Revised Regulatory Proposal

Supporting Information: Replace Urban Zone Transformers

Aurora response to the AER's Draft Distribution Determination

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1. Introduction

Aurora provided the AER with its *Regulatory Proposal* on 31 May 2011 in accordance with the provisions of Chapter 6 of the *Rules*. Aurora also set out its answers to the Regulatory Information Notice (RIN) issued by the AER on 21 April 2011 in its response (*RIN Response*) of 31 May 2011.

The AER have reviewed Aurora's *Regulatory Proposal* and *RIN Response* and provided Aurora with the AER's *Draft Distribution Determination*, associated consultant's reports and AER models on 29 November 2011 in accordance with the provisions of Chapter 6 of the *Rules*.

Aurora provides its *Revised Regulatory Proposal* to the AER in response to the AER's *Draft Distribution Determination* in accordance with the provisions of Chapter 6 of the *Rules*. This document provides specific supporting information as an appended attachment to Aurora's *Revised Regulatory Proposal*

2. Replace Urban Zone Substation Transformers (REUZT)

2.1. Summary

In Aurora's Regulatory Proposal, Aurora proposed to replace four of the ageing transformers at Aurora's urban zone substations. The aims of this program were to manage the risk of in-service failure associated with these assets and pro-actively manage the replacement of these assets. Aurora notes that there are a considerable number of these transformers are expected to reach their end of life within the next ten years.

The AER considers a more prudent approach is to defer the replacement of these assets, ensuring they are appropriately maintained and purchase a spare transformer.

Aurora has conducted a review of its zone substation transformer fleet and performed calculations to determine the number of spares required to support the AER's proposed arrangements.

The recommendations arising from this review are:

1 Three spare 33/11 kV, 25 MVA transformers be purchased immediately at an estimated cost of $3m;

2 One additional 33/11 kV, 25 MVA transformer be purchased in 2015 when the existing spare transformer is installed at Kingston at an estimated cost of $1m; and

3 Development of an appropriately oil-contained secure site for the storage of the spare transformers at an estimated cost of $650k.

2.2. Background

In Aurora's Regulatory Proposal, Aurora proposed to replace four of the ageing transformers at Aurora's urban zone substations. The aims of this program were to manage the risk of in-service failure associated with these assets and pro-actively manage the replacement of these assets. Aurora notes that there are a considerable number of these transformers are expected to reach their end of life within the next ten years.

The AER considers a more prudent approach is to defer the replacement of these assets, ensuring they are appropriately maintained and purchase a spare transformer.

The urban zone substation power transformer fleet can be divided into three types of transformers:

1 Medium urban transformers (33/11 kV, 20-25 MVA);

2 Large urban transformers (33/11 kV, 30 MVA); and

3 Trial Harbour transformers (66 44/22kV 20MVA).

2.2.1. Medium Urban Transformers (33/11 kV 20-25 MVA)

There are 15 medium urban transformers located at:

- Bellerive (third transformer to be installed 2013);
- Cambridge;
- Claremont;
- Derwent Park;
- Geilston Bay;
- Howrah (to be constructed 2012); and
- New Town.

Section 5 gives the year of manufacture, rating and maximum demand at each substation site.

As part of the program to address load growth on the Hobart Eastern Shore and in the Kingston area, Aurora has purchased four 25 MVA transformers.

Two of these transformers are to be installed at the new Howrah Zone Substation (due for completion in 2012).

One transformer is to be installed as the third transformer at Bellerive Zone Substation (due for completion in 2013).

The fourth transformer is to be held as a spare at Howrah Zone Substation in the spare third transformer bay until the construction of Kingston Zone Substation in 2013-14.

2.2.2. Large Urban Transformers (33/11kV 20/30MVA)

There are nine large urban transformers are located at:

- East Hobart;
- Sandy Bay; and
- West Hobart.

As part of the Hobart Area Supply Upgrade, which took place between 2001 and 2006, the transformers at these zone substations were replaced.

Section 5 gives the year of manufacture, rating and maximum demand at each substation site.

These transformers are relatively new and all three sites are either operating below N-1 or there is sufficient transfer capability within the 11 kV network to manage the load at these sites.

2.2.3. Trial Harbour Transformers (66-44/22kV 20MVA)

Trial Harbour Zone Substation was constructed in 2006 to supply the Zeehan Township and local mine sites. There are two power transformers at this site.

Due to a down turn in the mining sector, this substation is currently operating well below its N-1 rating.

2.3. Spares Calculation

2.3.1. Methodology

To determine the number of power transformer spares Aurora may consider holding, AusGrid's method of calculating the probability of having a spare when needed (refer Section 3) was applied to Aurora's population of zone substation transformers.

The urban zone substation power transformers were broken into three groups based on voltage and size (refer 5).

The failure rate of the transformers was taken from ESAA Doc 006 - 1997 *Guidelines for Reliability Assessment Planning*, Appendix 3: Transformers using the figures for 33/11kV transformers. The value used for failure rate was the average of the calculated failure rate for each transformer and not the failure rate for the average age of the transformers.

The provisioning time for a power transformer was taken to be 1 year.

The calculations were based on the age of the transformers in 2013 after Howrah Zone Substation is expected to be completed (including storing the transformer for Kingston Zone Substation in the future) and a third transformer installed at Bellerive Zone Substation.

The results are given in Table 1 and the full calculations can be found in Power Transformer Spares Holdings Calculations (reference 1).

Table 1: Number of spares required for greater than 99.9% probability of having a spare when required

Transformer Type	Number in system	Number of spares required
Medium urban (33/11kV 20-25 MVA)	10	4
Large urban (33/11kV 30MVA)	9	1
Trial Harbour (66-44/22kV 20MVA)	2	0

2.3.2. Medium Urban Transformers (33/11kV 20-25 MVA)

Based on the above analysis, Aurora will be required to hold four spare transformers of this size to ensure that a spare is available when it is needed 99.9% of the time.

As Aurora is already holding one spare transformer to be used at Kingston Zone Substation when it is constructed in 2016, it is recommended that three transformers are purchased immediately and an additional transformer is purchased in 2015 when prior to the existing transformer being used at Kingston. Based on recent transformer purchases, the cost of each spare is estimated at $1m.

As Aurora does not have a suitable location with oil-containment to store these transformers, it is also recommended that Aurora procure and develop a location for the storage of these transformers. Based on recent zone substation construction projects it is estimated that the construction of a suitably bunded, secure area for four transformers, excluding the purchase of the land would be $450k. It is estimated the cost of land at a suitable site would be $200k.

2.3.3. Large Urban Transformer (33/11kV 30MVA)

As these transformers are relatively new and all three sites are either operating below N-1 or there is sufficient transfer capability within the 11 kV network to manage the load at these sites, it is recommended that no spares be held for these transformers.

In the event that one of these transformers was to fail and system capacity was not sufficient to transfer load, one of the spare medium urban transformers could be used as an interim measure until a new transformer was sourced.

2.3.4. Trial Harbour Transformers (66-44/22kV 20MVA)

Due to the age and load at Trial Harbour Zone Substation, there is no requirement to hold spare transformers of this size.

2.4. Operational Expenditure

It is anticipated that there would be a small increase in operational expenditure requirements associated with the management of spare transformers, including silica gel breather inspections, periodic inspections for oil-leaks and oil tests.

2.5. Recommendation

Aurora has conducted a review of its zone substation transformer fleet and performed calculations to determine the number of spares required to support the AER's proposed arrangements.

The following recommendations are made for addressing the spares holding issues associated with the power transformers at Aurora's urban zone substations:

1. Three spare 33/11 kV, 25 MVA transformers be purchased immediately at an estimated cost of $3m;
2. One additional 33/11 kV, 25 MVA transformer be purchased in 2015 when the existing spare transformer is installed at Kingston at an estimated cost of $1m; and
3. Development of an appropriately oil-contained secure site for the storage of the spare transformers at an estimated cost of $650k.

2.6. References

1. Power Transformer Spares Holding Calculations (NW-#276173-V3)

3. Spares Availability Calculation

Based on the work presented by AusGrid at the Electricity Industry Plant Working Group, the following methodology is used to determine the probability of having a spare of a particular item available when required.

The information used to analyse spares requirements are:

- the reliability of the item;
- the installed population of the item;
- the probability of having a spare item available when required; and
- the provisioning period of the item (i.e. the lead time).

The relationship between these items can be described by:

$$P = \sum_{n=0}^{n=s} \left[\frac{R(-\ln(R))^n}{n!} \right]$$

where

P = probability of having a spare of a particular item available when required

S = number of spare parts carried in stock

R = composite reliability (probability of survival); $R=e^{-K\lambda T}$

K = installed population

λ = the failure rate of the item

T = provisioning of the item (lead time in years)

AusGrid's policy is to aim for greater than 99.9% probability of having a spare available.

4. Confidentiality

Aurora does not consider any information contained within this document to be confidential.

5. Summary of Aurora Energy Zone Substation Transformers

A.1. Medium Transformers (33/11 kV, 20-25 MVA)

Substation	Number of T'formers	Year of Manufacture	Rating of T'formers (MVA)	N-1 (MVA)	Substation Maximum Demand – Winter 2010 (MVA)
Bellerive	3	T1/T2 – 1971 T3 – 2011	15/22.5	22.5	19.9
Cambridge	2	2009	20	20	11.5
Claremont	2	1969	15/22.5	22.5	26.6
Derwent Park	2	1964	15/22.5	22.5	25.6
Geilston Bay	2	1964	15/22.5	22.5	26.4
Howrah	2	2011	25	25	18 (est)
New Town	2	T1 – 2005 T2 – 1999	15/22.5	22.5	12.9

A.2. Large Transformers (33/11 kV, 30 MVA)

Substation	Number of T'formers	Year of Manufacture	Rating of T'formers (MVA)	N-1 (MVA)	Substation Maximum Demand – Winter 2010 (MVA)
East Hobart	3	2004	20/30	45 Note 1	32.3
Sandy Bay	3	2004	20/30	45 Note 1	46.9
West Hobart	3	2001	20/30	60	39.8

Notes:

1. The subtransmission feeders are the limiting factor for the capacity of this substation

A.3. Trial Harbour Road (66-44/22kV, 20 MVA)

Substation	Number of T'formers	Year of Manufacture	Rating of T'formers (MVA)	N-1 (MVA)	Substation Maximum Demand – Winter 2010 (MVA)
Trial Harbour Road	2	2006	20	20	11.7