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NETWORK SERVICE PROVIDER

DISTRIBUTION LOSS FACTOR

OAKY CREEK COAL NSP

AUSTRALIAN ENERGY REGULATOR

FINANCIAL YEAR 2011-12

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1. SUMMARY

The terms of Hill Michael's engagement with Oaky Creek Coal Network Service Provider (OCCNSP) include calculation of distribution loss factors in accordance with Section 3.6.3 (i) of the National Electricity Rules (NER). An extract of the relevant clause from the current version (Version 41) of the NER is given below:

"Each year the Distribution Network Service Provider must determine the distribution loss factors to apply in the next financial year in accordance with clause 3.6.3(g) and provide these to AEMO for publication by 1 April. Before providing the distribution loss factors to AEMO for publication, the Distribution Network Service Provider must obtain the approval of the AER for the distribution loss factors it has determined for the next financial year."

Hill Michael has calculated the distribution loss factors based on the proposed generation for the 2011-12 financial year and historical mine load data for the year 2010. The estimates of loads are subject to change. The embedded generation is dependant on the mine for fuel (coal seam methane gas), therefore, changes to the production level of the mine will impact the generation output.

The site specific DLF calculated using a Marginal Loss Factor (MLF) approach is **0.9871** for the Envirogen generation connected to the **Oaky Creek Coal NSP**. This distribution loss factor has been calculated in accordance with the methodology approved by the QCA as described in **Report NCM 17699 Determination of Distribution Loss Factors for Embedded/Local Generators**.

This report has been provided to IES (Intelligent Energy Systems) for independent positive certification. In addition to this report, supporting evidence has been provided to IES to enable independent verification of calculations.

Submitted on the 21st day of March 2011

Author	Reviewer
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Consulting Engineer	**Senior Consulting Engineer**

2. METHODOLOGY AND CALCULATIONS

2.1 METERED DATA - GENERATION AND CONNECTION POINT

The reconciled metered data for the parent meter and the revenue meter at the generator (National Metering Identifiers are given below) have been obtained from the authorised Metering Provider.

Parent NMI	QAAALV0004
TNI / MDA	QLIL
Generator NMI	7102000028

Below is the summary of the half hourly metered data based on the most recent data available for a consecutive 12 month period at the time of determining loss factors. The mine load is estimated based on the difference between the connection point and the generation metered data.

- Connection Point (MWh): This is the total energy from connection point meter.

  Net negative energy indicates that the energy provided by generation is higher than the energy consumed by the load for that month. The converse is true for Net positive energy.

- Generation (MWh): This is the monthly energy output of the generator measured at the generator revenue meter.

  Net negative energy indicates the energy provided by the generators to the system

- Estimated Mine Load (MW): Difference of Connection Point (MWh) and Generation (MWh) converted to MW. The conversion between MWh to MW is calculated based on 24 hours a day operation of the mine.

Date	Connection Point (MWh)	Generation (MWh)	Estimated Mine Load (MW)
Jan-10	5,294.67	-9,002.22	19.22
Feb-10	4,924.61	-7,567.97	18.59
Mar-10	5,398.81	-8,304.53	18.42
Apr-10	3,061.46	-10,903.18	19.40
May-10	1,954.72	-10,540.44	16.79
Jun-10	-1,172.74	-10,728.12	13.27
Jul-10	2,301.98	-12,657.25	20.11
Aug-10	3,192.62	-12,756.98	21.44
Sep-10	4,317.78	-11,495.81	21.96
Oct-10	2,761.02	-12,101.29	19.98
Nov-10	1,104.34	-13,161.01	19.81
Dec-10	3,604.69	-10,087.38	18.40

Table 1: Metered Data and Estimated Mine Load for 2010

2.1.1 Generation and Load Projection for 2011/12

2.1.1.1 Generation Projection for 2011/12

Envirogen Power Station has provided the following estimated generation availability for 2011/12. This availability takes into account contingencies and planned outages. The installed capacity of the power station is 20 MW. The generation availability depends on the availability of coal seam methane fuel from the mine activity and the power transfer capacity limitation of the transformer.

Date	Generation (kW)	Generation (MWh)
Jul-11	17,708	13,175
Aug-11	17,708	13,175
Sep-11	17,708	12,750
Oct-11	17,708	13,175
Nov-11	16,201	11,665
Dec-11	13,281	9,881
Jan-12	13,281	9,881
Feb-12	17,357	11,664
Mar-12	17,708	13,175
Apr-12	17,708	12,750
May-12	17,708	13,175
Jun-12	17,708	12,750

Table 2: Generation Forecast Data for 2011-12

2.1.1.2 Mine Load Projection for 2010/11

The mine load forecast and the power factor are based on the historical load data in year 2010. Distribution of the loads within the mine has been considered as given in the **Error! Reference source not found.** below.

Month	Estimated mine load	PF	Industrial Fdr@37.88 %	German Creek Fdr@10.15 %	Oaky North @ 25.37%	Oaky1 @17.00%	Aquilla Feeder @ 9.60%
	MW		MW	MW	MW	MW	MW
Jul-11	20.11	0.80	7.62	2.04	5.10	3.42	1.93
Aug-11	21.44	0.81	8.12	2.18	5.44	3.64	2.06
Sep-11	21.96	0.80	8.32	2.23	5.57	3.73	2.11
Oct-11	19.98	0.75	7.57	2.03	5.07	3.40	1.92
Nov-11	19.81	0.83	7.51	2.01	5.03	3.37	1.90
Dec-11	18.40	0.85	6.97	1.87	4.67	3.13	1.77
Jan-12	19.22	0.83	7.28	1.95	4.88	3.27	1.84
Feb-12	18.59	0.82	7.04	1.89	4.72	3.16	1.78
Mar-12	18.42	0.81	6.98	1.87	4.67	3.13	1.77
Apr-12	19.40	0.76	7.35	1.97	4.92	3.30	1.86
May-12	16.79	0.74	6.36	1.70	4.26	2.86	1.61
Jun-12	13.27	0.72	5.03	1.35	3.37	2.26	1.27

Table 3: Approximation of Forecast Load Distribution for 2011-12

2.1.2 Network Connection Points

The Oaky Creek Network Service Provider (OCCNSP) operates a 66 kV distribution network which is connected to the Ergon Energy Corporation Limited (EECL) Lilyvale distribution substation.

Clause 3.6.3 of the National Electricity Rules (NER) discusses distribution losses in the context of the National Electricity Market (NEM). In particular, a Distribution Network Service Provider must calculate the Distribution Loss Factor (DLF) for the connection points on its distribution network.

OCCNSP has only one customer – the embedded generator owned and operated by Envirogen (Oaky) Pty Ltd – and therefore, OCCNSP has only one distribution network connection point. The Oaky Creek mine is a customer of EECL and the mine distribution network connection point is located at the Lilyvale 66 kV bus. The mine connection point is also the OCCNSP connection point to the EECL network service.

The site specific DLF for this connection point has been calculated in accordance with the methodology approved by the Queensland Competition Authority (QCA) as described in **Report NCM 17699 Determination of Distribution Loss Factors for Embedded/Local Generators**. (Refer appendix 2 – report ncm17699)

Figure 1 below shows the location of the connection points and the network for which losses are calculated. The connection point for the generator is a Tee-off at Pole 114 on the [1]Aquila Feeder.

[1] The Aquila Feeder is owned by OCCNSP.

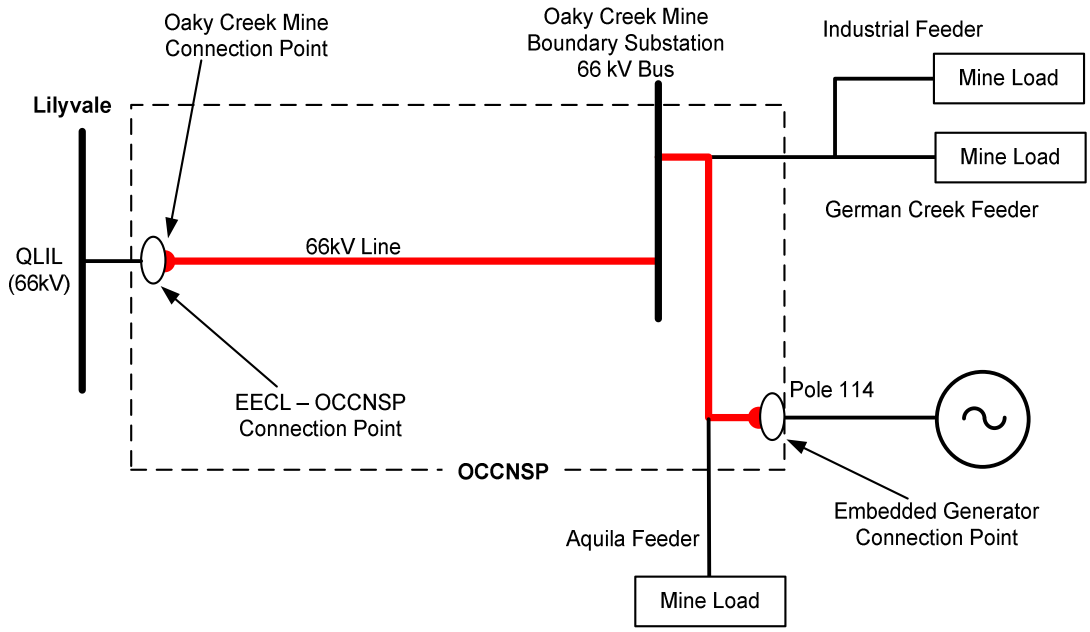

Figure 1: Simplified Representation of the Network

2.1.3 Methodology

<u>**Envirogen Generator DLF Calculation**</u>

The site specific DLF for the Envirogen generator is calculated using a Marginal Loss Factor (MLF) approach in accordance with the methodology approved by the QCA as described in **Report NCM 17699 Determination of Distribution Loss Factors for Embedded/Local Generators**. (Refer appendix 2 – report ncm17699)

The DLF is a static loss factor applied to the embedded generator distribution network connection point for the full financial year. The steps undertaken to calculate the DLF are summarised below.

1. Request expected mine consumption and embedded generation forecasts for the 2011-12 financial year.

2. Request the metered data for the previous calendar year (2010).

3. Prepare and review the network model for the OCCNSP distribution network by incorporating any proposed changes to the network occurring in the period leading up to the financial year for which the embedded generator DLF is being calculated.

   The PSS SINCAL network model (given in Appendix 1) represents the following:

   a. Lilyvale (QLIL) 66 kV connection point as an **infinite bus**;

   b. Oaky Creek mine load is distributed along the feeder as shown in Table 3.

   c. Envirogen Generation connection to the 66 kV network.

4. Using the Network Model and Load Flow Analysis, the following steps are performed

   (Load flow studies are performed with the distributed loads along the feeder as shown in Table 3.)

   - Run a set of load flow studies for each month of the next financial year using the forecast mine load and embedded generation data.
   - Record the loss on the NSP network for initial generation (A). The NSP network is between the 66kV OCCNSP connection point at Lilyvale and the Envirogen embedded generator connection point at the Boundary Substation
   - Increment the generation by 1 MW and note the new loss on the NSP Network (B).
   - The loss due to the increment in generation per MW is calculated (B-A)/1000.

5. Calculate the MLF and DLF in accordance with the methodology approved by the QCA as described in **Report NCM 17699 Determination of Distribution Loss Factors for Embedded/Local Generators**.

2.1.4 Distribution Loss Factor

The loss under existing generation on the NSP network is noted (A), then the generation is incremented by 1 MW and the new loss on the NSP network is observed (B). The difference in the loss after the 1 MW increment is (B-A)/1000 per MW. The marginal loss factor is 1 less the loss per MW of generation increment.

The volume weighted DLF is weighted on the average forecast generation per month.

DLF calculation results for the forecast generation data for 2011/12 and the historical mine load data for the year 2010 is given in Table 4.

Period	A (kW) NSP Loss	B (kW) NSP Loss for Increment in Generation	MLF [1 - (B-A)/1000]	DLF SQRT (MLF)
Jul-11	221	247	0.9736	0.9867
Aug-11	218	243	0.9746	0.9872
Sep-11	222	247	0.9750	0.9874
Oct-11	241	267	0.9734	0.9866
Nov-11	179	203	0.9766	0.9882
Dec-11	111	129	0.9825	0.9912
Jan-12	114	131	0.9834	0.9917
Feb-12	200	227	0.9731	0.9865
Mar-12	212	240	0.9721	0.9860
Apr-12	230	257	0.9732	0.9865
May-12	235	264	0.9710	0.9854
Jun-12	251	283	0.9678	0.9838
Volume Weighted Average DLF				**0.9871**

Table 4: Volume Weighted Average DLF

3. APPENDIX 1 – SCHEMATIC OF OAKY CREEK COAL NSP

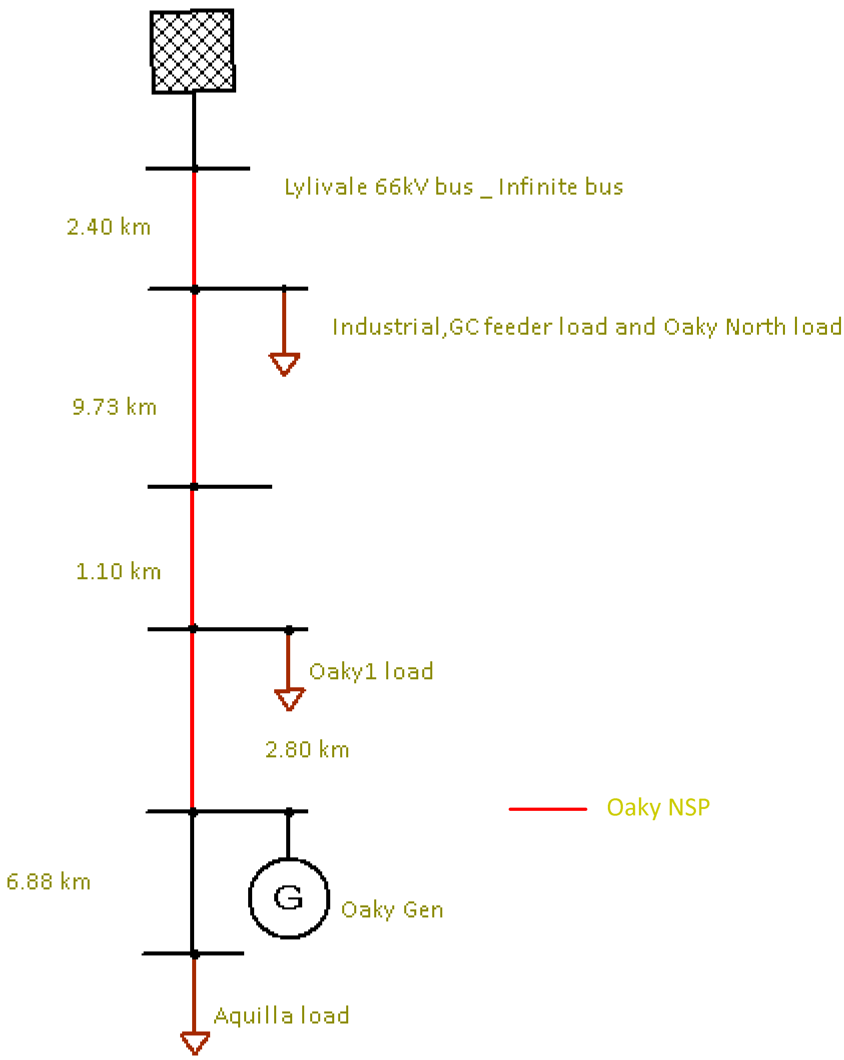

Figure 2: Oaky Creek Coal Network as modelled in SINCAL

4. APPENDIX 2 – REPORT NCM17699

DETERMINATION OF DISTRIBUTION LOSS FACTORS FOR EMBEDDED/LOCAL GENERATORS

REPORT NCM17699

1.0 Introduction

Section 3.6.3 of the National Electricity Code describes the requirement for Distribution Loss Factors for Market Generators (or market generating units). The NEC goes on to describe the Distribution Loss Factor for a market generating unit as:

> "a site specific factor that describes the volume weighted average electricity loss incurred in the *distribution* of electricity between a *transmission network connection point* and the relevant *Generator's connection point* for a defined period of time and associated operating conditions."

This Code clause indicates that non-scheduled market generators are to be allocated an average rather than a half hourly marginal distribution loss factor. This interpretation is consistent with previous decisions of the Jurisdictional Regulator in relation to distribution loss factors for generators not directly connected to the transmission network.

This paper sets out the process that ENERGEX Limited and Ergon Energy Corporation Limited ("the Distributors") propose to use for calculating DLF's for those NEMMCO registered embedded generators who are not selling their entire energy output to the local retailer and therefore require a DLF.

2.0 Calculation Methodology

The procedure developed by the Distributors for calculation of DLF's for distribution network connected market generators is:

Step 1

The appropriate part of the subtransmission network should be modelled by including all directly connected 132kV, 66kV, 33kV, 22kV, and 11kV customers along with direct connected loads representative of the 22kV and 11kV feeders (lumped at the 22kV and 11kV buses and/or distributed along the feeder on which the embedded generator is connected). The Embedded Generators should be modelled at their metering points. The Transmission Network Connection Point may be modelled as an infinite bus.

DETERMINATION OF DISTRIBUTION LOSS FACTORS FOR EMBEDDED/LOCAL GENERATORS

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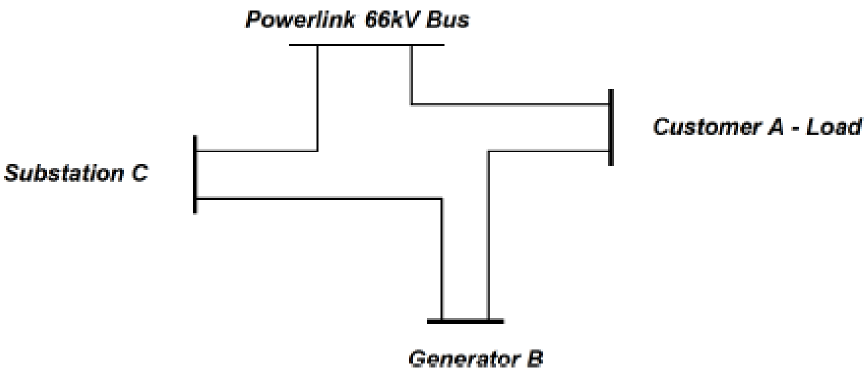
A set of generator operating states is developed relative to the network load and generation patterns with a state for each reasonable distinguishable discrete generator/load condition. Each state will be defined by a time period, a constant average load and a constant average generator output. The load and generation are the averages during the time period of the operating state being studied. The operating states combined must occupy the full time frame associated with the required DLF. This will normally be one year.

A table of operating states with time periods, average loads and average generator outputs should be developed

An example network is described below:



Customer A has a single shift operation and a load of 10MW between 0700 and 1700.

Generator B has an output of 15MW over the period 0600 to 2100. The generator output and operating periods for the full year are to be specified by the Financially Responsible market Participant. Only one average DLF will be calculated for the year.

Substation C is a domestic type load which can be characterised by 0700 to 1800 – 5MW, 1800 to 2100 – 8MW and 2100 to 0700 - 2MW

The resultant discrete operating states table would be :

State	*Duration*	*Load A*	*Gen B*	*Sub C*
1	0700 – 1700	10MW	15MW	5MW
2	1700 – 1800	0	15MW	5MW
3	1800 – 2100	0	15MW	8MW
4	2100 – 0600	0	0	2MW
5	0600 – 0700	0	15MW	2MW

State 4 does not need to be modelled as the Generator is not operating during that period.

As an alternative the operating states table may be developed from a load duration curve when sufficient data exists and the generator output is reasonably constant

Step 2

A load flow study is run for each of the relevant operating states with the average load and average generation in that state.

The output from the embedded generator is incremented and the load flow studies are repeated for each of the relevant operating states with the same average loads

The net increase in system demand (generation output plus Transmission Network Connection Point load) for each operating state is recorded.

The Marginal Loss Factor for that generator in that operating state is calculated by dividing the net system demand (generator output plus load at the Transmission Network Connection Point) increase by the increase in generation and subtracting the result from 1. [There has been no change in load so that the net system demand change is a loss change

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FOR EMBEDDED/LOCAL GENERATORS

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due to sourcing the increment from the generator instead of from the Transmission Network Connection Point].
MLF = 1 - (System Demand Increase/Generator Output Increase)

Step 3

Convert the set of Marginal Loss Factors to an equivalent set of Distribution Loss Factors by taking the square root of the MLF.
Note:

- *Distribution Loss Factor (average)= SQRT(MLF X LF)*
- *As we are using constant average loads to model for each operating state, the Load Factor (LF) = 1 for that state*
- *Thus in this model DLF (average) = SQRT(MLF)*

An operating states table is then built with MLF, DLF' and the energy exported by the Generator during that operating state.

The table developed for our example is:

State	MLF	DLF	Energy Exported
1	1.04	1.02	150 MWh
2	0.96	0.98	15 MWh
3	0.98	0.99	45 MWh
5	0.88	0.94	15 MWh

Step 4

The annual volume weighted distribution loss factor for each generator is calculated from the tabulated DLF's and generation energy exported for each of the discrete operating states .

For example, in our test network the DLF would be

DETERMINATION OF DISTRIBUTION LOSS FACTORS FOR EMBEDDED/LOCAL GENERATORS

REPORT NCM17699

$$DLF = \frac{1.02 * 150\ MWh + 0.98 * 15MWh + 0.99 * 45\ MWh + 0.94 * 15MWh}{(150 + 15 + 45 + 15)\ MWh}$$

= 1.006

Step 5 - Two or more generators in the network

Steps 1 to 4 are undertaken to calculate the DLF for each generator separately The DLF for any generator is calculated by incrementing only that generator's output and running all the load flow studies with the average generation from each of the other generators.

3.0 Reality Check

A generator which is reducing losses in the system will have a DLF greater than unity. That is, the losses in the network are reduced by taking incremental supply from the generator rather than from the Transmission Network Connection Point and therefore more capacity is saved at the Transmission Network Connection Point than was added by the generator. A DLF greater than unity will result in the generation energy adjusted to the Transmission Network Connection Point being greater than the metered generator energy output

A generator which increases losses will have a DLF below unity.

These DLF's for embedded generators are consistent with the TLF's applied to transmission grid connected generators. That is if the generator adds to the total amount of losses in the system, then the DLF or TLF will be less that unity. If the generator reduces the losses in the system, the DLF or TLF will be greater than unity.

K Kehl
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