Trip of Lefevre Transformers and Quarantine Unit 5 on 18 July 2014

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| An aemo power system operating incident report for the national electricty market |

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VERSION RELEASE HISTORY

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INCIDENT CLASSIFICATIONS

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| Time and date and of incident | 1615 hrs 18 July 2014 |
| Region of incident | South Australia |
| Affected regions | South Australia |
| Event type | Loss of Transmission element(s) and Generating units |
| Primary cause | Transmission Equipment failure |
| Generation Impact | 124MW lost |
| Load Impact | No load lost |
| Associated reports | Nil |

ABBREVIATIONS

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| Abbreviation | Term |
| AEMO | Australian Energy Market Operator |
| CB | Circuit Breaker |
| GT5 | Gas Turbine Generating Unit 5 at Quarantine Power Station |
| kV | Kilovolt |
| LFS | Lefevre Substation |
| MW | Megawatt |
| NER | National Electricity Rules |
| QPS | Quarantine Power Station |
| SEF | Sensitive Earth Fault |
| T4 | T4 275/66 kV transformer at Lefevre |
| T5 | T5 275/66 kV transformer at Lefevre |
| TINS | Torrens Island North Substation |
| TIPS | Torrens Island Power Station |
| TIPS – TINS line | Torrens Island Power Station B - Torrens Island North 66 kV line |

IMPORTANT NOTICE

Purpose

AEMO has prepared this document to provide information about this particular Power System Operating Incident.

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# OVERVIEW

This report reviews a power system operating incident that occurred on Friday 18 July 2014 at Lefevre Substation (LFS) in South Australia. This incident involved the trip of two transformers at LFS and a generating unit at Quarantine Power Station (QPS). A failed dropper conductor (dropper)[[1]](#footnote-1) at nearby Torrens Island Power Station Substation (TIPS) caused this incident. No customer load was lost as a result of this incident.

AEMO is required to assess power system security over the course of this incident as the incident is classified as a non-credible contingency under the National Electricity Rules (NER).[[2]](#footnote-2) Specifically, AEMO is required 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.[[3]](#footnote-3)

AEMO concluded that following the failure of the dropper all relevant protection schemes operated correctly and power system security was maintained over the course of the incident.

This report is based on information provided by ElectraNet[[4]](#footnote-4), Origin Energy (Origin)[[5]](#footnote-5) and AEMO. National Electricity Market time (Australian Eastern Standard Time) is used in this report.

# The Incident

On Friday 18 July 2014, at 1615 hrs, 275/66 kV transformers T4 and T5 at LFS, generating unit GT5 at QPS, and TIPS House South transformer tripped. These trips were caused by an open circuit due to a failed dropper on the TIPS B – Torrens Island North (TINS) 66 kV line (TIPS – TINS line). As a result of the T4 and T5 transformer trips, four transmission lines connected to LFS were offloaded. See Appendix 1 for a power system diagram illustrating the incident and Appendix 2 for a chronological log of the incident.

The reason for investigating this incident is that T4 and T5 transformers and GT5 generating unit tripped simultaneously. This type of multiple contingency is known in power system security terms as a non-credible contingency event.[[6]](#footnote-6) Generally, power system elements are required to remain connected to the power system for faults that occur on other elements.

# ELECTRANET and ORIGIN Investigations

ElectraNet investigated the trip of the transformers and found that one phase of the TIPS – TINS line open circuited when a 66 kV dropper connection failed. A bolt connecting the dropper lug to a bushing palm had corroded. The dropper conductor connected a line conductor from a transmission tower to plant in TIPS.

Transformer T4 and T5 tripped on Sensitive Earth Fault (SEF) protection after the dropper failed. The following lines were offloaded as a result of the tripped transformers:

1. Lefevre – TIPS B 275 kV line
2. Lefevre – Pelican Point 275 kV line
3. Lefevre – New Osbourne No.1 and No.2 66 kV lines
4. Lefevre – Blackpool 66 kV line

Once ElectraNet had identified the open circuit, ElectraNet concluded that the transformer protection system at LFS operated as expected for an open circuit on the transmission system.[[7]](#footnote-7)

Origin investigated the trip of GT5 at QPS and found that GT5 tripped from 124MW on imbalance protection 14 seconds after the transformer trips at LFS. Origin then resynchronised GT5 at 1641 hrs and 1801 hrs but on both occasions GT5 tripped on imbalance protection. At this stage ElectraNet had not identified the open circuit. Once ElectraNet had identified the open circuit, Origin concluded that GT5 protection operated correctly and as expected for an open circuit on the transmission system.

# Power System Security

This section assesses how the power system security was managed over the course of the incident.[[8]](#footnote-8)

1. The dropper connection failure that caused the open circuit on the TIPS-TINs line most likely occurred as GT5 was increasing generation (GT5 synchronised at 1551 hrs). The resulting T4 and T5 transformer trips and GT5 trip were as a result of the power system imbalance caused by the open circuit.
2. Immediately following the trips, AEMO should have invoked a constraint to manage the output of Pelican Point. This was required to maintain power system security for the loss of Pelican Point – Parafield Gardens West 275 kV transmission line.[[9]](#footnote-9) This constraint was assessed as inappropriate due to a constraint description error within the AEMO constraint management system. In the absence of an appropriate constraint AEMO continually assessed power system security during this period using a power system contingency analysis application. No action was required as the output of Pelican Point did not exceed secure levels over the course of the incident. AEMO subsequently rectified this constraint description error.
3. At 1641 hrs Origin re-synchronised GT5 to the power system, and at 1647 hrs GT5 tripped from 64 MW on imbalance protection.
4. At 1735 hrs AEMO issued Market Notice 46075, 80 minutes after the initial trips, to notify the market of the non-credible contingency event.[[10]](#footnote-10)
5. ElectraNet returned T4 and T5 transformers and the off-loaded transmission lines to service at the following times:

* 1734 hrs T4 transformer at LFS
* 1736 hrs Lefevre – TIPS 275 kV line, and Lefevre – Pelican Point 275 kV line
* 1738 hrs T5 transformer at Lefevre, Lefevre – New Osbourne No.1 66 kV line, and Lefevre – Blackpool 66 kV line

The transformers did not trip again (even though the open circuit was still present) because GT5 was not generating at a sufficient level to cause protection systems to detect an imbalance.

1. At 1801 hrs Origin re-synchronised GT5 to the power system, and at 1807 hrs GT5 tripped on imbalance protection from 65 MW.
2. AEMO then assessed whether or not to reclassify the event as a credible contingency[[11]](#footnote-11). AEMO reclassified the incident as a credible contingency because the cause of the incident had not been identified and AEMO considered the incident could reoccur. At 1830 hrs AEMO issued Market Notice 46076 to reclassify the incident as a credible contingency.
3. ElectraNet notified AEMO at 2200 hrs that a dropper had disconnected on the TIPS-TINS line, and that the TIPS-TINS circuit had been removed from service.
4. AEMO invoked constraint set S-TITN1 at 2200 hrs. This constraint set sets GT5 market dispatch to zero, which is required whilst the TIPS-TINS line is out of service.
5. At 2259 hrs AEMO issued Market Notice 46081 to cancel the reclassification of the incident as a credible contingency. AEMO was satisfied that the cause had been identified and that the incident was unlikely to reoccur.
6. At 1810hrs on 19 July ElectraNet informed AEMO that the dropper repair had been completed and that the TIPS-TINS line had been returned to service. AEMO then revoked constraint set S-TITN1.

For this incident, power system security was maintained over the course of the incident. AEMO correctly assessed and reclassified the incident and appropriate notifications were issued.

# Conclusions

1. This incident was caused by a 66 kV dropper connection that had corroded and subsequently failed.
2. Protection systems that tripped LFS T4 and T5 transformers and GT5 generating unit operated correctly for this type of incident.
3. AEMO failed to invoke an appropriate constraint to manage the output of Pelican Point whilst the Lefevre-Pelican Point 275kV transmission line was off-loaded. During this period AEMO continually assessed power system security using a power system contingency analysis application.
4. The provision and response of facilities and service were adequate to maintain power system security over the course of this incident.
5. There are no outstanding issues as a result of this incident.

# Appendix 1 – Power System Diagram

The power system after the incident



# Appendix 2 – incident event log

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| Time and Date | Event |
| 1615 hrs 18 July 2014 | TIPS South House transformer Tripped.  12 seconds later T4 and T5 transformers at LFS tripped which off-loaded:   * Lefevre – Torrens Island B Power Station 275 kV line * Lefevre – Pelican Point Power Station 275 kV line * Lefevre – New Osbourne No.1 and No.2 66 kV line * Lefevre – Blackpool 66 kV line   14 seconds later GT5 tripped from 124 MW (GT5 had synchronised 25 minutes earlier) |
| 1641 hrs 18 July 2014 | Origin resynchronised GT5 to the power system |
| 1647 hrs 18 July 2014 | GT5 tripped from 64 MW |
| 1734 hrs 18 July 2014 | ElectraNet returned T4 transformer at LFS to service |
| 1735 hrs 18 July 2014 | AEMO issued Market Notice 46075 to notify the Market of the non-credible contingency event |
| 1736 hrs 18 July 2014 | ElectraNet returned the following transmission lines to service:   * Lefevre – Torrens Island B Power Station 275 kV line * Lefevre – Pelican Point Power Station 275 kV line |
| 1738 hrs 18 July 2014 | ElectraNet returned the following transmission lines to service:   * T5 275/66 kV transformer at LFS * Lefevre – New Osbourne No.1 66 kV line * Lefevre – Blackpool 66 kV line |
| 1801 hrs 18 July 2014 | Origin resynchronised GT5 to the power system |
| 1807 hrs 18 July 2014 | GT5 tripped from 65 MW |
| 1830 hrs 18 July 2014 | AEMO issued Market Notice 46076 to reclassifying the incident as a credible contingency |
| 2200 hrs 18 July 2014 | ElectraNet identified an open circuit on the TIPS-TINS No.1 Line caused by a disconnected dropper |
| 2200 hrs 18 July 2014 | AEMO invoked constraint set S-TITN1 for the outage of TIPS-TINS Line No.1 66 kV transmission line |
| 2203 hrs 18 July 2014 | ElectraNet de-energised TIPS – TINS No.1 66 kV transmission line |
| 2215 hrs 18 July 2014 | AEMO issued Market Notice 46081 to cancel the reclassification of this incident |
| 1810 hrs 19 July 2014 | ElectraNet completed dropper repair  ElectraNet returned TIPS – TINS No.1 66 kV transmission line to service AEMO revoked constraint set S-TITN1 |

1. A conductor connecting a transmission tower to electrical plant in a substation [↑](#footnote-ref-1)
2. Clause 4.8.15(a)(1)(i) and AEMC Reliability Panel Guidelines for Identifying Reviewable Operating Incidents [↑](#footnote-ref-2)
3. NER Clause 4.8.15 (b) [↑](#footnote-ref-3)
4. ElectraNet is the Transmission Network Service Provider in the South Australia region [↑](#footnote-ref-4)
5. Origin Energy is the operator of Quarantine Power Station [↑](#footnote-ref-5)
6. A credible contingency is a power system event that AEMO considers to be reasonably possible e.g. the trip of a transmission line or a generating unit; a non-credible contingency is an event other than a credible contingency. See NER 4.2.3 for definitions. AEMO is required to operate the power system in a secure state which means that the power system should be in a satisfactory state following a credible contingency event. See NER 4.2.2 and 4.2.4 [↑](#footnote-ref-6)
7. Sensitive earth fault protection is expected (depending upon trip settings) to trip under open circuit conditions due to zero sequence current flow – this element has a long time delay and provides protection for the transformer earthing reactors tripping the transformers before the earthing reactors are damaged by a long term earth fault/zero sequence current. [↑](#footnote-ref-7)
8. AEMO is responsible for power system security in the NEM and is required to operate the power system in a secure operating state (NER Clause 4.2.4 (a)). AEMO must thereby ensure that the power system is maintained in, or returned to, a secure operating state following a contingency event. AEMO is required to return the power system to a secure state within thirty minutes following a contingency event - NER Clause 4.2.6 (b) [↑](#footnote-ref-8)
9. Such a constraint was required because Pelican Point generation is islanded for the trip of the Pelican Point-PGWest 275 kV transmission line (with Lefevre-Pelican Point 275 kV transmission line out of service or off-loaded). [↑](#footnote-ref-9)
10. 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 10.3 [↑](#footnote-ref-10)
11. AEMO is required to assess whether or not to reclassify a non credible contingency event as a credible contingency - NER Clause 4.2.3A (c)) - and to report how re-classification criteria were applied - NER Clause 4.8.15 (ca). AEMO has to determine if the condition that caused the non-credible contingency event has been resolved. [↑](#footnote-ref-11)