# OPTIONS EVALUATION REPORT (OER)

Protection - Schweitzer SELxxx Condition

OER 000000001380 revision 2.0

**Ellipse project no.:** P0008033
**TRIM file: [TRIM No]**

**Project reason:** Capability - Asset Replacement for end of life condition
**Project category:** Prescribed - Asset Renewal Strategies

**Approvals**

| | | |
|---|---|---|
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| **Date submitted for approval** | 15 December 2016 | |

**Change history**

| Revision | Date | Amendment |
|---|---|---|
| 0 | 23 June 2016 | Initial issue |
| 1 | 31 October 2016 | Update to 2016/17 dollars and SFAIRP/ALARP data |
| 2 | 15 December 2016 | Update to format |

## 1. Need/opportunity

The assets raised within this Need will have exceeded their nominal average life by 2023. Manufacturer support for the majority of models is limited, meaning that repair and replacement facilities are expected to be unavailable by 2023. Spares currently held by TransGrid for this model are projected to be exhausted.

The use of duplicated protection schemes across all transmission lines and transformers are a continuing requirement of the Australian Energy Regulator (AER) as outlined in the National Electricity Rules (NER). These protection schemes are required into the foreseeable future.

## 2. Related Needs/opportunities

The following Needs address parts of the omitted relays covered by this Need:

- Need ID 1180 – Wagga 330kV Secondary Systems Renewal
- Need ID 1186 – Murrumburrah Secondary Systems Renewal
- Need ID 1191 – Deniliquin Secondary Systems Renewal
- Need ID 1192 – Lower Tumut Secondary Systems Renewal
- Need ID 1193 – Broken Hill Secondary Systems Renewal
- Need ID 1194 – Tenterfield Secondary Systems Renewal
- Need ID 1196 – Coleambally Secondary Systems Renewal
- Need ID 1243 – Tamworth 330kV Secondary Systems Renewal
- Need ID 1244 – Wallerawang 330kV Secondary Systems Renewal
- Need ID 1246 – Panorama Secondary Systems Renewal
- Need ID 1247 – Muswellbrook Secondary Systems Renewal
- Need ID 1252 – Cowra Secondary Systems Renewal
- Need ID 1253 – Darlington Point Secondary Systems Renewal
- Need ID 1255 – Ingleburn Secondary Systems Renewal
- Need ID 1258 – Regentville Secondary Systems Renewal
- Need ID 1263 – Tuggerah Secondary Systems Renewal
- Need ID 1266 – Marulan Secondary Systems Renewal
- Need ID 1267 – Molong Secondary Systems Renewal
- Need ID 1599 – Liverpool Secondary Systems Renewal

## 3. Options

All dollar values in this document are expressed in un-escalated 2016/17 dollars.

**Base Case**

The Base Case for this Need is to run these assets to failure. This approach does not address the increasing failure rates or the risk cost associated with the Need. At $1.54m per annum, the risks are significant and foreseen to increase as the probability of failure of the assets will also likely increase. Key drivers for this risk cost are:

- Consequence assumes black start for assets protecting primary plant at 330kV and above with "N-1" redundancy. The restoration time has been set as 8 hours with an assumed 1,296MW of load interrupted to mixed customers (residential, commercial, and agricultural) to model a number of potential network scenarios based on this consequence.
- The population of this asset group is 20 units across all voltage levels and sites within the network.

Increasing the maintenance for the assets cannot reduce the probability of failure in order to reduce the risk cost.

**Option A — Replacement of Individual Assets [OFR 1380A, OFS 1380A]**

This option covers the replacement of assets in a "like for like" manner. This involves removing the panel and replacing it with a new relay panel utilising the same features currently in use. This option doesn't include any upgrade of systems to maximise the utilisation of available technology.

Operating costs have been estimated at $4.25k per annum for this option based on current maintenance plan settings.

Due to the "like for like" nature of this option, no benefit has been calculated in accordance with TransGrid's Renewal and Maintenance Strategy for Secondary Systems Site Installations[1].

The expected total capital cost to replace all 41 assets identified under this Need is $4.72m. This costing is estimated using TransGrid's "Success" estimating system. This cost has been adjusted to $2.33m for analysis in this OER to account for the reduction of 21 assets that will be replaced under Secondary Systems Renewal Needs or are utilised on negotiated services. This adjustment has been carried out using the unit costs provided in the Option Feasibility Study (OFS).

The residual risk associated with this option upon completion of the project amounts to $0.24m per annum (base case risk cost = $1.54m). The risk reduction is realised through the reduction in the probability of failure for all assets.

The assets under investigation have been divided into two broad categories:

**Assets protecting primary assets ≤220kV and ≤150MW**

This configuration covers only replacing the assets protecting primary assets where the peak load at risk is less than 150MW and service voltage is less or equal to 220kV.

The expected capital cost to replace this category of assets is $0.73m. This costing was estimated using the unit costs provided under OFS 1380A and applying them to those assets that would be replaced. These costs are broken down in Table 1.

**Table 1 – Expected costs for replacing assets protecting primary assets ≤220kV and ≤150MW ($ thousand)**

| Item | Unit Cost, Including Labour | Quantity | Total Cost |
|---|---|---|---|
| Line Protection ≤220kV, ≤150MW | 94.0 | 5 | 470 |
| Transformer Protection ≤220kV, ≤150MW | 130 | 2 | 260 |

[1] Refer SSA Strategy - Renewal and Maintenance -Secondary Systems Site Installations

| Item | Unit Cost, Including Labour | Quantity | Total Cost |
|---|---|---|---|
| **Total estimated cost** | | | **730** |

The residual risk associated with this portion of assets upon completion of the project amounts to $0.01m per annum (base case risk cost component = $0.30m). The risk reduction is realised through the reduction in the probability of failure for the affected assets.

**Assets protecting primary assets ≥330kV**

This configuration covers only replacing the assets classified as protecting primary assets operating at 330kV and above.

The expected capital cost to replace this category of assets is $1.60m. This costing was estimated using the unit costs provided under OFS 1380A and applying them to those assets that would be replaced. These costs are broken down in Table 2.

**Table 2 – Expected costs for replacing assets protecting primary assets ≥330kV ($ thousand)**

| Item | Unit Cost, Including Labour | Quantity | Total Cost |
|---|---|---|---|
| Line Protection ≥330kV | 123 | 13 | 1,600 |
| **Total estimated cost** | | | **1,600** |

The residual risk associated with this portion of upon completion of the project amounts to $0.21m per annum (base case risk cost component = $1.33m). The risk reduction is realised through the reduction in the probability of failure for the affected assets.

# 4. Evaluation

Evaluation of the proposed options has been completed using the ALARP (As Low as Reasonably Practicable) regulatory requirements and economic considerations. The results of this evaluation are outlined below.

## 4.1 Commercial evaluation

The result of commercial evaluation for each of the technically feasible options is summarised in Table 3.

**Table 3 – Commercial evaluation ($ million)**

| Option | Description | Total capex | Annual opex | Annual post project risk cost | Economic NPV @10% | Financial NPV @10% | Rank |
|---|---|---|---|---|---|---|---|
| Base Case | Run-to-fail | N/A | 0 | 2.34 | N/A | N/A | 2 |
| A | Replace individual Assets | 2.33 | 0 | 0.24 | 4.35 | (1.08) | 1 |
| i) | Replace Assets ≤220kV, ≤150MW | 0.73 | 0 | 0.01 | 0.81 | (0.09) | - |
| ii) | Replace Assets ≥330kV | 1.60 | 0 | 0.21 | 4.06 | (0.95) | - |

The commercial evaluation is based on:

> Economic life of the assets is assumed 15 years, hence this assessment period has been applied.

- Write-offs have not been estimated.
- Capital cost is not escalated and it does not include capitalised interest.

Sensitivities on economic Net Present Value (NPV) for the options with changing discount rates are shown in Table 4.

**Table 4 – Discount rate sensitivities ($ million)**

| Option | Description | Economic NPV @13% | Economic NPV @6.75% |
|---|---|---|---|
| A | Replace individual Assets | 2.90 | 6.72 |
| i) | Replace Assets ≤220kV, ≤150MW | 0.50 | 1.32 |
| ii) | Replace Assets ≥330kV | 2.79 | 6.13 |

## 4.2 SFAIRP/ALARP evaluation

Options to reduce the network safety risk as per the risk treatment hierarchy have been considered in other lifecycle stages of the asset, and it has been determined that no reasonably practicable options exist to reduce the risk further than those capital investment options listed below.

Evaluation of the proposed options has been completed against the SFAIRP (So Far As Is Reasonably Practicable)/ALARP (As Low As Reasonably Practical) obligation, as required by the Electricity Supply (Safety and Network Management) Regulation 2014 and the Work Health and Safety Act 2011. The Key Hazardous Events and the disproportionality multipliers considered in the evaluation are as follows:

- Conductor drop/structure failure - 6 times the bushfire risk, 6 times the safety risk and 10% of the reliability risk (applicable to safety)

The results of this evaluation are summarised in the tables below.

**Table 5 – Feasible options ($ thousand)**

| Option | Description | CAPEX | Expected Life | Annualised CAPEX |
|---|---|---|---|---|
| Base | Run-to-fail | N/A | N/A | N/A |
| A | Replace individual Assets | 2,330 | 15 years | 160 |

**Table 6 – Annual risk calculations ($ thousand)**

| Option | Annual Residual Risk | | | Annual Risk Savings | | |
|---|---|---|---|---|---|---|
| | Safety Risk | Reliability Risk | Bushfire Risk | Safety Risk | Reliability Risk | Bushfire Risk |
| Base | 0 | 1,360 | 10 | N/A | N/A | N/A |
| A | 0 | 210 | 0 | 0 | 1,150 | 10 |

**Table 7 – Reasonably practicable test ($ thousand)**

| Option | Network Safety Risk Reduction[2] | Annualised CAPEX | Reasonably practicable[3]? |
|---|---|---|---|
| A | 175 | 160 | Yes |

Option A is reasonably practical

## 4.3 Preferred option

The outcome of the SFAIRP/ALARP evaluation is that Option A is the preferred option as it is reasonably practicable and provides the greatest network safety risk reduction, and is therefore required to satisfy the organisation's SFAIRP/ALARP obligations.

The option to address the condition of the identified assets, Option A – Replacement of Individual Assets is the preferred option for the assets identified.

This option has been selected due to its technical viability and reduction in reliability risk. This option provides significant technical benefits and provides a positive NPV.

Refer to Attachment 1 for details of the assets to be replaced under this Need.

**Capital and operating expenditure**

There is negligible difference in predicted ongoing operational expenditure between the option and Base Case. Implementing Option A will reduce callouts to address defects and this benefit has been captured in the risk assessment.

**Regulatory Investment Test**

A Regulatory Investment Test for Transmission (RIT-T) is not required as this is an asset replacement project with no augmentation component.

# 5. Recommendation

It is recommended to proceed with the replacement of all 20 identified assets.

[2] The Network Safety Risk Reduction is calculated as 6 x Bushfire Risk Reduction + 3 x Safety Risk Reduction + 0.1 x Reliability Risk Reduction

[3] Reasonably practicable is defined as whether the annualised CAPEX is less than the Network Safety Risk Reduction

# Attachment 1 – Assets for replacement

## A.1 Protection for ≤220kV, ≤150MW assets

| EQUIP_NO | EQUIP_CLASS | PLANT_NO | ITEM_NAME_1 | EQUIP_LOCATION |
|---|---|---|---|---|
| 000000048865 | PT | NTPINVCRA122C1 | 9U2 MOREE 132KV FEEDER NO1 PROTECTION | INV |
| 000000062822 | PT | SWPYA2CRB206J1 | 7L4 LEETON 33KV FEEDER NO1 PROTECTION | YA2 |
| 000000062825 | PT | SWPYA2CRB186M1 | 7L5 MURRAMI 33KV FEEDER NO1 PROTECTION | YA2 |
| 000000062831 | PT | SWPYA2CRB244F1 | 841 NARRANDERA 66KV FDR NO1 PROTECTION | YA2 |
| 000000048927 | PT | NTPKLKCRA202A2 | NO1 132/66/11KV TRANSFORMER NO2 PROT | KLK |
| 000000049787 | PT | NTPKS2CRB246X1 | 7R1 PRINCE STREET 33KV FEEDER NO1 PROT | KS2 |
| 000000082828 | PT | NTPKLKCRA242C2 | NO3 132/66/11KV TRANSFORMER NO2 PROT | KLK |

## A.2 Protection for ≥330MW assets

| EQUIP_NO | EQUIP_CLASS | PLANT_NO | ITEM_NAME_1 | EQUIP_LOCATION |
|---|---|---|---|---|
| 000000007239 | PT | CMPSE1CR1521P2 | 28 SYDNEY NORTH 330KV FDR NO2 PROTECTION | SE1 |
| 000000011231 | PT | COPMTPCRA131G2 | 71 WALLERAWANG 330 - 330KV FDR NO2 PROT | MTP |
| 000000020274 | PT | NNPLD1CR2821AJ1 | 83 MUSWELLBROOK 330KV FDR NO1 PROTECTION | LD1 |
| 000000048669 | PT | NTPAR1CRB451G2 | 85 TAMWORTH 330 - 330KV FEEDER NO2 PROT | AR1 |
| 000000048672 | PT | NTPAR1CR0551P2 | 86 TAMWORTH 330 - 330KV FEEDER NO2 PROT | AR1 |
| 000000074796 | PT | NTPAR1CR0491H2 | 8E DUMARESQ 330KV FDR NO2 PROTECTION | AR1 |
| 000000075735 | PT | NTPDMQCRD021A12 | 8E ARMIDALE 330 - 330KV FEEDER N02 PROT | DMQ |
| 000000075737 | PT | NTPDMQCRD051AB2 | 8C ARMIDALE 330 - 330KV FEEDER NO2 PROT | DMQ |
| 000000075739 | PT | NTPDMQCRD081B12 | 8M BULLI CREEK 330KV FDR NO2 PROTECTION | DMQ |
| 000000075741 | PT | NTPDMQCRD111BD2 | 8L BULLI CREEK 330KV FDR NO2 PROTECTION | DMQ |

| EQUIP_NO | EQUIP_CLASS | PLANT_NO | ITEM_NAME_1 | EQUIP_LOCATION |
|---|---|---|---|---|
| 000000076456 | PT | NTPAR1CR0751Q2 | 8C DUMARESQ 330KV FDR NO2 PROTECTION | AR1 |
| 000000009925 | PT | CMPSYSCR5141M1 | 78 INGLEBURN 330KV FEEDER NO1 PROTECTION | SYS |
| 000000009928 | PT | CMPSYSCR0091R1 | 76 WALLERAWANG 330 - 330KV FDR NO1 PROT | SYS |

### Option A NPV calculation

| Project_Option Name | Option A - Individual Asset Replacements - All Assets |
|---|---|

**1. Financial Evaluation** (excludes VCR benefits)

| | | | | |
|---|---|---|---|---|
| NPV @ standard discount rate | 10.00% | -$1.08m | *NPV / Capital (Ratio)* | *-0.47* |
| NPV @ upper bound rate | 13.00% | -$1.13m | *Pay Back Period (Yrs)* | *-0.01 Yrs* |
| NPV @ lower bound rate (WACC) | 6.75% | -$0.96m | *IRR%* | *-0.76%* |

**2. Economic Evaluation** (includes VCR benefits but excludes tax benefits from non-cash transactions, ENS penalty and overall tax cost)

| | | | | |
|---|---|---|---|---|
| NPV @ standard discount rate | 10.00% | $4.35m | *NPV / Capital (Ratio)* | *1.87* |
| NPV @ upper bound rate | 13.00% | $2.90m | *Pay Back Period (Yrs)* | *1.80 Yrs* |
| NPV @ lower bound rate (WACC) | 6.75% | $6.72m | *IRR%* | *30.09%* |

**Benefits**

| Risk cost | As Is | To Be | Benefit |
|---|---|---|---|
| *Systems (reliability)* | *$1.36m* | *$0.21m* | *$1.15m* |
| *Financial* | *$0.17m* | *$0.03m* | *$0.14m* |
| *Operational/compliance* | *$0.00m* | *$0.00m* | *$0.00m* |
| *People (safety)* | *$0.00m* | *$0.00m* | *$0.00m* |
| *Environment* | *$0.01m* | *$0.00m* | *$0.01m* |
| *Reputation* | *$0.00m* | *$0.00m* | *$0.00m* |
| Total Risk benefits | $1.54m | $0.24m | $1.30m |
| Cost savings and other benefits | | | $0.00m |
| Total Benefits | | | $1.30m |

| | |
|---|---|
| *VCR Benefit* | *$1.15m* |
| *ENS Penalty* | *$0.00m* |
| *All other risk benefits* | *$0.15m* |
| Total Risk benefits | $1.30m |
| Benefits in the financial NPV* | $0.15m |
| **excludes VCR benefits* | |
| Benefits in the economic NPV** | $1.30m |
| ***excludes ENS penalty* | |

**Other Financial Drivers**

| | | | |
|---|---|---|---|
| Incremental opex cost pa (no depreciation) | -$0.00m | Write-off cost | $0.00m |
| Capital - initial $m | -$2.33m | Major Asset Life (Yrs) | 15.00 Yrs |
| Residual Value - initial investment | $0.00m | Re-investment capital | $0.00m |
| Capitalisation period | 5.00 Yrs | Start of the re-investment period | 0.00 Yrs |

**Option A(i) NPV calculation**

| Project_Option Name | Option A - Individual Asset Replacements - Only Assets <=220 |
|---|---|

**1. Financial Evaluation** (excludes VCR benefits)

| | | | | |
|---|---|---|---|---|
| NPV @ standard discount rate | 10.00% | -$0.09m | *NPV / Capital (Ratio)* | *-0.12* |
| NPV @ upper bound rate | 13.00% | -$0.17m | *Pay Back Period (Yrs)* | *0.08 Yrs* |
| NPV @ lower bound rate (WACC) | 6.75% | $0.06m | *IRR%* | *7.83%* |

**2. Economic Evaluation** (includes VCR benefits but excludes tax benefits from non-cash transactions, ENS penalty and overall tax cost)

| | | | | |
|---|---|---|---|---|
| NPV @ standard discount rate | 10.00% | $0.81m | *NPV / Capital (Ratio)* | *1.11* |
| NPV @ upper bound rate | 13.00% | $0.50m | *Pay Back Period (Yrs)* | *2.53 Yrs* |
| NPV @ lower bound rate (WACC) | 6.75% | $1.32m | *IRR%* | *23.70%* |

**Benefits**

| Risk cost | As Is | To Be | Benefit | | |
|---|---|---|---|---|---|
| *Systems (reliability)* | *$0.20m* | *$0.01m* | *$0.19m* | *VCR Benefit* | *$0.19m* |
| *Financial* | *$0.10m* | *$0.00m* | *$0.10m* | *ENS Penalty* | *$0.00m* |
| *Operational/compliance* | *$0.00m* | *$0.00m* | *$0.00m* | *All other risk benefits* | *$0.10m* |
| *People (safety)* | *$0.00m* | *$0.00m* | *$0.00m* | Total Risk benefits | $0.29m |
| *Environment* | *$0.00m* | *$0.00m* | *$0.00m* | | |
| *Reputation* | *$0.00m* | *$0.00m* | *$0.00m* | Benefits in the financial NPV* | $0.10m |
| Total Risk benefits | $0.30m | $0.01m | $0.29m | **excludes VCR benefits* | |
| Cost savings and other benefits | | | $0.00m | | |
| Total Benefits | | | $0.29m | Benefits in the economic NPV** | $0.29m |
| | | | | ***excludes ENS penalty* | |

**Other Financial Drivers**

| | | | |
|---|---|---|---|
| Incremental opex cost pa (no depreciation) | -$0.00m | Write-off cost | $0.00m |
| Capital - initial $m | -$0.73m | Major Asset Life (Yrs) | 15.00 Yrs |
| Residual Value - initial investment | $0.00m | Re-investment capital | $0.00m |
| Capitalisation period | 5.00 Yrs | Start of the re-investment period | 0.00 Yrs |

**Option A(ii) NPV calculation**

| Project_Option Name | Option A - Individual Asset Replacements - Only Assets >=330 |
|---|---|

| 1. Financial Evaluation (excludes VCR benefits) | | | | |
|---|---|---|---|---|
| NPV @ standard discount rate | 10.00% | -$0.95m | *NPV / Capital (Ratio)* | *-0.59* |
| NPV @ upper bound rate | 13.00% | -$0.93m | *Pay Back Period (Yrs)* | *-0.06 Yrs* |
| NPV @ lower bound rate (WACC) | 6.75% | -$0.95m | *IRR%* | *-6.09%* |

| 2. Economic Evaluation (includes VCR benefits but excludes tax benefits from non-cash transactions, ENS penalty and overall tax cost) | | | | |
|---|---|---|---|---|
| NPV @ standard discount rate | 10.00% | $4.06m | *NPV / Capital (Ratio)* | *2.54* |
| NPV @ upper bound rate | 13.00% | $2.79m | *Pay Back Period (Yrs)* | *1.43 Yrs* |
| NPV @ lower bound rate (WACC) | 6.75% | $6.13m | *IRR%* | *34.79%* |

| Benefits | | | | | |
|---|---|---|---|---|---|
| Risk cost | As Is | To Be | Benefit | *VCR Benefit* | *$1.06m* |
| *Systems (reliability)* | *$1.26m* | *$0.20m* | *$1.06m* | *ENS Penalty* | *$0.00m* |
| *Financial* | *$0.06m* | *$0.01m* | *$0.05m* | *All other risk benefits* | *$0.06m* |
| *Operational/compliance* | *$0.00m* | *$0.00m* | *$0.00m* | Total Risk benefits | $1.12m |
| *People (safety)* | *$0.00m* | *$0.00m* | *$0.00m* | | |
| *Environment* | *$0.01m* | *$0.00m* | *$0.01m* | Benefits in the financial NPV* | $0.06m |
| *Reputation* | *$0.00m* | *$0.00m* | *$0.00m* | **excludes VCR benefits* | |
| Total Risk benefits | $1.33m | $0.21m | $1.12m | | |
| Cost savings and other benefits | | | $0.00m | Benefits in the economic NPV** | $1.12m |
| Total Benefits | | | $1.12m | ***excludes ENS penalty* | |

| Other Financial Drivers | | | |
|---|---|---|---|
| Incremental opex cost pa (no depreciation) | -$0.00m | Write-off cost | $0.00m |
| Capital - initial $m | -$1.60m | Major Asset Life (Yrs) | 15.00 Yrs |
| Residual Value - initial investment | $0.00m | Re-investment capital | $0.00m |
| Capitalisation period | 5.00 Yrs | Start of the re-investment period | 0.00 Yrs |