NEM SCHEDULING ERROR

5 AUGUST 2016 TO 17 AUGUST 2016 –

INCORRECT SCADA FOR 7145 FEEDER IN QUEENSLAND

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AEMO
AUSTRALIAN ENERGY MARKET OPERATOR

IMPORTANT NOTICE

Purpose

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1. SUMMARY

AEMO has determined that a scheduling error occurred from 05 August 2016 to 17 August 2016 because of incorrect Supervisory Control and Data Acquisition (SCADA) readings received for Feeder 7145 (Boyne Island – Calliope River 132 kV line) in Queensland. The incorrect data resulted from a faulty transducer at the Boyne Island sub-station.

The incorrect readings were used as an input to the Q>NIL_BI_FB constraint equation used in central dispatch. During the scheduling error period, this constraint bound[1] for 409 dispatch intervals (DIs) and limited the output from Gladstone Power Station.

While the scheduling error did not affect power system security, there was a market impact of 2,622 MWh (refer Section 2.4.3).

Under NER clause 3.16.2(a), Market Participants affected by a scheduling error may apply to the dispute resolution panel established under NER clause 8.2.6A for a determination of compensation.

[1] A constraint equation is binding when it actively influences central dispatch outcomes

2. DESCRIPTION OF THE ERROR

2.1 Background

There are two parallel 132kV feeders, No.7145 and No.7146, connecting Calliope River to Boyne Island. Due to similar impedance[2] attributes, the flow on both feeders are generally similar[3].

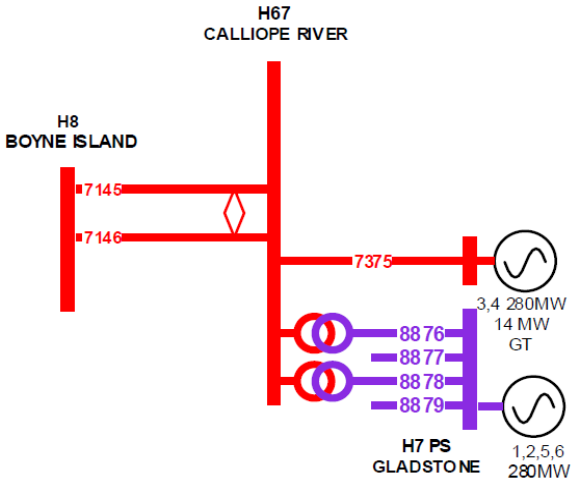

Figure 1 Feeders 7145 and 7146 Line Diagram

During the scheduling error period, the SCADA data from the 7145 feeder indicated a flow level inconsistent with the flow on the 7146 feeder. The difference in flow reached up to 43 MVA, significantly higher than the normal average difference of 5.9 MVA[4]. Note, there were no outages that could have affected the flow on these two feeders during the scheduling error period.

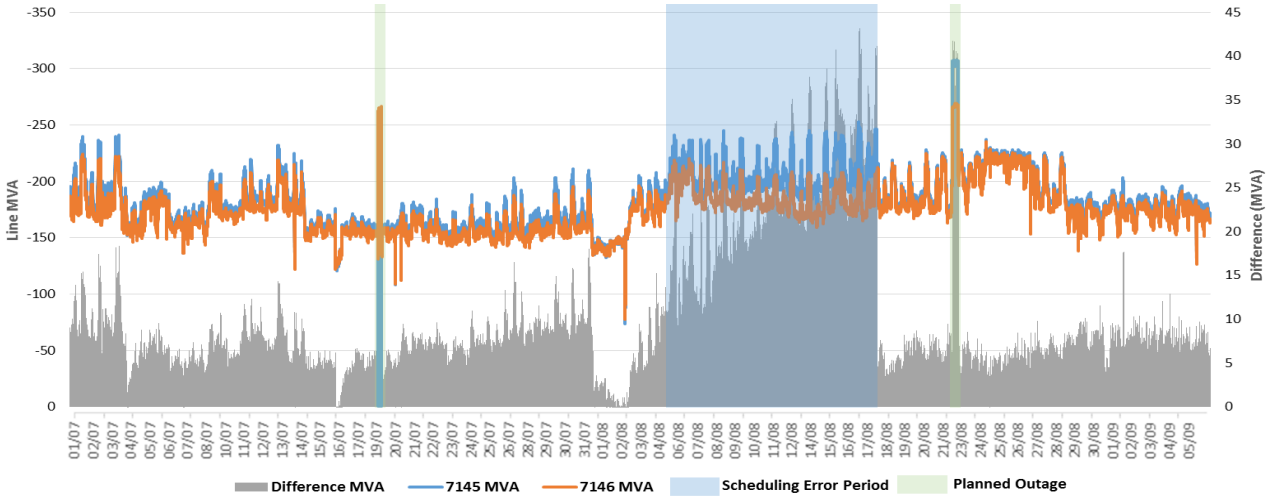

Figure 2 Feeders 7145 and 7146 MVA flows

[2] An expression of the opposition that an electronic component, circuit or system offers to alternating and/or direct electrical current.
[3] During network outages, the flow on feeders could be dissimilar.
[4] Average difference between flow on feeders 7145 and 7146 over time period from 5th March 2016 0 4th August 2016, removing periods of outages which could affect flow on these feeders.

2.2 Cause of the Error

At 17:21 hrs on 17 August 2016, an energy trader from CS Energy called the AEMO Control Room regarding constraint equation Q>NIL_BI_FB, which was binding. AEMO Real Time Operations (RTO) rectified the error by replacing the SCADA input with Energy Management System (EMS) state estimator values at 20:05 hrs on 17 August 2016. On 19 August 2016, Powerlink confirmed incorrect SCADA readings were being received for Feeder 7145 at Boyne Island due to a faulty transducer at the Boyne Island sub-station. Powerlink informed AEMO that the error began from 00:15:01 on 05 August 2016.

Power system security was not impacted by the incorrect SCADA data but a scheduling error occurred as these incorrect SCADA values were inputs into a constraint equation.

2.3 Constraint Equation Q>NIL_BI_FB

SCADA data from Feeders 7145 and 7146 are inputs to the Right Hand Side (RHS) of the Q>NIL_BI_FB constraint equation. This constraint equation avoids overloading the Boyne Island feeder bushing on a Calliope River – Boyne Island 132 kV feeder, for the loss of the parallel Calliope River – Boyne Island 132 kV feeder. These feeder terms both possess positive coefficients and, as the MVA readings of Feeder 7145 were lower due to the error, it resulted in the constraint equation becoming more restrictive and binding more frequently.

When it is binding, this constraint equation constrains off generation from Gladstone PS units 1 – 6 (each of these units has a positive coefficient) to reduce the loading on the 7145 and 7146 Feeders. Gladstone PS units 3 and 4 were more heavily impacted as these units had a coefficient of 1 while units 1, 2, 5 and 6 had a coefficient of 0.1013. The formulation of the constraint equation can be found in Appendix A.

2.4 Market Impact

To assess the market impact due to the scheduling error, AEMO did a simulated rerun of National Electricity Market Dispatch Engine (NEMDE) Dispatch files between 0000 hrs on 5 August 2016 to 2010 hrs on 17 August 2016 (3,699 Dispatch Intervals), replacing the incorrect SCADA values from Feeder 7145 with the SCADA values from Feeder 7146. The constraint, interconnector and generator target outcomes from the simulated run are summarised in Section 2.4.1, Section 2.4.2 and Section 2.4.3.

The market impact was assessed for the 409 DIs when the Q>NIL_BI_FB constraint equation bound.

2.4.1 Constraint Equations

The constraint equation was observed to bind for only 1 DI in the simulated run as compared to 409 Dispatch Intervals (DIs) in the original run.

Table 5 shows the dates that the affected constraint equations were binding in the original and the simulated runs, and the number of DIs involved.

Table 1 No. of Dispatch Intervals when constraint bound during scheduling error period

Date	Original Run	Simulated Run
05/08/2016	61	0
06/08/2016	57	1
07/08/2016	29	0
08/08/2016	5	0

Date	Original Run	Simulated Run
09/08/2016	11	0
10/08/2016	0	0
11/08/2016	7	0
12/08/2016	15	0
13/08/2016	39	0
14/08/2016	40	0
15/08/2016	62	0
16/08/2016	48	0
17/08/2016	35	0
Total	**409**	**1**

2.4.2 Interconnectors

The interconnector flow trend in the simulated run indicated that, generally, the flow from QLD to the southern regions increased. The flow across each interconnector for the DIs when the Q>NIL_BI_FB constraint equations bound in the original run is detailed below.

QNI (NSW1-QLD1):

In the simulated run, the MWh flow towards NSW on QNI increased while the flow towards QLD remained the same.

Table 2 Energy (MWh) flow during binding DIs when QNI is exporting or importing

Flow Direction	Original Run – MWh flow when in this direction	Simulated Run – MWh flow when in this direction
NSW -> QLD (Export)	14 MWh	14 MWh
QLD -> NSW (Import)	14,400 MWh	15,742 MWh

Directlink (N-Q-MNSP1):

Similar to the QNI, the MWh flow towards NSW increased in the simulated run while there was no flow towards QLD in either run.

Table 3 Energy (MWh) flow during binding DIs when Directlink is exporting or importing

Flow Direction	Original Run – MWh flow when in this direction	Simulated Run – MWh flow when in this direction
NSW -> QLD (Export)	0 MWh	0 MWh
QLD -> NSW (Import)	2,247 MWh	2,379 MWh

VIC – NSW:

In the simulated run, the MWh flow towards NSW on the VIC – NSW interconnector reduced while the MWh flow towards VIC increased.

Table 4 Energy (MWh) flow during binding DIs when VIC-NSW is exporting or importing

Flow Direction	Original Run – MWh flow when in this direction	Simulated Run – MWh flow when in this direction
VIC -> NSW (Export)	14,172 MWh	13,729 MWh
NSW -> VIC (Import)	1,168 MWh	1,335 MWh

Murraylink (V-S-MNSP1):

In the simulated run, the MWh flow towards SA on Murraylink increased while the MWh flow towards VIC had a negligible increase.

Table 5 Energy (MWh) flow during binding DIs when Murraylink is exporting or importing

Flow Direction	Original Run – MWh flow when in this direction	Simulated Run – MWh flow when in this direction
VIC -> SA (Export)	2,376 MWh	2,476 MWh
SA -> VIC (Import)	0 MWh	0.3 MWh

Heywood (V-SA):

In the simulated run, the MWh flow towards SA on Heywood increased while there was no flow towards VIC in either run.

Table 6 Energy (MWh) flow during binding DIs when Heywood is exporting or importing

Flow Direction	Original Run – MWh flow when in this direction	Simulated Run – MWh flow when in this direction
VIC -> SA (Export)	16,697 MWh	16,703 MWh
SA -> VIC (Import)	0 MWh	0 MWh

Basslink (T-V-MNSP1):

In the simulated run, the MWh flow towards VIC on Basslink reduced while there was no flow towards TAS in either run.

Table 7 Energy (MWh) flow during binding DIs when Basslink is exporting or importing

Flow Direction	Original Run – MWh flow when in this direction	Simulated Run – MWh flow when in this direction
TAS -> VIC (Export)	8,163 MWh	8,112 MWh
VIC -> TAS (Import)	0 MWh	0 MWh

2.4.3 Generators

A total of 2,622 MWh of generation was constrained off across all regions due to the scheduling error. The constrained-off MWh in each region is listed in Table 12.

The constrained-off MWh for each scheduled and semi-scheduled generating unit in the NEM is provided in Appendix B. It is determined as the difference between the What-If target (from the simulation run) and the larger of the original target and InitialMW, times 1/12[5]. In accordance with NER clause 3.16.2(d), only

[5] The difference in MW is multiplied by 1/12 to convert to energy (MWh) during the DI.

generating units that would have been dispatched higher in the simulated run for each trading interval of the scheduling error period have been considered in determining the constrained-off MWh.

Table 8 Generation constrained off in each region

Region	Constrained-off MWh
NSW	354
QLD	1,671
SA	148
TAS	197
VIC	252

3. ASSESSMENT OF THE ERROR

3.1 Assessment against Criteria for a Scheduling Error

Under NER clause 3.8.24(a)(2), a scheduling error occurs when AEMO determines that it has failed to follow the central dispatch process set out in rule 3.8.

In this case, incorrect SCADA inputs for the 7145 feeder resulted in incorrect representation of the flow on the feeder and unreasonably constrained-off generation.

3.2 Outcomes

Under NER clause 3.16.2(a), Market Participants affected by a scheduling error may apply to a dispute resolution panel established under NER clause 8.2.6A for a determination on whether they are entitled to compensation.

4. RESULTING ACTIONS

AEMO rectified the error by applying EMS state estimator values to replace the incorrect SCADA readings on Feeder 7145 at 20:05 hrs on 17 August 2016. The state estimator values were in place until 20:50 on 26 October 2016 when the SCADA reading for feeder 7145 was found to be within an expected range and the state estimator was revoked. Boyne Island identified that a harmonic filter was out of service at the time this issue occurred resulting in the transducer error and have subsequently confirmed that this error will not occur the next time the filter is out of service.

APPENDIX A. CONSTRAINT FORMULATION FOR Q>NIL_BI_FB

Constraint type: LHS<=RHS
Effective date: 05/09/2016
Author: SHENGG
Version No: 1
Weight: 30
Constraint active in: Dispatch and DS PASA, Predispatch and PD PASA
5 Min Predispatch RHS: Predispatch

Constraint description: Out= Nil, H8 Boyne Island feeder bushing (FB) limit on Calliope River to Boyne Island 132 kV lines, 7104 and 7105 (T022 Callide A to T152 Gladstone South) 132 kV lines open with 132 kV intact between T022 Callide A and H015 Lilyvale.
Impact: Qld Generation
Source: AEMO
Limit type: Thermal
Reason: Trip of one Calliope River to Boyne Island 132 kV line
Modifications: Revised PFs, RDF and PD RHS for better performance
Additional Notes: CCR2965

LHS=

0.1013 x Gladstone unit 1 (ENERGY)
0.1013 x Gladstone unit 2 (ENERGY)
+ Gladstone unit 3 (ENERGY)
+ Gladstone unit 4 (ENERGY)
0.1013 x Gladstone unit 5 (ENERGY)
0.1013 x Gladstone unit 6 (ENERGY)

RHS

Default RHS value= 600

Dispatch RHS=
2.98 x **(** Min
(
-1 x [Qld: 7146 Calliope River to Boyne Island 132kV Emergency Rating]
+ MVA flow on 7146 132kV line at Boyne Island
+ 0.6 x [MVA flow on 7145 132kV line at Boyne Island],
-1 x [Qld: 7145 Calliope River to Boyne Island 132kV Emergency Rating]
+ MVA flow on 7145 132kV line at Boyne Island
+ 0.6 x [MVA flow on 7146 132kV line at Boyne Island]
)
- 10 {Operating_Margin}**)**
+ 0.1013 x [Gladstone unit 1]
+ 0.1013 x [Gladstone unit 2]
+ Gladstone unit 3
+ Gladstone unit 4
+ 0.1013 x [Gladstone unit 5]
+ 0.1013 x [Gladstone unit 6]

Predispatch RHS=
2.98 x **(** -1 x **(** Max

((
Qld: 7146 Calliope River to Boyne Island 132kV Emergency Rating,
Qld: 7145 Calliope River to Boyne Island 132kV Emergency Rating
))
- (0.8 x ((0.0004 x [Gladstone unit 3]
+ 0.0004 x [Gladstone unit 4]
+ 0.2554 {Constant})
x (MVA flow on 865 275kV line at Wurdong, line end switched flow
+ MVA flow on 866 275kV line at Wurdong, line end switched flow
- MVA flow on 7146 132kV line at Boyne Island
- MVA flow on 7145 132kV line at Boyne Island)))
- 10 {Operating_Margin}**)**
+ 0.1013 x [Gladstone unit 1]
+ 0.1013 x [Gladstone unit 2]
+ Gladstone unit 3
+ Gladstone unit 4
+ 0.1013 x [Gladstone unit 5]
+ 0.1013 x [Gladstone unit 6]

APPENDIX B. MWH CONSTRAINED OFF FOR EACH GENERATING UNIT

B.1 New South Wales

DUID	Constrained-off MWh
ER04	108
ER03	81
TALWA1	30
BW01	26
BW02	22
ER01	19
BW04	13
BW03	13
SHGEN	11
MP2	10
TUMUT3	9
SITHE01	5
MP1	4
UPPTUMUT	2

B.2 Queensland

DUID	Constrained-off MWh
GSTONE4	792
GSTONE3	720
STAN-4	42
DDPS1	35
STAN-1	26
GSTONE5	12
GSTONE1	11
TARONG#1	9
STAN-3	6
TARONG#4	5
GSTONE2	5
TARONG#2	3
TARONG#3	3
MPP_1	1

B.3 South Australia

DUID	Constrained-off MWh
TORRB1	36
TORRB4	36
TORRB3	25

DUID	Constrained-off MWh
TORRA4	10
TORRB2	10
AGLHAL	8
OSB-AG	5
LADBROK2	4
TORRA3	2
QPS1	2
TORRA1	2
LONSDALE	2
QPS5	1
MINTARO	1
QPS2	1
DRYCGT3	1

B.4 Tasmania

DUID	Constrained-off MWh
POAT220	99
TREVALLN	28
REECE2	16
TUNGATIN	14
POAT110	11
TARRALEA	7
MACKNTSH	6
CETHANA	5
JBUTTERS	5
REECE1	3
MEADOWBK	2
DEVILS_G	1

B.5 Victoria

DUID	Constrained-off MWh
HWPS4	154
LYA1	29
MURRAY	15
YWPS3	13
WKIEWA2	10
WKIEWA1	9
MORTLK12	9
LYA4	8
LYA2	1
LYA3	1

DUID	Constrained-off MWh
JLB03	1
LOYYB2	1

ABBREVIATIONS

Abbreviation	Expanded name
AEMO	Australian Energy Market Operator
DI	Dispatch Interval
EMS	Energy Management System
kV	Kilovolt
LHS	Left Hand Side
MNSP	Market Network Service Provider
MW	Megawatt
MWH	Megawatt Hour
NEM	National Electricity Market
NER	National Electricity Rules
NSW	New South Wales
NSW1-QLD1	New South Wales – Queensland Interconnector
N-Q-MNSP1	Directlink Interconnector
QLD	Queensland
QNI	Queensland – New South Wales Interconnector
RHS	Right Hand Side
SA	South Australia
SCADA	Supervisory Control and Data Acquisition
TAS	Tasmania
TNSP	Transmission Network Service Provider
T-V-MNSP1	Basslink Interconnector (MNSP)
VIC	Victoria
VIC–NSW	Victoria – New South Wales Interconnector
V–SA	Victoria – South Australia Interconnector
V-S-MNSP1	Murraylink Interconnector

GLOSSARY

Term	Definition
DI	Dispatch Interval
DIs	Dispatch Intervals
Supervisory Control and Data Acquisition	Supervisory Control and Data Acquisition is a system that gathers real-time data from remote terminal units and other communication sources in the field and enables operators to control field devices from their consoles.
Scheduling Error	As defined in NER clause 3.8.24