# Investment Evaluation Summary (IES)

## Project Details:

| | |
|---|---|
| Project Name: | Replacement Substandard Overhead Copper Conductor (REMCU) |
| Project ID: | 00591 |
| Business Segment: | Distribution |
| Thread: | Overhead |
| CAPEX/OPEX: | CAPEX |
| Service Classification: | Standard Control |
| Scope Type: | A |
| Work Category Code: | REMCU |
| Work Category Description: | Replace HV copper conductor |
| Preferred Option Description: | Review and replace defective and substandard Copper Conductor based on condition. |
| Preferred Option Estimate (Dollars $2016/2017): | $8,523,240 |

| | 19/20 | 20/21 | 21/22 | 22/23 | 23/24 | 24/25 | 25/26 | 26/27 | 27/28 | 28/29 |
|---|---|---|---|---|---|---|---|---|---|---|
| Unit ($) | $51,656 | $51,656 | $51,656 | $51,656 | $51,656 | $51,656 | $51,656 | $51,656 | $51,656 | $51,656 |
| Volume | 33.00 | 33.00 | 33.00 | 33.00 | 33.00 | 33.00 | 33.00 | 33.00 | 33.00 | 33.00 |
| Estimate ($) | $1,704,648 | $1,704,648 | $1,704,648 | $1,704,648 | $1,704,648 | $1,704,648 | $1,704,648 | $1,704,648 | $1,704,648 | $1,704,648 |
| Total ($) | $1,704,648 | $1,704,648 | $1,704,648 | $1,704,648 | $1,704,648 | $1,704,648 | $1,704,648 | $1,704,648 | $1,704,648 | $1,704,648 |

## Governance:

| | | | |
|---|---|---|---|
| Works Initiator: | David Eccles | Date: | 11/08/2017 |
| Team Leader Endorsed: | Darryl Munro | Date: | 11/08/2017 |
| Leader Endorsed: | Nicole Eastoe | Date: | 24/11/2017 |
| General Manager Approved: | Wayne Tucker | Date: | 25/02/2017 |

## Related Documents:

| Description | URL |
|---|---|
| NPV REMCU | http://reclink/R0000732574 |
| REMCU_REMGI Volumes_Dollars | http://teamzone.tnad.tasnetworks.com.au/asset-strategy/Shared%20Documents/DD17/Overhead%20Thread/REMCU_REMGI%20-%20Substandard%20Conductor/REMCU_REMGI%20Volumes_Dollars.xlsx |
| Conductor Age Profile Data | http://assetzone.tnad.tasnetworks.com.au/distribution/overhead-system-and-structures/Installation%20%20Maintenance%20Information/HV%20Overhead%20Conductor%20Estimated%20Install%20Date%20Data/Conductor_Age_Profile_Data_DD17_10JUN15.xlsx |
| Conductor Inventory | http://assetzone.tnad.tasnetworks.com.au/distribution/overhead-system-and-structures/Installation%20%20Maintenance%20Information/DD17%20Data/REMGI_REMCU/Conductor_Inventory.xlsx |
| Conductor Failure Data 2010-2014 | http://assetzone.tnad.tasnetworks.com.au/distribution/overhead-system-and-structures/Installation%20%20Maintenance%20Information/Conductor%20Replacement%20Strategy/Conductor_Failure_Update_2010-2014v2.xlsx |
| Overhead Conductors and Hardware Asset Management Plan | http://reclink/R7260427 |
| Reference document TasNetworks Transformation Roadmap 2025 | https://www.tasnetworks.com.au/customer-engagement/submissions/ |
| TasNetworks Corporate Plan - Planning period: 2017-18 | http://reclink/R0000745475 |
| TasNetworks Risk Management Framework | http://Reclink/R238142 |
| Distribution Network Planning Manual | http://reclink/R833234 |
| Overhead Conductor Replacement Programs Prioritisation Guideline | http://reclink/R603335 |

# Section 1 (Gated Investment Step 1)

## 1. Overview

### 1.1 Background

Overhead conductor installed in the past (now classified as substandard) is the cause of a number of mechanical conductor failures, which may result in risks to the community and environment through bushfires and safety risks, as well as interruption of supply. Typically, older intallations of copper, aluminium and galvanised iron conductor have been identified as the conductor types that are most prone to failure and have been selected for replacement programs.

Given the large volumes of work associated with a state-wide program and TasNetworks' ability to deliver such volumes, works have now been prioritised to ensure that the highest ranking risks are addressed first. Highest ranking risks include sites greater than forty years old, confirmed as being substandard, and within the high bushfire loss consequence area (HBLCA). This IES has been developed to address the risk associated with safety and reliability of supply concerns due to copper conductor failures not located within the HBLCA. A parallel program (IES 1509) has been developed to address the bushfire risk associated with failed copper conductor within the HBLCA.

The makeup of HV conductors in the distribution network and the number of bare wire overhead conductor breakages (from WASP Outage Data) is shown in *Table 1*, and *Figure 1* shows the current estimated age profile of HV overhead conductor within the network. *Table 1* is ordered in terms of most failures per 1000 KM for each conductor type with copper showing the highest failure rate.

*Table 1*: HV overhead conductors types and failure statistics (as at September 2017)

| Bare HV Conductors | | | Failures Per Year | | | | | | | | | | | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Type | Total Length | Percentage of Network | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | Per Year | Per 1000 KM of Conductor |
| Cu | 1,111 | 6.7 | 1 | 5 | 7 | 7 | 8 | 4 | 5 | 1 | 11 | 13 | 6.2 | 5.58 |
| ACSR | 732 | 4.4 | 2 | 0 | 4 | 6 | 2 | 1 | 4 | 3 | 4 | 1 | 2.7 | 3.69 |
| AAA | 2,783 | 16.8 | 4 | 1 | 6 | 10 | 9 | 8 | 3 | 5 | 10 | 13 | 6.9 | 2.48 |
| GI | 5,775 | 34.9 | 11 | 7 | 20 | 13 | 15 | 4 | 14 | 9 | 17 | 28 | 13.8 | 2.39 |
| AA | 6,147 | 37.1 | 8 | 10 | 13 | 11 | 9 | 3 | 12 | 9 | 12 | 8 | 9.5 | 1.55 |
| ABC | 19 | 0.1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0 | 0.00 |
| Total | 16,567 | 100 | 26 | 23 | 50 | 47 | 43 | 20 | 38 | 27 | 54 | 63 | 39.1 | 2.36 |

It can be seen that Copper conductors have historically had a significant higher failure rate compared to other conductor materials.

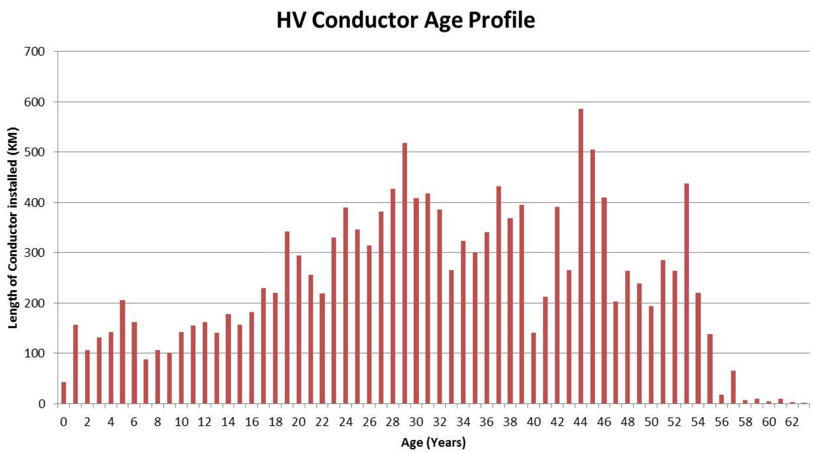


*Figure 1*: Estimated age profile for all HV conductor in the network

The replacement programs for copper and GI conductor have, prior to 2012, been replaced as part of Replace HV Feeders (Safety) (REHSA). To better manage and monitor business costs and field works associated with this replacement program two new work categories were created at the beginning of the 2012-2017 Revenue Reset period to accurately capture costs associated with copper and galvanised iron conductors, namely REMCU and REMGI respectively.

### 1.2 Investment Need

The majority of copper conductor in the LV and HV system was installed prior to 1964. Copper conductors range in size from 7/.044 to 19/.104.

When conductors are subjected to fault currents, they are rapidly heated, which may result in annealing if the fault is not adequately cleared. Copper conductor is typically not fault rated, so the exposure of conductor to fault currents for extended duration results in annealing, which reduces the tensile strength of the conductor. This may be identified by the conductor taking on an orange and scaling appearance. The condition of the conductor can also be determined by the number of joints installed in a span from a visual inspection. The smaller 7 stranded conductor is particularly susceptible to this failure mode.

Failing overhead conductor resulting in broken wires throughout the distribution network, presents risks to safety, interruption to supply, the community and environment. The key drivers for this program are to maintain safety and network performance associated with failure of copper conductors. The risk to community and environment from bushfire within the HBLCA is managed under a parallel program (IES 1509).

Given the potential failure modes mentioned above, copper conductor also creates unsafe working enviornment for field staff and restrictions currently apply for specific work methods when working on some copper conductors due to its tendency to fail whist being manouvered. For example, HV live line techniques cannot be used when working on small gauge copper conductors due to the safety risks posed by potential conductor failure. As such, operational costs and supply reliability are negativey impacted when works are required on copper conductors.

Table 2 shows that there have been a significant number of copper conductor failures over the past few years (from WASP outage data where the cause is 'Conductor Failure – Bare Wire – Broken'). The total number of failures per year is shown in Table 2 and illustrates the growing trend in conductor failures. This trend, if left unmitigated, also increases the risk of fires starts from the increased occurrances of conductor failure, which is a concern to TasNetworks given our risk appetite towards fire starts.

Table 2: Number of copper conductor failures by year

| Year | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 |
|---|---|---|---|---|---|---|---|---|---|
| Number of failures | 5 | 7 | 7 | 8 | 4 | 5 | 1 | 11 | 13 |

An analysis of copper conductor age and condition indicates that 99.96 per cent of all installed copper conductor is greater than forty years old with the majority being in poor condition and will require replacement in the near future.

Initial inspections indicate that approximately 35 per cent of all inspected conductor will require replacement in the near future, which would incur substantial cost. To manage the risk and cost balance effectively, conductor failure rates will continue to be monitored and routine conductor inspections will be continued.

### 1.3 Customer Needs or Impact

TasNetworks continues to undertake consumer engagement as part of business as usual and through the Voice of the Customer program.  This engagement seeks in depth feedback on specific issues relating to:

- how its prices impact on its services
- current and future consumer energy use
- outage experiences (frequency and duration) and expectations
- communication expectations
- STPIS expectations (reliability standards and incentive payments)
- Increasing understanding of the electricity industry and TasNetworks

Consumers have identified safety, restoration of faults/emergencies and supply reliability as the highest performing services offered by TasNetworks.

Consumers also identified that into the future they believe that affordability, green, communicative, innovative, efficient and reliable services must be provided by TasNetworks.

This project specifically addresses the requirements of consumers in the areas of safety, restoration of faults/emergencies and supply reliability

Customers will continue to be consulted through routine TasNetworks processes, including the Voice of the customer program, the Annual Planning Review and ongoing regular customer liaison meetings.

### 1.4 Regulatory Considerations

This project is required to achieve the following capital expenditure objectives as described by the National Electricity Rules section 6.5.7(a).

6.5.7 (a) Forecast capital expenditure:

(2) comply with all applicable *regulatory obligations or requirements* associated with the provision of *standard control services*;

(3) to the extent that there is no applicable *regulatory obligation or requirement* in relation to:

(i) the quality, reliability or security of supply of *standard control services*; or

(ii) the reliability or security of the *distribution system* through the supply of *standard control services*,

to the relevant extent:

(iii) maintain the quality, reliability and security of supply of *standard control services*; and

(iv) maintain the reliability and security of the *distribution system* through the supply of *standard control services*; and

(4) maintain the safety of the *distribution system* through the supply of *standard control services*

## 2. Project Objectives

To perform targeted replacement of HV Copper conductor with new standard conductor, to address the safety and supply reliability risks presented by the potential failure of these conductors. The replacement conductors shall be selected from TasNetworks' standard conductors as defined in the Distribution Network Planning Manual.

## 3. Strategic Alignment

### 3.1 Business Objectives

Strategic and operational performance objectives relevant to this project are derived from TasNetworks 2017-18 Corporate Plan, approved by the board in 2017. This project is relevant to the following areas of the corporate plan:

- We understand our customers by making them central to all we do;
- We enable our people to deliver value; and
- We care for our assets, delivering safe and reliable networks services while transforming our business.

### 3.2 Business Initiatives

The business initiatives reflected in TasNetworks Transformation Roadmap 2025 publication (June 2017) for transition to the future that have synergy with this project are as follows:

- Voice of the customer: We anticipate and respond to your changing needs and market conditions.
- Network and operations productivity: We'll improve how we deliver the field works program, continue to seek cost savings and use productivity targets to drive our business.
- Electricity and telecoms network capability: To meet your energy needs and ensure power system security, we'll invest in the network to make sure it stays in good condition, even while the system grows more complex.
- Predictable and sustainable pricing: To deliver the lowest sustainable prices, we'll transition our pricing to better reflect the way you produce and use electricity.
- Enabling and harnessing new technologies and services: By investing in technology and customer service, we'll be better able to host the technologies you're embracing.

## 4. Current Risk Evaluation

If TasNetworks does not continue to monitor and replace the condition of overhead conductors there is a risk that a conductor failure could result in a serious injury to a member of the public or staff or lead to a severe bushfire.

The business risk associated with these assets has been evaluated as High by using the TasNetworks risk management framework.

### 4.1 5x5 Risk Matrix

TasNetworks' business risks are analysed utilising the 5x5 corporate risk matrix, as outlined in TasNetworks Risk Management Framework.

Relevant strategic business risk factors that apply are as follows:

| Risk Category | Risk | Likelihood | Consequence | Risk Rating |
|---|---|---|---|---|
| Customer | Disruption to customer supply from declining network reliability | Possible | Negligible | Low |
| Environment and Community | Conductor failures pose a significant risk of igniting a bushfire and causing significant damage to local environements and communities. | Unlikely | Major | Medium |
| Financial | Excessive payout of reliability incentive schemes (STPIS, GSL, NCEF) from declining network reliability.<br><br>Asset failure results in catastrophic bushfire. Insurance providers refuse to cover TasNetworks for future events. | Rare | Moderate | Low |
| Network Performance | Localised interruption of supply to customers. | Unlikely | Minor | Low |
| Regulatory Compliance | Increased number of unplanned outages leads to systemic NCEF breaches. | Unlikely | Minor | Low |
| Reputation | Asset failure results in catastrophic bushfire or injury with significant media coverage. | Unlikely | Moderate | Medium |
| Safety and People | Asset failure results in a fatality or permanently impairs a persons life. | Unlikely | Severe | High |

## Section 2 (Gated Investment Step 2)

## 5. Preferred Option:

The preferred option is to replace a targeted selection of substandard conductor which has been identified as the highest risk

### 5.1 Scope

Replace HV copper conductor greater than forty years old (and based on condition assessment) to reduce the risk associated safety risk to public and supply reliability. This program has focus outside HBLCA. Volumes for conductor replacement driven by Bushfire Mitigation (BFM) and safety/network reliability (Non-BFM) are shown in Table 3 below.

| REMCU Replacement of aged/deteriorated HV Copper Conductors | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | 17/18 | 18/19 | 19/20 | 20/21 | 21/22 | 22/23 | 23/24 | 24/25 | 25/26 | 26/27 | 27/28 | 28/29 |
| Volumes (KM) | | | | | | | | | | | | |
| BFM | 19 | 29 | 48 | 48 | 48 | 19 | 19 | 19 | 19 | 19 | 19 | 19 |
| Non-BFM program (this program) | 8.4 | 0 | 33 | 33 | 33 | 33 | 33 | 33 | 33 | 33 | 33 | 33 |
| Total | 27.4 | 29 | 61 | 61 | 61 | 52 | 52 | 52 | 52 | 52 | 52 | 52 |

*Table 3: Replacement forecasts of HV Copper conductors*

### 5.2 Expected outcomes and benefits

The expected outcome of this program is a reduction in the frequency of HV Copper conductor failures. This will address the safety and supply reliability risks presented by the potential failure of these conductors.

### 5.3 Regulatory Test

A Regulatory Investment Test will not be required for this program.

## 6. Options Analysis

### 6.1 Option Summary

| Option description | |
|---|---|
| Option 0 | Do nothing. |
| Option 1 (preferred) | Review and replace defective and substandard Copper Conductor based on condition. |
| Option 2 | Replace Copper Conductors after 50 years. |

### 6.2 Summary of Drivers

| Option | |
|---|---|
| Option 0 | Advantages:<br>• Lowest Expenditure option; and<br>• Longest lifespan of existing conductors is used.<br>Disadvantages:<br>• Does not meet TasNetworks' risk appetite or align with Zero Harm initiatives;<br>• Conductors will fail in service risking public safety and bushfire ignition;<br>• Network reliability will be reduced; and<br>• Higher expenditure to replace conductors under emergency fault repair. |
| Option 1 (preferred) | Advantages:<br>• The risk of a conductor failing in service is significantly reduced;<br>• Emergency fault replacement jobs are reduced;<br>• Network reliability is maintained;<br>• TasNetworks' capability to delivery program; and<br>• The lifespan of current conductors is maximised. |

| | |
|---|---|
| | Disadvantages:<br><br>• Not all conductor deterioration may be recognisable; and<br>• Difficult to schedule / predict future program expenditure. |
| Option 2 | Advantages:<br><br>• Significantly reduces the risk of a conductor failing in service; and<br>• Easy to schedule/ predict future program expenditure.<br><br>Disadvantages:<br><br>• Highest expenditure option;<br>• Doesn't fully mitigate the risk of a conductor failing in service - Conductors may still fail prior to 50 years;<br>• Conductors will frequently be replaced with many years of functional life still remaining; and<br>• TasNetworks' capability to deliver program. |

### 6.3 Summary of Costs

| Option | Total Cost ($) |
|---|---|
| Option 0 | $0 |
| Option 1 (preferred) | $8,523,240 |
| Option 2 | $30,580,380 |

### 6.4 Summary of Risk

Option 0 - Do Nothing:

The associated risk of this option is unchanged and remains High in accordance with the TasNetworks risk management framework. This evaluation is driven by:

- The high risk to public and staff safety from conductor failure;
- Reduced network reliability of customer supply due to increased incidents of unplanned outages due to conductor failure; and
- This option has the lowest upfront capital expenditure, however high additional costs to the business are incurred in the form of higher fault response costs due to conductor failures. As this option does not address the risk to public safety it is highly likely to involve additional costs due to incidents and legal proceedings.

Option 1 - Replace Based on Condition (Preferred Option):

By replacing overhead conductors once they are identified as condmened, the ongoing risk is considered Low in accordance with the TasNetworks risk management framework. This evaluation is driven by:

- The risks to public safety from conductor failure are low but cannot be removed entirely;
- The liklihood of unplanned outages occuring due to conductor failures are significantly reduced; and
- This is the lowest capital expenditure option that still addresses the risk to public safety.

Option 2 - Replace after 50 years:

The associated risk of this option is remains High in accordance with the TasNetworks risk management framework. This evaluation is driven by:

- The risks to public safety from conductor failure are lower than Option 0 but still does not adequately address public safety;
- There will be a lower number of unplanned outages due to conductor failure compared to Option 0 but a higher number of outages compared to Option 1; and
- This is the highest capital expenditure option as it necessitates the premature replacement of some assets. Additional costs to the business in the form of regulatory and compliance breaches are lower than for Option 0 but are likely to be higher than Option 1.

### 6.5 Economic analysis

| Option | Description | NPV |
|---|---|---|
| Option 0 | Do nothing. | -$1,242,502 |
| Option 1 (preferred) | Review and replace defective and substandard Copper Conductor based on condition. | -$14,755,355 |
| Option 2 | Replace Copper Conductors after 50 years. | -$44,271,809 |

#### 6.5.1 Quantitative Risk Analysis

A quantitative risk analysis has not been completed for this program.

#### 6.5.2 Benchmarking

This HV copper conductor replacement program is consistent with programs implemented by other Australian Distribution Network Service Providers to manage the safety and supply reliability risks associated with failed HV copper conductors..

#### 6.5.3 Expert findings

Not Applicable.

6.5.4 Assumptions

- All conductor replacements under this program would be for overhead high voltage rural lines – economic life of 60 years.
- Replacement volumes would be consistent for each of the ten years.
- The unit rate would be $58,203 to replace 1 km of conductor (assumed to be 1km of 3 x 19/3.25AAC HV Replacement - 9 x 120m Spans).
- A condition audit process will be consistent over the ten year period.

Related Projects

Conductor replacement programs for Copper, Galvanised Steel and Aluminium are similar projects aimed at prevention of conductor failure for their specific design/construction characterisitics. Parallel conductor programs also exist for each type of conductor that focus on the bushfire risk within the HBLCA.

Material Specifications

Whilst new conductor technology is being investigated, the main strategy for Copper conductor is to replace with Aluminium 19/3.25AAC conductor.