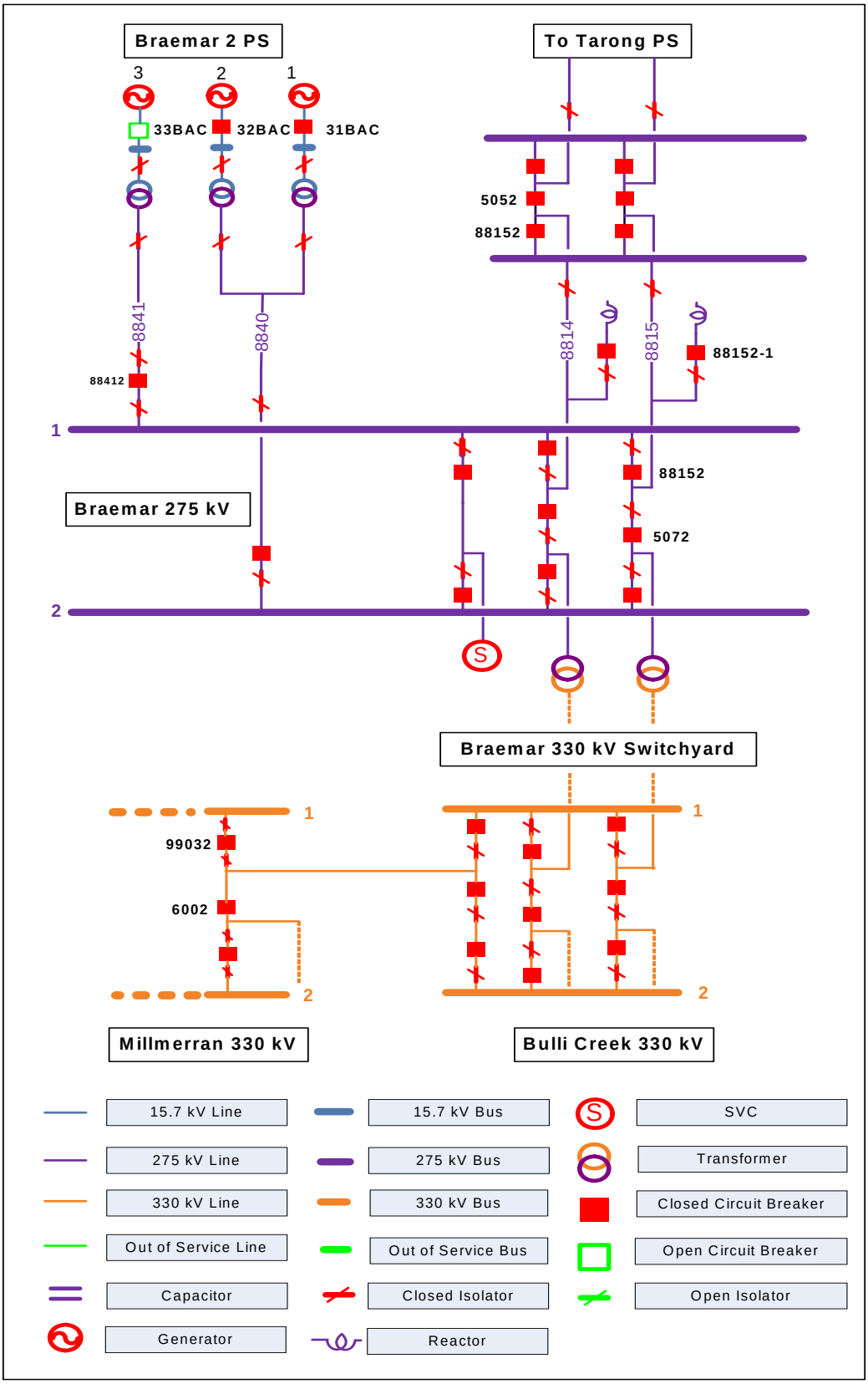

Figure 1: Single line diagram showing status of the relevant transmission plant before the event

2.1 Fault 1: Braemar - Tarong 275 kV transmission line

Powerlink advised that at 19:28:54 hours on 13 November 2009, a fault occurred on phase "B" of the Tarong – Braemar (8815) 275 kV transmission line, during a lightning storm. The protection systems operated and performed a single pole trip at both Braemar and Tarong 275 kV substations to successfully clear the fault from the power system.

Coincident with the trip of 8815 transmission line, the Braemar - Braemar 2 Power Station (8841) 275 kV transmission line tripped. The trip of 8841 transmisison line was due to the operation of Braemar 2 Power Station protection systems at Braemar 2 Power Station.

ERM Power advised that due to a lightning strike in the immediate vicinity of the Braemar 2 Power Station, the unit 3 transformer protection operated to trip 8841 transmission line by sending a protection inter-trip signal to the Braemar 275 kV substation to open the circuit breakers associated with 8841 transmission line (refer to Figure 2). The Braemar 2 Power Station generating unit 3 was not in service and was on turning gear at the time.

The following circuit breakers operated to clear the first fault on the power system:

- 88152 - Tarong 275 kV substation;
- 5052 - Tarong 275 kV substation;
- 88152 - Braemar 275 kV substation;
- 5072 - Braemar 275 kV substation; and
- 88412 - Braemar 275 kV substation.

Figure 2 shows the status of relevant circuit breakers at Tarong and Braemar 275 kV substations and Braemar 2 Power Station after the first fault.

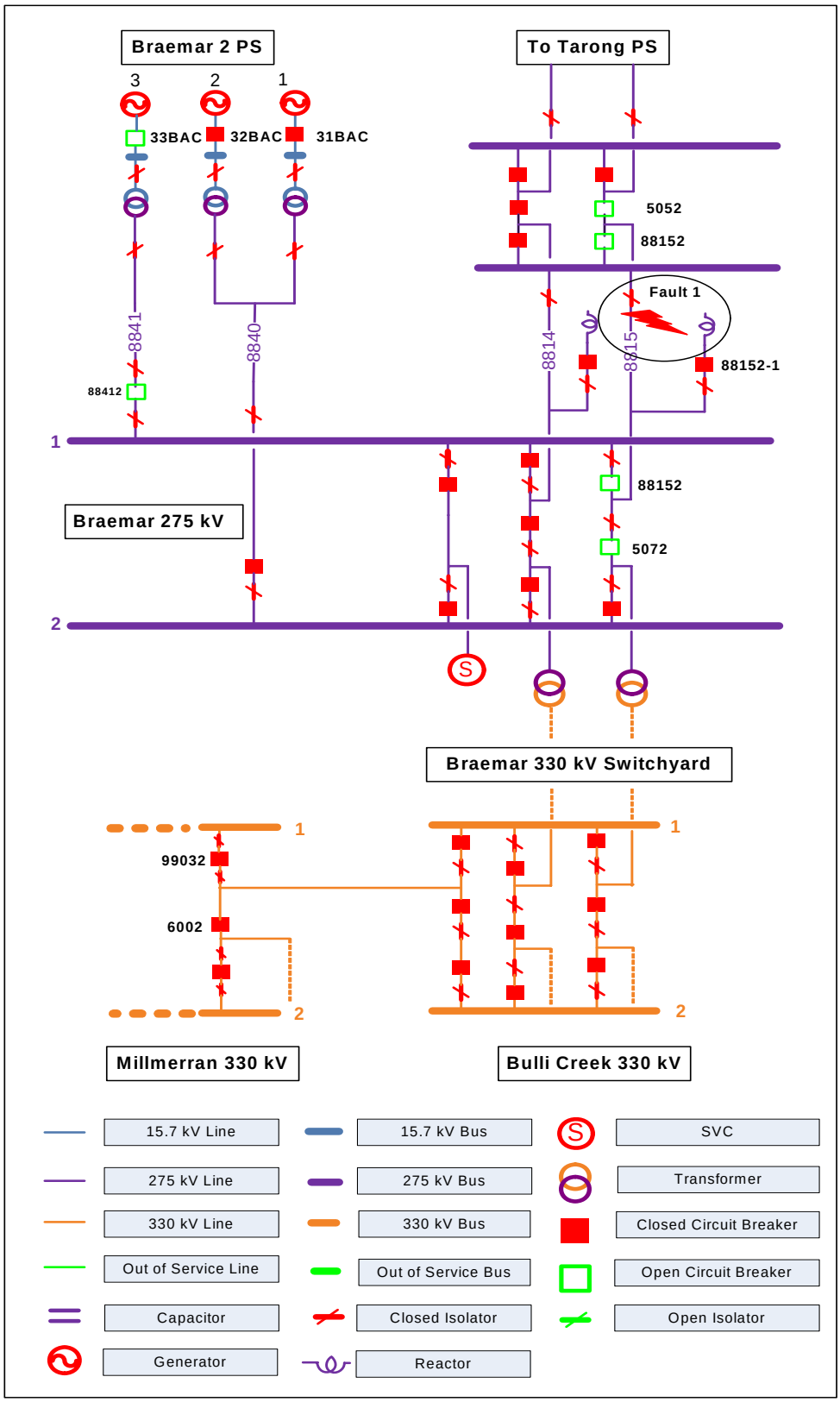

Figure 2: Single line diagram showing status of relevant transmission plant after the first fault

2.2 Fault 2: Braemar 275 kV Reactor Surge Arrestor Failure

Powerlink advised that at 19:29:02 hours on 13 November 2009, the “B” phase of Braemar-Tarong (8815) 275 kV transmission line auto-reclosed re-energising phase “B” of the 8815 transmission line as well as 275 kV Reactor at Braemar 275 kV substation.

On re-energising of 8815 transmission line, the 275 kV Reactor associated with the 8815 line at Braemar tripped. The protection systems are designed such that the Braemar to Tarong 8815 transmission line also trips for faults on the Braemar 275 kV Reactor.
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The protection systems operated to trip the 8815 transmission line and 275 kV Reactor successfully clearing the fault from the power system. The cause of the fault was the failure of the 275 kV phase “B” surge arrestor associated with the Reactor (refer to Figure 3 for the location of second fault).

Coincident with the trip of the 275 kV Reactor, the Braemar-Braemar 2 Power Station (8840) 275 kV transmission line tripped. The trip of the 8840 transmission line was due to operation of protection systems at Braemar 2 Power Station sending a protection intertrip to Braemar 275 kV substation. The trip of the 8840 transmission line disconnected Braemar 2 Power Station from the transmission network. The combined output from Braemar 2 Power Station generating units 1 and 2 was approximately 305 MW immediately before this event.

Coincident with the trip of the 275 kV Reactor, the Millmerran- Bulli Creek (9903) 330 kV transmission line also tripped at Millmerran end only, off-loading the transmission line. The trip occurred due to operation of the transmission line protection systems at Millmerran.

The following circuit breakers operated to clear the second fault from the power system:

- 88152 – Braemar 275 kV substation;
- 88152-1 - Braemar 275 kV substation;
- 88402 - Braemar 275 kV substation;
- 31BAC - Braemar 2 Power Station;
- 32BAC – Braemar 2 Power Station;
- 99032 - Millmerran 275 kV substation; and
- 6002 - Millmerran 275 kV substation.

Figure 3 shows the status of relevant circuit breakers at Tarong 275 kV, Braemar 275 kV and Millmerran 330 kV substations.

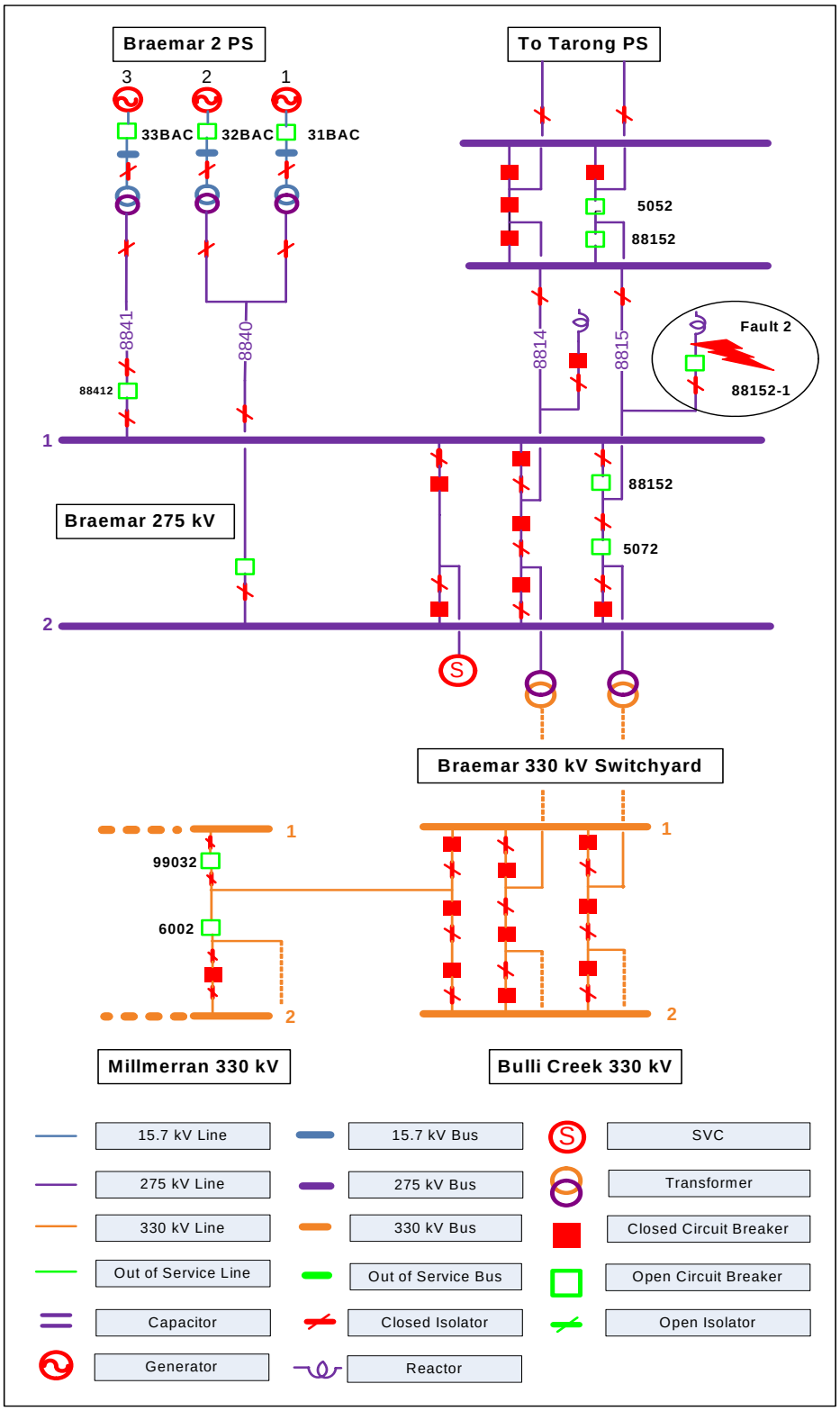

Figure 3: Single line diagram showing status of the relevant transmission plant after the second fault

2.3 Plant Restoration

The transmission elements were restored in the following sequence:

- 13 November 2009 at 19:33 hrs the transmission line 9903 was switched back on load;
- 13 November 2009 at 19:37 hrs the transmission line 8815 was returned to service;
- 14 November 2009 at 07:00 hrs the transmission line 8841 was returned to service;
- 14 November 2009 at 08:18 hrs the transmission line 8840 was returned to service; and
- 16 November 2009 at 16:55 hours, the 275 kV Reactor associated with transmission line 8815 was available for service following replacement of the faulted surge arrestor.

ERM Power advised that at the time of the incident the Local Supply Authority 22 kV back up supply to the power station also lost power supply. As a result, returning the generating units to service took longer than expected.

3. Management of Power System Security

At the time of the second fault on the 275 kV transmission network, the Braemar – Braemar 2 Power Station (8840) 275 kV transmission line tripped disconnecting approximately 305 MW of generation from the power system.

The power system frequency declined to 49.83 Hz and remained outside the normal operating frequency band for approximately 6 seconds. This was within the time allowed by the Reliability Panel's frequency operating standards.

AEMO invoked the constraint set for outage of Braemar - Tarong (8815) 275 kV transmission line for the relevant period. As lightning activity had moved north of Braemar substation, it was assessed that there was no above normal risk of tripping of both Braemar-Tarong 275 kV transmission lines, 8814 and 8815, hence reclassification of loss of both 275 kV transmission lines to a credible contingency event was not required.

The faults on the transmission network were cleared by the protection systems within the requirements specified in the National Electricity Rules (NER) and power system security was maintained during the event.

The reason for protection systems operation at Braemar 2 Power Station is not clear at this stage. ERM Power continue to investigate the cause of trips of the Braemar 2 Power Station unit protection systems which in-turn intertripped the Braemar-Braemar 2 Power Station (8840 & 8841) 275 kV transmission lines.

The protection systems at Millmerran 330 kV substation operated to disconnect the Bulli Creek-Millmerran 330 kV transmission line from Millmerran end. Powerlink advised that the protection system operated due to a protection setting issue at Millmerran..

4. Follow up actions

Electricity Market Notice 28747 was issued on 13 November 2009 advising the occurrence of this non-credible contingency event.

Powerlink advised that the analysis of Millmerran-Bulli Creek 330 kV transmission line protection system undertaken immediately after the event identified protection setting issue that caused the trip of Millmerran-Bulli Creek 330 kV transmission line. The issue was corrected and the protection system was returned to service. The other protection systems in the area were also checked to determine whether they were also affected by the same issue. There were no other relays identified with the same issue.

ERM Power are investigating the reason why the operation of Braemar 2 Power Station protection system sent an inter-trip signal to disconnect 8840 and 8841 transmission lines resulting in loss of Braemar 2 Power Station generating units.

The damaged surge arrestor associated with phase “B” of the Braemar-Tarong (8815) 275 kV transmission line was replaced.

5. Conclusions

On 13 November 2009 the thunderstorm activity present in the vicinity of Braemar 275 kV substation initiated a sequence of faults that resulted in multiple disconnection of transmission elements. The protection systems correctly operated to trip the Braemar-Tarong (8815) 275 kV transmission line. Coincident with the first fault the Braemar 275 kV substation to Braemar Power Station (8841) 275 kV transmission line was disconnected. The exact cause of this operation is under investigation.

Following the auto-reclose of the 8815 transmission line, the 275 kV Reactor surge arrestor failed resulting in tripping of the Braemar 275 kV Reactor, the 8815 transmission line and Braemar 275 kV substation to Braemar Power Station (8840) 275 kV transmission line, thus completely disconnecting Braemar 2 Power Station from the transmission network. The exact cause of the trip of 8840 line is under investigation. AEMO will follow-up with ERM Power to identify and rectify any issues that resulted in the shutdown of the Power Station.

Coincident with the second fault the Millmerran-Bulli Creek (9903) 330 kV transmission line opened from the Millmerran end. The 9903 line tripped due to a protection setting issue. Powerlink advised that the appropriate corrective action has been undertaken.

6. Recommendations

AEMO makes the following recommendation:

- ERM Power will continue to investigate the reasons for operation of the Braemar 2 Power Station unit protection systems which in-turn intertripped the Braemar-Braemar 2 Power Station (8840 & 8841) 275 kV transmission lines. ERM Power will inform the outcomes of its investigation to AEMO by the end of May 2010.