

OPTIONS EVALUATION REPORT (OER)



Line 12 330kV Transmission Line Renewal

OER 000000001271 revision 2.0

Ellipse project description: P0005447

TRIM file: [TRIM No]

Project reason: Capability - Asset Replacement for end of life condition

Project category: Prescribed - Replacement

Approvals

| | | |
|------------------------------------|--------------------|---|
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| Endorsed | Steve Stavropoulos | Transmission Lines and Cables Asset Manager |
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| Approved | Lance Wee | Manager/Asset Strategy |
| Date submitted for approval | 21 October 2016 | |

Change History

| Revision | Date | Amendment |
|----------|-----------------|--|
| 0 | 17 June 2016 | Initial Issue |
| 1 | 22 June 2016 | Minor Editorial Amendments |
| 2 | 21 October 2016 | Option B Added. Revised for Updated Risk Cost and New SFAIRP/ALARP Methodology |
| | | |

1. Need/opportunity

Line 12 is a steel tower 330kV transmission line between Liverpool and Sydney South 330kV substations, with a route length of 17.5 km. The transmission line links generation to the Sydney metro area. The single circuit section of this line covered in this document was constructed in 1965 and consists of 23 structures, a route length of 7.4km. The line passes through urban areas of Sydney.

Condition assessment [NACA-000000001271](#) performed in January 2016 has identified a number of condition related issues with Line 12 which require rectification in the short – medium term (within the 2018-2023 Regulatory Control Period) to ensure that asset risk levels remain within an acceptable level in the longer term.

2. Related needs/opportunities

Need 1094 – Line 12 Earthing and Clearance (RMS): There may be an opportunity to deliver all or part of the work more efficiently if the work under both needs is combined.

3. Options

Base Case — Run-To-Fail

Condition assessment [NACA-000000001271](#) has identified existing issues with the line which require rectification. A summary of these can be found in Needs Statement [NS-000000001271](#).

Under a base case ‘run-to-fail’ option, the associated risk cost from the issues identified in Table 1 is \$0.0297 million per annum. A breakdown of the base case risk cost by category is shown in Table 1.

Table 1 – Base Case Risk Cost by Category

| Risk Category | Annual Risk Cost (\$m) |
|------------------------|------------------------|
| Reliability (System) | \$0.0068 |
| Financial | \$0.0006 |
| Operational/Compliance | \$0.0000 |
| People (Safety) | \$0.0113 |
| Environment | \$0.0109 |
| Reputation | \$0.0001 |
| Total | \$0.0297 |

It can be seen from Table 1 that the category with the highest risk costs are associated with the ‘people (safety)’ and ‘environmental’, due to the consequences associated with an earthwire drop event. The other contributor to the overall risk cost is the ‘reliability (system)’ category from the associated outage event.

The risk cost per kilometre of line is \$0.0040 million per annum.

Option A — Line Refurbishment ([OFR-000000001271A](#), [OFS-000000001271A](#))

This option involves the refurbishment of Line 12 by the replacement of components which have reached end of life due to corrosion. The scope of this option is summarised in Table 2.

Table 2 – Transmission Line 12 Option A Scope of Works

| Issue | Qty | Remediation |
|-------------------------------------|---------------------|---|
| Damaged conductor vibration dampers | 10% of line | Replacement of Stockbridge vibration dampers |
| | 56 dampers | Assumed 8 vibration dampers per full tension span per phase |
| Corrosion of earthwire | 7.4 km of earthwire | Like for like replacement of SC/GZ earthwire |

It is estimated that the capital expenditure associated with the refurbishment outlined in this option is \$0.66 million $\pm 25\%$ in 2016-2017 Australian dollars. Details can be found in Section 6 of [OFS-000000001271A](#).

Following the refurbishment under this option, the risk cost associated with the remediated line is \$0.0221 per annum. A breakdown of the Option A risk cost by category is shown in Table 3.

Table 3 – Option A Risk Cost by Category

| Risk Category | Annual Risk Cost (\$m) |
|------------------------|------------------------|
| Reliability (System) | \$0.0059 |
| Financial | \$0.0005 |
| Operational/Compliance | \$0.0000 |
| People (Safety) | \$0.0048 |
| Environment | \$0.0108 |
| Reputation | \$0.0001 |
| Total | \$0.0221 |

The total projected risk reduction as a result of implementing Option A is \$0.0076 million per annum. It can be seen from Table 3 that largest component of the reduction is in the 'safety' category, due to the reduced likelihood of earthwire drop. Risk costs under the 'reliability (system)' category have also decreased.

The total projected risk reduction per kilometre of line is \$0.0010 million per annum.

Option B — Line Refurbishment with OPGW Retrofitting ([OFR-000000001271B](#), [OFS-000000001271B](#))

As with Option A, this option involves the refurbishment of Line 12 by the replacement of components which have reached end of life due to corrosion. However, given the considerable proportion of earthwire identified with corrosion related issues, this option proposes to replace one earthwire with OPGW Type A between Liverpool and

Sydney South. Sections of the other earthwire with identified corrosion related issues will be replaced like for like with SC/GZ earthwire.

With the proposed installation of OPGW, the requisite secondary systems modifications and fibre termination works has been included. The scope of this option is summarised in Table 4.

Table 4 – Transmission Line 12 Option B Scope of Works

| Issue | Qty | Remediation |
|-------------------------------------|-------------------------------|--|
| Damaged conductor vibration dampers | 10% of line 56 dampers | Replacement of Stockbridge vibration dampers Assumed 8 vibration dampers per full tension span per phase |
| Corrosion of earthwire | 3.7 km of earthwire | Like for like replacement of SC/GZ earthwire |
| Corrosion of earthwire | 17.6 km of earthwire | Replacement with OPGW Type A |
| Sydney South Substation works | | Termination of OPGW into non-metallic conductor at substation gantry. Non-metallic conductor run to cable trench system in buried conduit and then run in conduit to the communications room to be terminated onto new optical distribution frame. |
| Liverpool Substation works | | Termination of OPGW into non-metallic conductor at substation gantry. Non-metallic conductor run to cable trench system in buried conduit and then run in conduit to the communications room to be terminated onto new optical distribution frame. |

It is estimated that the capital expenditure associated with the refurbishment outlined in this option is \$1.82 million $\pm 25\%$ in 2016-2017 Australian dollars. Details can be found in Section 6 of [OFS-000000001271B](#).

Following the refurbishment and OPGW replacement works under this option, it is expected that the risk cost associated with the retrofitted line will be the same as that under Option A at \$0.0221 per annum. The total projected risk reduction as a result of implementing Option B is \$0.0076 million per annum, a total reduction per kilometre of line of \$0.0010 million per annum.

The replacement of an earthwire with OPGW will improve the communications system by bringing fibre to Liverpool, allowing for duplicated paths between Liverpool and Sydney South (one microwave and one fibre). The additional benefits of this option arise from reduced OPEX through maintenance and licensing savings, with an expected quantified benefit of \$0.0115 million per annum and an additional efficiency savings benefit specific to the Liverpool site of \$0.015 million per annum. It is noted that other organisation benefits have not been taken into account.

4. Evaluation

4.1 Technical evaluation

All of the options mentioned in Section 3 are considered to be technically feasible¹.

4.2 Commercial evaluation

The commercial evaluation of the technically feasible options is set out in Table 5. Details of the NPV calculations for both Options A and B are provided in Attachment 1.

Table 5 — 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 | - | - | \$0.030 | - | - | - |
| A | Line Refurbishment | \$0.66 | - | \$0.022 | -\$0.45 | -\$0.46 | 2 |
| B | Line Refurbishment with OPGW Retrofitting | \$1.82 | -\$0.027 | \$0.022 | -\$0.43 | -\$0.43 | 1 |

The commercial evaluation is based on:

- > A 10% discount rate
- > A life of the investment of 20 years and a corresponding residual/terminal value
- > An allowance for CAPEX avoidance for the required end of life secondary systems and earthwire replacement under Option B

Discount rate sensitivities based on TransGrid's current AER-determined pre-tax real regulatory WACC of 6.75% and 13% appear in Table 6.

Table 6 — Discount Rate Sensitivities (\$ million)

| Option | Description | Economic NPV @ 13% | Economic NPV @ 6.75% |
|--------|---|--------------------|----------------------|
| A | Line Refurbishment | -\$0.43 | -\$0.47 |
| B | Line Refurbishment with OPGW Retrofitting | -\$0.47 | -\$0.30 |

4.3 SFAIRP/ALARP evaluation

In the context of the Network Asset Risk Assessment Methodology, the SFAIRP (So Far As Is Reasonably Practicable)/ALARP (As Low As Reasonably Practical) principle is applicable to the following Key Hazardous Events:

- > Conductor / earthwire drop

¹ An option is technically feasible if TransGrid reasonably considers that there is a high likelihood that the option, if developed, will provide the relevant service while complying with all relevant laws.

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 in Table 7.

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 / earthwire drop – 6 times the environment (bushfire) risk, 6 times the safety risk and 10% of the reliability risk (applicable to safety)

Table 7: Feasible Options (\$ million)

| Option | Description | CAPEX | Expected Life | Annualised CAPEX |
|------------------|---|--------|---------------|------------------|
| Base Case | Run-To-Fail | N/A | N/A | N/A |
| A | Line Refurbishment | \$0.66 | 20 years | \$0.033 |
| B | Line Refurbishment with OPGW Retrofitting | \$1.82 | 20 years | \$0.091 |

Table 8: Annual Risk Calculations (\$ million)

| Options | Annual Residual Risk | | | Annual Risk Reductions | | |
|------------------|----------------------|------------------|------------------|------------------------|------------------|------------------|
| | Safety Risk | Reliability Risk | Environment Risk | Safety Risk | Reliability Risk | Environment Risk |
| Base Case | \$0.0113 | \$0.0068 | \$0.0108 | - | - | - |
| A | \$0.0048 | \$0.0059 | \$0.0108 | \$0.0066 | \$0.0009 | \$0.0000 |
| B | \$0.0048 | \$0.0059 | \$0.0108 | \$0.0066 | \$0.0009 | \$0.0000 |

Table 9: ALARP Evaluation (\$ million)

| Option | Network Safety Risk Reduction ² | Annualised CAPEX | Reasonably Practicable (Y/N) |
|----------|--|------------------|------------------------------|
| A | \$0.039 | \$0.033 | Yes |
| B | \$0.039 | \$0.091 | No |

From the above evaluation, it is considered that only Option A is reasonably practicable.

4.4 Preferred option

From the SFAIRP/ALARP evaluation, Option A is considered to be reasonably practicable and is required, at a minimum, to be undertaken in order to satisfy the organisation's SFAIRP/ALARP obligations. Neither Option A nor Option B are considered commercially viable (as per the commercial evaluation).

² The Network Safety Risk Reduction is calculated as 6 x Environment (Bushfire) Risk Reduction + 6 x Safety Risk Reduction + 0.1 x Reliability Risk Reduction.

However, Option B, due to its newer technology, is expected to provide further future efficiency savings which have not been quantified at this stage. In addition, the improvement to the communications system with the addition of fibre will provide greater visibility and interrogation of assets at the site and is foreseen to improve asset management and maintenance practices. It also meets the telecommunications development strategy of retiring the microwave network and associated assets by 2028.

For the aforementioned reasons, it is proposed that Option B be scoped in further detail. It is expected that Option B will provide the same level of network safety risk reduction as Option A.

Capital and Operating Expenditure

The estimated capital expenditure associated with the refurbishment outlined under Option A in this option is \$0.66 million $\pm 25\%$ in 2016-2017 Australian dollars. Under Option B, the capital expenditure estimate for the refurbishment and OPGW retrofitting is \$1.82 million $\pm 25\%$ in 2016-2017 Australian dollars, with an expected quantified OPEX saving of \$0.027 million per annum. In both instances, the vast majority of the capital expenditure is proposed to be carried out in 2022-2023.

It is expected that should works not occur by the need date, under both Options A and B, an increase in corrective maintenance and subsequent operating expenditure is expected.

Regulatory Investment Test

No RIT-T analysis is required for Option A as the works are condition based. Under Option B, no RIT-T analysis is required as the estimated CAPEX comes under the \$5 million threshold.

5. Recommendation

Under the SFAIRP/ALARP evaluation, Option A is considered to be reasonably practicable and is required, at a minimum, to be undertaken in order to satisfy the organisation's SFAIRP/ALARP obligations. Neither option is considered to be commercially viable, and as Option B is foreseen to significantly improve asset management and maintenance practices, it is recommended that detailed scoping for the refurbishment of Line 12 including OPGW retrofitting as outlined under Option B is undertaken. Furthermore, deploying Option B provides a technically superior option that will meet TransGrid's increasing telecommunications requirements into the foreseeable future and provide a link in a robust optical fibre backbone that will be established (in accordance with the Telecommunications Infrastructure Renewal and Maintenance Strategy) to facilitate the withdrawal of microwave infrastructure from the network.

Attachment 1 – Commercial evaluation report

Option A NPV Evaluation

| Project_Option Name | | | Line 12 (SC Only) Line Refurbishment | | |
|---|---------|----------|--------------------------------------|-----------------------------------|-----------|
| 1. Financial Evaluation (excludes VCR benefits) | | | | | |
| NPV @ standard discount rate | 10.00% | -\$0.46m | NPV / Capital (Ratio) | -0.69 | |
| NPV @ upper bound rate | 13.00% | -\$0.43m | Pay Back Period (Yrs) | -0.09 Yrs | |
| NPV @ lower bound rate (WACC) | 6.75% | -\$0.48m | IRR% | -9.13% | |
| 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% | -\$0.45m | NPV / Capital (Ratio) | 0.15 | |
| NPV @ upper bound rate | 13.00% | -\$0.43m | Pay Back Period (Yrs) | Not measurable | |
| NPV @ lower bound rate (WACC) | 6.75% | -\$0.47m | IRR% | -8.63% | |
| Benefits | | | | | |
| Risk cost | As Is | To Be | Benefit | VCR Benefit | \$0.00m |
| Systems (reliability) | \$0.01m | \$0.01m | \$0.00m | ENS Penalty | \$0.00m |
| Financial | \$0.00m | \$0.00m | \$0.00m | All other risk benefits | \$0.01m |
| Operational/compliance | \$0.00m | \$0.00m | \$0.00m | Total Risk benefits | \$0.01m |
| People (safety) | \$0.01m | \$0.00m | \$0.01m | | |
| Environment | \$0.01m | \$0.01m | \$0.00m | Benefits in the financial NPV* | \$0.01m |
| Reputation | \$0.00m | \$0.00m | \$0.00m | *excludes VCR benefits | |
| Total Risk benefits | \$0.03m | \$0.02m | \$0.01m | | |
| Cost savings and other benefits | | | \$0.00m | Benefits in the economic NPV** | \$0.01m |
| Total Benefits | | | \$0.01m | **excludes ENS penalty | |
| Other Financial Drivers | | | | | |
| Incremental opex cost pa (no depreciation) | | | \$0.00m | Write-off cost | \$0.00m |
| Capital - initial \$m | | | -\$0.66m | Major Asset Life (Yrs) | 20.00 Yrs |
| Residual Value - initial investment | | | \$0.03m | Re-investment capital | \$0.00m |
| Capitalisation period | | | 3.00 Yrs | Start of the re-investment period | 0.00 Yrs |

Option B NPV Calculation

Project_Option Name

Line 12 (SC Only) Line Refurbishment with OPGW Retrofit

1. Financial Evaluation (excludes VCR benefits)

| | | | | |
|-------------------------------|--------|----------|-----------------------|----------|
| NPV @ standard discount rate | 10.00% | -\$0.43m | NPV / Capital (Ratio) | -0.38 |
| NPV @ upper bound rate | 13.00% | -\$0.48m | Pay Back Period (Yrs) | 0.03 Yrs |
| NPV @ lower bound rate (WACC) | 6.75% | -\$0.31m | IRR% | 3.00% |

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% | -\$0.43m | NPV / Capital (Ratio) | 0.14 |
| NPV @ upper bound rate | 13.00% | -\$0.47m | Pay Back Period (Yrs) | 12.74 Yrs |
| NPV @ lower bound rate (WACC) | 6.75% | -\$0.30m | IRR% | 3.10% |

Benefits

| | | | | | |
|---------------------------------|---------|---------|---------|--------------------------------|---------|
| Risk cost | As Is | To Be | Benefit | VCR Benefit | \$0.00m |
| Systems (reliability) | \$0.01m | \$0.01m | \$0.00m | ENS Penalty | \$0.00m |
| Financial | \$0.00m | \$0.00m | \$0.00m | All other risk benefits | \$0.01m |
| Operational/compliance | \$0.00m | \$0.00m | \$0.00m | Total Risk benefits | \$0.01m |
| People (safety) | \$0.01m | \$0.00m | \$0.01m | Benefits in the financial NPV* | \$0.03m |
| Environment | \$0.01m | \$0.01m | \$0.00m | *excludes VCR benefits | |
| Reputation | \$0.00m | \$0.00m | \$0.00m | Benefits in the economic NPV** | \$0.03m |
| Total Risk benefits | \$0.03m | \$0.02m | \$0.01m | **excludes ENS penalty | |
| Cost savings and other benefits | | | \$0.03m | | |
| Total Benefits | | | \$0.03m | | |

Other Financial Drivers

| | | | |
|--|----------|-----------------------------------|-----------|
| Incremental opex cost pa (no depreciation) | \$0.00m | Write-off cost | \$0.00m |
| Capital - initial \$m | -\$1.14m | Major Asset Life (Yrs) | 20.00 Yrs |
| Residual Value - initial investment | \$0.00m | Re-investment capital | \$0.64m |
| Capitalisation period | 3.00 Yrs | Start of the re-investment period | 2021-22 |