NEED/OPPORTUNITY STATEMENT (NOS)

Constraints in Endeavour Energy's 132 and 66 kV Network between Macarthur and Nepean

NOS- 000000001438 revision 4.0

Ellipse project description: Constraints in Endeavour Energy's 132 and 66 kV Network between Macarthur and Nepean

TRIM file: [TRIM No]

Project reason: Reliability - To meet connection point reliability requirements
Project category: Prescribed - Augmentation

Approvals

Author	Ronny Schnapp	Network & Connection Analysis Engineer
Endorsed	Vincent Ong	Network & Connection Analysis Manager
Endorsed	Garrie Chubb	Investment Support Manager
Endorsed	Azil Khan	Investment Analysis Manager
Approved	Nalin Pahalawaththa	M/PSA
Date submitted for approval	8 December 2016	

Change history

Revision	Date	Amendment
0	31/05/2016	Initial Issue
1	27/10/2016	Updated risk costs
2	8/12/2016	Clarified all risk cost breakdowns

1. Background

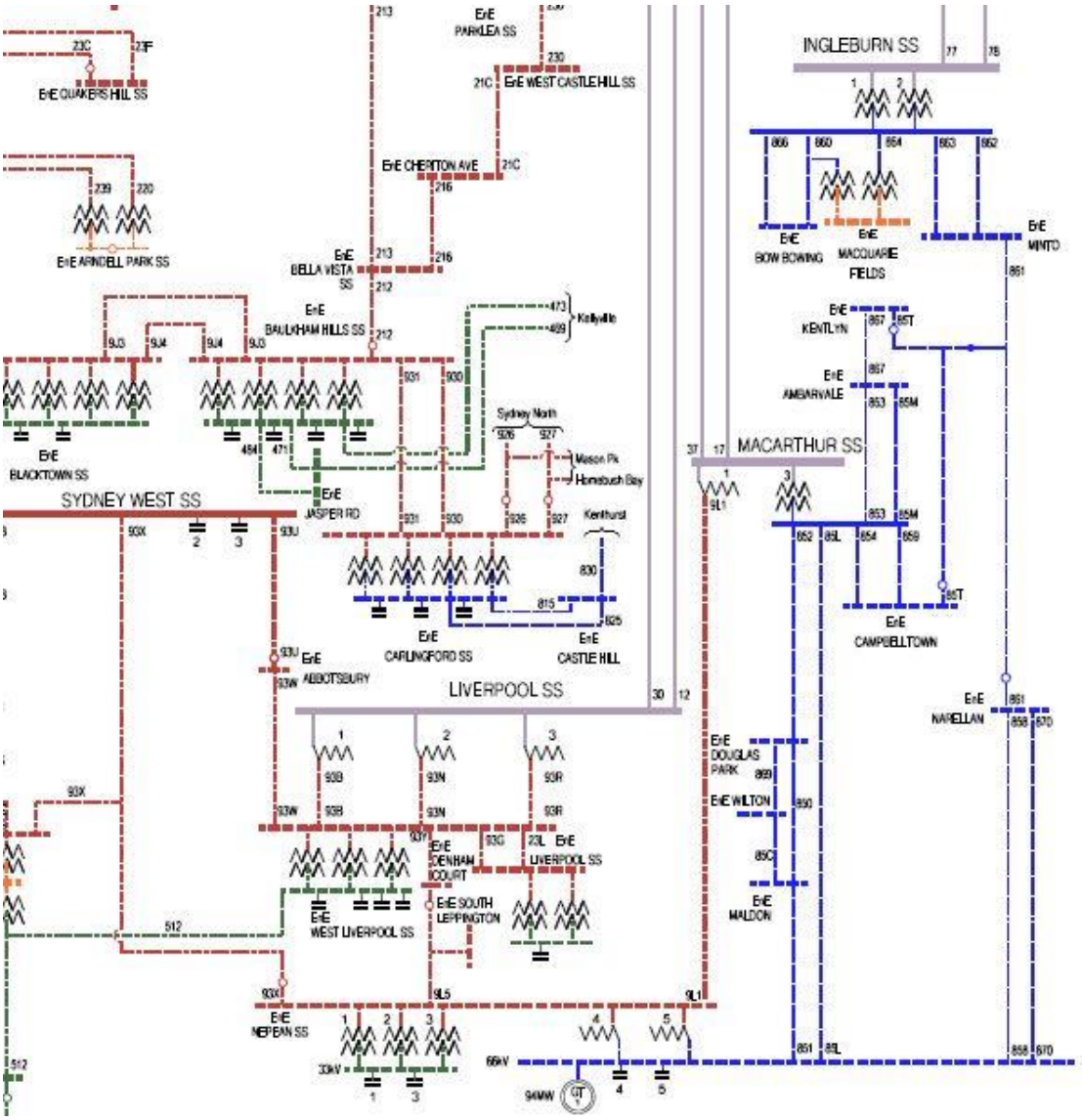
The Endeavour Energy 66 kV network in the Macarthur–Nepean area is supplied by one 250 MVA 330/66 kV transformer at TransGrid's Macarthur substation, and two 120 MVA 132/66 kV transformers at Endeavour Energy's Nepean substation. The high-capacity 66 kV 85L Macarthur to Nepean circuit allows transfer of capacity between the two sites. The schematic of the relevant network is shown in Figure 1.

A single 375 MVA 330/132 kV transformer at TransGrid's Macarthur substation provides 132 kV supply to Endeavour Energy's Nepean substation via the tail-ended high capacity 91L Macarthur to Nepean 132 kV circuit. The normally open 93X and 93Y/9L5 132 kV circuits provide a limited level of backup to Nepean at 132 kV from Sydney West and Liverpool.

There is limited capability to transfer an amount of the 66 kV system load (Ambarvale and Kentlyn) to Ingleburn BSP. There are also embedded generators within the 66 kV system located at the Tower and Appin collieries.

Constraints due to outages within the network are currently managed by transferring a portion of 66 kV load to Ingleburn.

Figure 1: Macarthur and Nepean supply network



2. Need/opportunity

The population in Sydney's south-west sector is expected to grow steadily over the next decade to 2026. An average 3.9% p.a. increase in the maximum summer demand at Macarthur BSP is forecast over the same period.[a]

As a result, Endeavour Energy has carried out, and TransGrid have reviewed, a comprehensive planning study on its Macarthur-Nepean network which identifies the nature and likely timing of emerging constraints as follows:[b]

(1) A forced outage of the Macarthur 330/66 kV transformer at times of peak demand would cause:

- (a) Endeavour Energy's Nepean 132/66 kV transformers to exceed their contingency rating of 127 MVA from 2016;
- (b) Endeavour Energy's 132 kV 9L1 line to Nepean to exceed its thermal contingency rating of 358 MVA from 2016; and
- (c) TransGrid's Macarthur 330/132 kV transformer to exceed its contingency rating of 412.5 MVA from 2018.[c]

Transfer of Ambarvale and Kentlyn loads to Ingleburn would provide some relief to this constraint until 2020; however the capacity of the Ingleburn 66 kV network is forecast to be reached around 2022.[d]

(2) A forced outage of the Macarthur 330/132 kV transformer at times of peak demand would cause:

- (a) TransGrid's Macarthur 330/66 kV transformer to exceed its short-time step rating by 2018.[e]

As above, transfer of Ambarvale and Kentlyn loads to Ingleburn would provide some relief to this constraint until 2020; however the capacity of the Ingleburn 66 kV network is forecast to be reached around 2022.

(3) There are also problems associated with maintenance outages of the Endeavour Energy Nepean No.4 132 kV bus section that result in the entire 66 kV network load being supplied radially by the Macarthur 330/66 kV transformer and 85L 66 kV line Macarthur to Nepean.

2.1 Date to Address the Need

This Need 1438 was published in TransGrid's Transmission Annual Planning Report 2016 (TAPR 2016), section 4.4, which anticipated a date of between 2021 and 2026. At the time TAPR 2016 publication, preliminary technical studies indicated the Need would have to be addressed within a 5-10 year timeframe.

However, as indicated above, Endeavour Energy's more recent study[f] shows that transfers of Ambarvale and Kentlyn loads from Macarthur BSP to Ingleburn BSP would provide some relief from the constraints until 2020. However, beyond that, a more permanent solution would need to be implemented.

Therefore, this Need should be addressed by December 2020.

---

[a] Based on the demand forecast for Macarthur 132 and 66 kV published in TransGrid's Transmission Annual Planning Report (TAPR) 2016, p.76. Note that AEMO acknowledges that in its assessment of transmission network adequacy, it does not consider "local transmission augmentations driven by local demand growth" (AEMO 2015, *National Transmission Network Development Plan*, November 2015, p.20), which may be higher at a given BSP than the overall demand growth across the NEM.

[b] Endeavour Energy, *Macarthur BSP Transformer Outage Study*, August 2016, Endeavour Energy Letter attachment 9.

[c] For TransGrid, the transformer contingency rating is defined as 110% of its nameplate rating (in this case 110% of 375 MVA).

[d] See footnote b.

[e] *Operating Manual (OM) 320 – Transformer Ratings* explains that short-time ratings are "the calculated maximum values up to which the 3-phase transformer may be safely operated" based on the ambient temperature and the transformer's initial (pre-contingent) loading. See *OM 322 – Transformer Ratings in Central Region* for specific transformer data.

[f] See footnote b.

2.2 Risks

The National Electricity Rules (NER) clause 5.14 – Joint Planning requires TransGrid (and Endeavour Energy) to jointly plan their regional electricity network. In this case, should TransGrid not participate with Endeavour Energy in evaluating options to address this Need, it would be violating this statutory obligation.

A further risk of not addressing this Need is a loss of load, that is, unserved energy (USE), in the Macarthur/Nepean area following a single critical contingency of a TransGrid-owned transformer at Macarthur BSP.

TransGrid and Endeavour Energy have assessed the peak load at risk[g] based on Endeavour Energy's load forecasts (published in the TransGrid Transmission Annual Planning Report 2016), the studies in their report sent to TransGrid on 19 August 2016[h], and an adjustment calculation to take into consideration the ratings of TransGrid's Macarthur transformers[i]. This load at risk is due to developments in the South West Sector (with new zone substations being built by Endeavour Energy at North Leppington, Catherine Park, Smeaton Grange, Austral, Menangle Park, Mt Gilead, North Catherine Field and Maryland) and the Greater Macarthur area. These developments increase the level of unsupportable load in Endeavour Energy's network upon outage of a Macarthur transformer. .

The risk cost of not addressing this Need is therefore composed of the following components:

- exposing customer load of 88 MW (peak)[j] to risk of being lost on outage of the 330/66 kV transformer.
- exposing customer load of 124.5 MW (peak)[k] to risk of being lost on outage of the 330/132 kV transformer.
- damage to TransGrid's reputation (negative media coverage).
- litigation by customers/consumer groups.

The total cost of these risks has been calculated in TransGrid's Investment Risk Tool thus:

VCR Risk Cost (Unserved Energy)

$$VCR\ risk\ cost = \{peak\ load\ at\ risk * probability\ of\ outage\ of\ Macarthur\ 330/132\ kV\ Tx\ at\ time\ of\ peak\ load + peak\ load\ at\ risk * probability\ of\ outage\ of\ Macarthur\ 330/66\ kV\ Tx\ at\ time\ of\ peak\ load\} * VCR^{l}$$

$$\therefore VCR\ risk\ cost = \{124.5\ MW * \frac{[Tx1\ yearly\ failure\ rate^{m} * Tx\ failure\ duration^{n}]}{[Total\ hours\ of\ peak\ load]^{o}} + 88\ MW * \frac{[Tx2\ yearly\ failure\ rate^{p} * Tx\ failure\ duration^{q}]}{[Total\ hours\ of\ peak\ load]^{r}}\} * VCR$$

$$\therefore VCR\ risk\ cost = 212.5\ MW * \frac{[0.17 * 24hrs]}{[8hrs]} * \$38{,}350/MWh$$

$$\therefore VCR\ risk\ cost = 212.5\ MW * 0.51 * \$38{,}350/MWh$$

$$\boldsymbol{\therefore VCR\ risk\ cost = \$4.16\ million\ per\ annum}$$

---

[g] See risk cost components list below.

[h] See footnote b.

[i] See footnote c.

[j] See foonotes h and i.

[k] See foonotes h and i.

[l] TransGrid's Investment Risk Tool bases the Value of Customer Reliability (VCR) on figures published by AEMO in its *Value of Customer Reliability Review - Final Report*, September 2014. In this case we use the mixed residential/industrial figure of $38,350/MWh.

[m] IPART 2016, *Electricity transmission reliability standards Energy — Supplementary Draft Report September 2015* (sic), Table C.10, p.50.

[n] ibid, Table C.1, p.40.

[o] By definition, peak load occurs only once a year. For our calculations, we assume that the peak load occurs for 8 hours on the hottest day of the year.

[p] See footnote i.

[q] See footnote j.

[r] See footnote k.

Reliability Risk Cost

$$Reliability\ risk\ cost = VCR\ risk\ cost + litigation\ costs$$

$$\therefore \boldsymbol{Reliability\ risk\ cost} = \$\mathbf{4.16m} + \$\mathbf{0.02m}^{s} = \mathbf{4.18\ million\ per\ annum}$$

Financial Risk Cost

$$Financial\ risk\ cost\ = internal\ investigation\ costs = \$10{,}000^{t}$$

Reputational Risk Cost

$$Reputational\ risk\ cost\ = external\ consultations\ \&\ communications\ costs = \$14{,}500^{u}$$

Total Risk Cost

$$Total\ risk\ cost = Reliability\ risk\ cost + Financial\ risk\ cost + Reputational\ risk\ cost$$

$$\therefore \boldsymbol{Total\ risk\ cost} = \$\mathbf{4.20\ million\ per\ annum}$$

A risk-cost summary extract from the Investment Risk Tool appears in Attachment 1.

3. Related needs/opportunities

The following Needs at Macarthur BSP have similar Need dates and consideration should be given to packaging all emerging works into a single project, if possible:

- Need 1437 – Macarthur 66 kV Line Switchbay (Menangle Park ZS) – Need Date 2020

  This switchbay will be needed to supply the proposed Menangle Park ZS, which has been identified as a distribution supply point for the NSW Government's Greater Macarthur Land Release.

- Need 1440 – Macarthur 66 kV Line Switchbay (Mt Gilead ZS) – Need Date 2021

  This switchbay will be needed to supply the proposed Mt Gilead ZS, which has been identified as another distribution supply point for the NSW Government's Greater Macarthur Land Release.

4. Recommendation

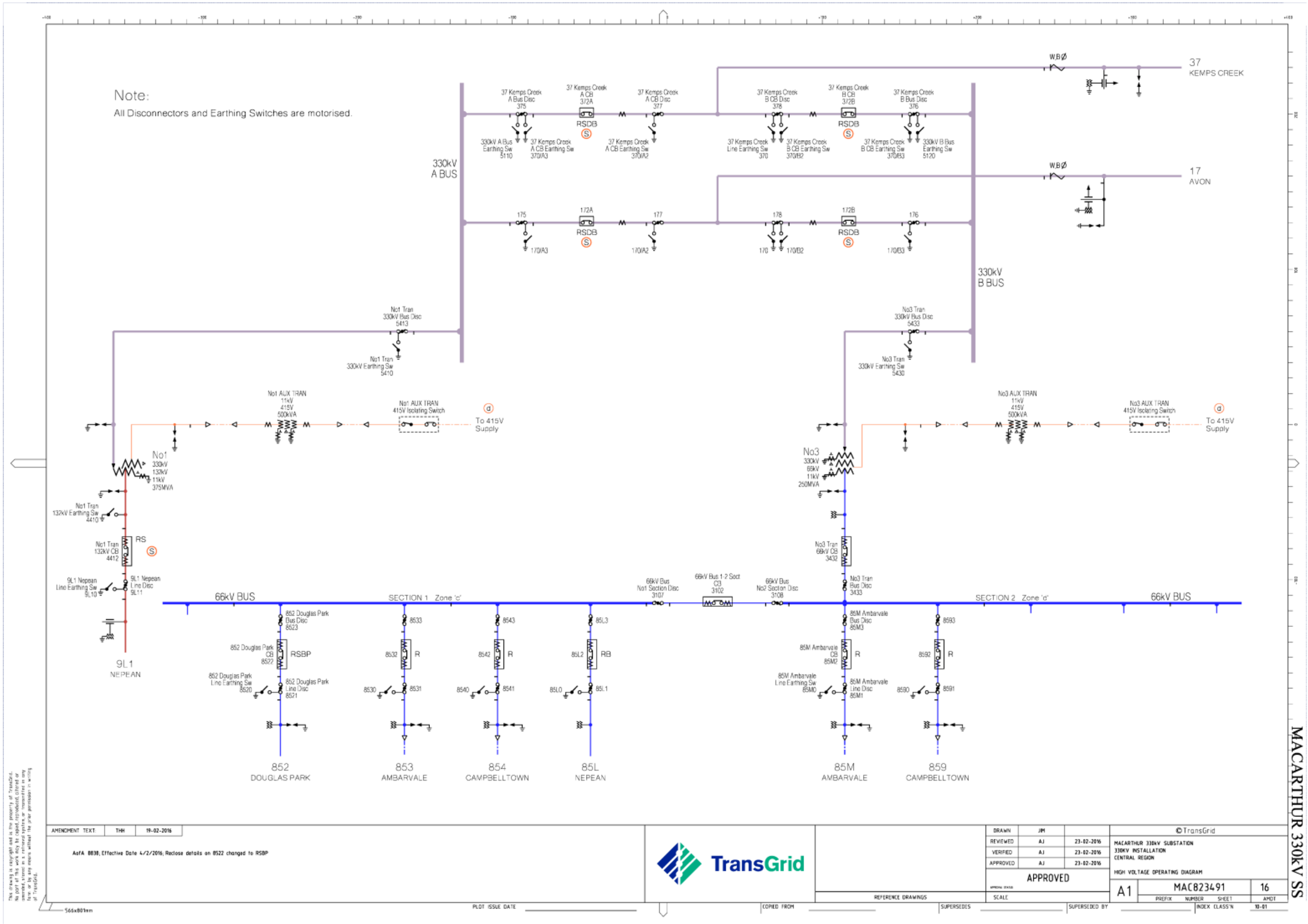
It is recommended that options be considered to address the identified need by 2020.

[s] This component is an assumed litigation risk cost if the event occurred.

[t] This component is an assumed financial risk cost if the event occurred.

[u] This component is an assumed reputational risk cost if the event occurred.

Figure 2: Macarthur 330/132 kV Substation High Voltage Operating Diagram



Attachment 1 Risk Assessment and Cost

Current Option Assessment - Risk Summary

Project Name: Constraints in Endeavour Energy's 132 kV Network between Macarthur and Nepean

Option Name: 1438 - Base Case

Option Assessment Name: 1438 - Option A - Assessment 1

Rev Reset Period: Next (2018-23)

Major Component	No.	Minor Component	Sel. Hazardous Event	LoC x CoF ($M)	Failure Mechanism	NoxLoC xCoF ($M)	PoF (Yr 1)	Total Risk ($M)	Risk ($M) (Rel)	Risk ($M) (Op)	Risk ($M) (Fin)	Risk ($M) (Peo)	Risk ($M) (Env)	Risk ($M) (Rep)
No.1 375 MVA 330/132 kV Transformer	1	Winding and Core	Unplanned Outage - HV (No.1 375 MVA 330/132 kV Transformer)	$4.82	Failure	$4.82	51.00%	$2.46	$2.45		$0.01			$0.01
No.3 250 MVA 330/66 kV Transformer	1	Winding and Core	Unplanned Outage - HV (No.3 250 MVA 330/66 kV Transformer)	$3.42	Failure	$3.42	51.00%	$1.74	$1.73		$0.01			$0.01
				$8.24		$8.24		$4.20	$4.18		$0.01			$0.01

Total VCR Risk: $4.16 Total ENS Risk: $0.00

Printed by: p85764 on 5/12/2016 at 6:47:21 PM

Page 1 of 1