Investment Evaluation Summary (IES)

Project Details:

Project Name:	Replacement Substandard Overhead Copper Conductor (REMCU)
Project ID:	00591
Thread:	Overhead
CAPEX/OPEX:	CAPEX
Service Classification:	Standard Control
Scope Type:	D
Work Category Code:	REMCU
Work Category Description:	Replace HV copper conductor
Preferred Option Description:	Risk based replacement. Overhead copper and GI conductors are -Analysed to quantify the risk they pose to public safety, fire start and network reliability.; and -Prioritized for replacement, based on the outcomes of this analysis; and -Audited to confirm the type and true condition before the replacement is performed. This NPV analysis covers the whole program of substandard conductor replacement
Preferred Option Estimate (Nominal Dollars):	$27,273,150

	17/18	18/19	19/20	20/21	21/22	22/23	23/24	24/25	25/26	26/27
Unit ($)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Volume	33	33	33	33	33	33	33	33	33	33
Estimate ($)										
Total ($)	$1,920,683	$1,920,683	$1,920,683	$1,920,683	$1,920,683	$1,920,683	$1,920,683	$1,920,683	$1,920,683	$1,920,683

Governance:

Project Initiator:	Gary Carleton	**Date:**	24/03/2015
Thread Approved:	David Ellis	**Date:**	02/11/2015
Project Approver:	David Eccles	**Date:**	30/10/2015

Document Details:

Version Number:	1

Related Documents:

Description	URL
NPV - REMGI_REMCU	http://teamzone.tnad.tasnetworks.com.au/asset-strategy/Shared%20Documents/DD17/Overhead%20Thread/REMCU_REMGI%20-%20Substandard%20Conductor/NPV-REMCU_REMGI.xlsm
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

IES - REMGI_REMCU	http://teamzone.tnad.tasnetworks.com.au/asset-strategy/Shared%20Documents/DD17/Overhead%20Thread/REMCU_REMGI%20-%20Substandard%20Conductor/IES-REMGI_REMCU.docx
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

Section 1 (Gated Investment Step 1)

1. Background

Substandard overhead conductor installed in the past is the cause of a number of mechanical conductor failures, which may result in bushfires and safety risks, as well as interruption of supply. Copper and Galvanised Iron Conductor have been identified as the conductor types that are most prone to failure and have been selected for replacement programs. Two main programs have been developed in previous years to replace substandard overhead conductor:

1. Replace Substandard Overhead Copper Conductor (REMCU); and
2. Replace Substandard Overhead Galvanised Iron (GI) Conductor (REMGI).

The number of bare wire overhead conductor breakages (from WASP Outage Data) is shown in Table 1, Figure 1 shows the current estimated age profile of HV overhead conductor within the network

Table 1: Failure Statistics for "Bare Wire Conductor Failures"

Cond Type	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**Total**
AA	1	1	3	7	8	10	13	11	9	3	12	9	12	8	63
AAA	2	0	2	2	4	1	6	10	9	8	3	5	10	13	36
ACSR	0	0	0	1	2	0	4	6	2	1	4	3	4	1	15
Cu	0	0	4	2	1	5	7	7	8	4	5	1	11	13	34
GI	7	3	1	7	11	7	20	13	15	4	14	9	17	28	84
ALL (known)	10	4	10	19	26	23	50	47	43	20	38	27	54	63	232
All TOTAL	**38**	**40**	**48**	**48**	**46**	**44**	**67**	**53**	**43**	**20**	**38**	**27**	**54**	**63**	**428**

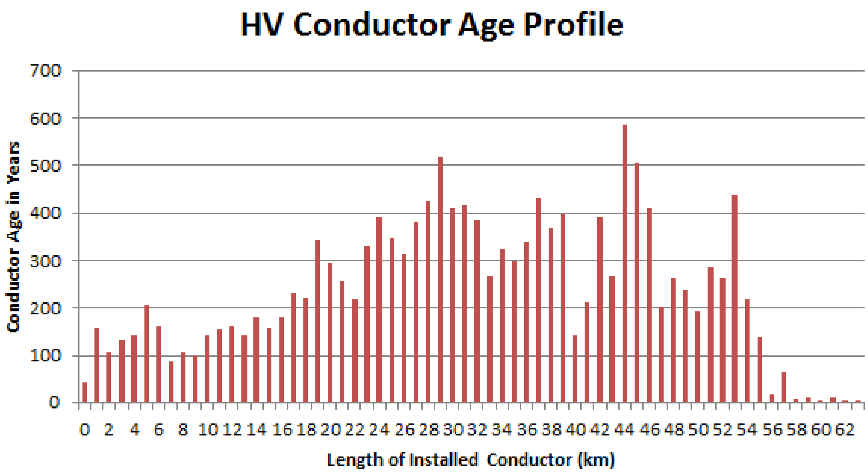

Figure 1: Estimated age profile for all HV conductor in the network

Table 2: HV overhead conductors and cables installed in TasNetworks' distribution system (as at June 2015)

Conductor Type	Total Length (km)	Percentage of Population
AA	5332	35.25%
AAA	2395	15.83%
ABC	17	0.11%
ACSR	690	4.56%
Cu	1181	7.81%
GI	5512	36.44%
Grand Total	15126	100.00%

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 Determination Period to ring-fence cost associated with copper and galvanised iron conductors, namely REMCU and REMGI respectively. To date 89 km's of copper and 38 km's of GI have been replaced. Table 3 shows the circuit length replaced per annum since the commencement of the project.

Table 3: HV overhead conductor replacements per year for copper and GI replacements 2013 – 2014.

Work Category	Year of replacement (km)		Total Length Replaced (km)
	2013	**2014**	
REMCU	24	65	89
REMGI	13	25	38
Total Length replaced per year (km)	37	90	127

1.1 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 easily 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 in a span that have previously been performed from a visual inspection. The smaller 7 stranded conductor is particularly susceptible to this failure mode.

The drivers for this program are therefore to maintain network performance, safety and compliance with regulatory responsibilities. Substandard overhead conductor may result in broken wires; increasing the likelihood of an interruption to supply, catastrophic bushfire and fatality or impairment to a person's life.

Analysis of conductor failures has shown that the percentage of copper conductor failures in the network is higher than any other conductor type. Copper conductors make up 15% of the total failures while only representing 8.6% of total conductors.

Table 4 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 4 and illustrates the growing trend in conductor failures.

Table 4: 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

Initial inspections indicate that approximately 35% 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.

1.2 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.

1.3 Regulatory Considerations

This project is required to achieve the following capital and operational expenditure objectives as described by the National Electricity Rules section 6.5.7(a) and 6.5.6(a). 6.5.7 (a) Forecast capital expenditure (1) meet or manage the expected demand for standard control services over that period; (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. Forecast operating expenditure 6.5.6 (a) (1) meet or manage the expected demand for standard control services over that period; (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 GI and Copper conductor with new standard conductor, to address the safety and environmental 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 2014 Corporate Plan, approved by the board in 2014. 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 that relate to this project are as follows:

- Safety of our people and the community, while reliably providing network services, is fundamental to the TasNetworks business and remains our immediate priority
- We care for our assets to ensure they deliver safe and reliable network services
- We will transform our business with a focus on developing an appropriate approach to the management and allocation of risk

- The strategic key performance indicators that will be impacted through undertaking this project are as follows:
- Customer engagement and service – customer net promoter score
- Price for customers – lowest sustainable prices
- Zero harm – significant and reportable incidents
- Network service performance – meet network planning standards
- Network service performance – outcomes under service target performance incentive schemes
- Sustainable cost reduction – efficient operating and capital expenditure

4. Current Risk Evaluation

Do nothing is not an acceptable option to TasNetworks' risk appetite. The level of risk identified above is such that a treatment plan is required to reduce the risks to a tolerable level, in line with 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 follows:

Risk Category	Risk	Likelihood	Consequence	Risk Rating
Customer	Disruption to customers from declining network reliability	Possible	Minor	Low
Environment and Community	Asset failure results in a catastrophic bushfire with widespread loss of property	Unlikely	Severe	High
Financial	Asset failure results in catastrophic bushfire. Insurance providers refuse to cover TasNetworks for future events	Unlikely	Severe	High
Financial	Excessive payout of reliability incentive schemes (STPIS, GSL, NCEF) from declining network reliability	Unlikely	Moderate	Medium
Network Performance	Localised interruption of supply to customers	Unlikely	Minor	Low
Regulatory Compliance	Increased number of unplanned outages leads to systemic NCEF breaches	Possible	Moderate	Medium
Reputation	Asset failure results in catastrophic bushfire with significant media coverage	Unlikely	Moderate	Medium
Safety and People	Asset failure results in a fatality or permanently impairs a person's life	Unlikely	Severe	High

Section 1 Approvals (Gated Investment Step 1)

Project Initiator:	Gary Carleton	**Date:**	24/03/2015
Line Manager:		**Date:**	
Manager (Network Projects) **or** **Group/Business Manager (Non-network projects):**		**Date:**	
[Send this signed and endorsed summary to the Capital Works Program Coordinator.]			

Actions			
CWP Project Manager commenced initiation:		**Assigned CW Project Manager:**	
PI notified project initiation commenced:		**Actioned by:**	

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

The works to be undertaken: The development of the conductor replacement programs is a three-stage process:

1. Desktop analysis to identify high-risk spans: Desktop analysis to be performed using information in TasNetwork's asset information systems to identify sections of conductor that may be in poor condition.
2. Condition assessment of high-risk spans: The conductors identified by the desktop analysis are audited to determine their actual condition.
3. Prioritisation of poor condition conductor: high-risk spans, in poor condition are included in the program of work to be replaced with a suitable replacement.

5.2 Expected outcomes and benefits

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

5.3 Regulatory Test

6. Options Analysis

Option description	
Option 0 - Do Nothing	Do nothing. All overhead conductors are run to failure. Repairs are only performed under fault to restore supply. The disadvantages are that there will be an unplanned outage whenever a conductor fails, and the replacement cost will be slightly higher if it is done under fault rather than as planned work.
Option 1	Risk based replacement. Overhead copper, galvanised iron and other conductors assessed as being in poor condition. • Analysed to quantify the risk they pose to public safety, fire start and network reliability; and • Prioritized for replacement, based on the outcomes of this analysis; and • Audited to confirm the type and true condition before the replacement is performed.
Option 2	Proactively replace all HV overhead conductors at 60 years based on the estimated install age. The advantages of this option are that it is low risk and reduces the number of unplanned outages due to conductor failures. The disadvantages are that some assets will be replaced while they still have some functional life remaining, and will not be able to identify all conductors before they fail due to other factors, so some will still fail in service.

6.1 Option Summary

Option description	
Option 0	Do nothing. All overhead conductors are run to failure. Repairs are only performed under fault to restore supply.
Option 1 (preferred)	Risk based replacement. Overhead copper and GI conductors are -Analysed to quantify the risk they pose to public safety, fire start and network reliability.; and -Prioritized for replacement, based on the outcomes of this analysis; and -Audited to confirm the type and true condition before the replacement is performed. This NPV analysis covers the whole program of substandard conductor replacement
Option 2	Proactively replace all HV overhead conductors at 60 years based on the estimated install age. The advantages of this option are that it is low risk and reduces the number of unplanned outages due to conductor failures. The disadvantages are that some assets will be replaced while they still have some functional life remaining, and will not be able to identify all conductors before they fail due to other factors, so some will still fail in service.

6.2 Summary of Drivers

Option	

Option 0	Reliability Reliability levels will not be maintained. Environment and Community – Fire Start Poses an unacceptable risk of fire start from asset failure. Leaves the Business very exposed to the risk of a fire caused by a conductor failure. Public Safety Poses an unacceptable risk to public safety from an asset failure. Leaves the Business very exposed to the risk of severe injury or fatality.
Option 1 (preferred)	Public Safety Replacement strategy considers the prioritisation of conductors in denser populated areas. Environment and Community – Fire Start Prioritisation will consider replacement in the high Bushfire Loss Consequence Zone. Reliability Prioritise conductor segments which have the highest customer count or connected kVA to maximise effectiveness in maintaining reliability levels.
Option 2	Reliability Prioritisation of conductor segments only considers age, therefore does not consider reliability areas or connected customers. Environment and Community – Fire Start Prioritisation does not consider replacement in the high Bushfire Loss Consequence Zone. Public Safety The risks to public safety from unplanned conductor failure are low, but proactively replacing conductor based on age will not entirely reduce the risk. Premature failure of conductors happens sporadically due to other factors such as the environment or weather.

6.3 Summary of Costs

Option	Total Cost ($)
Option 0	$0
Option 1 (preferred)	$27,273,150
Option 2	$110,122,458

6.4 Summary of Risk

The preferred option is the proactive risk based replacement. The residual risk therefore of this option can be taken as the uncontrolled risk as documented in Section 4. This is within TasNetworks’ risk appetite which states:

- Financial: We have a **low appetite** for volatility in returns to shareholders.
- Customer: We have a **low appetite** for risking the trust our customers place in us by not delivering on our commitments to our customers. (Noting that the risk identified to customers is considered not likely to damage the trust of customers as failures are spread throughout the network and unlikely to affect any single group of customers multiple times.)
- Network Performance: We have a **moderate appetite** to accept a reduction in the reliability of our network and the quality of our services provided that these remain within acceptable norms for Tasmania.
- Environment & Community: Accordingly, we have a **low appetite** for the potential to cause widespread environmental harm as a result of our network or operations.
- Safety & People: We have a **low appetite** for the potential of injury of members of the public in conducting our business.

6.5 Economic analysis

Option	Description	NPV
Option 0	Do nothing. All overhead conductors are run to failure. Repairs are only performed under fault to restore supply.	$0
Option 1 (preferred)	Risk based replacement. Overhead copper and GI conductors are -Analysed to quantify the risk they pose to public safety, fire start and network reliability.; and -Prioritized for replacement, based on the outcomes of this analysis; and -Audited to confirm the type and true condition before the replacement is performed. This NPV analysis covers the whole program of substandard conductor replacement	-$11,256,430
Option 2	Proactively replace all HV overhead conductors at 60 years based on the estimated install age. The advantages of this option are that it is low risk and reduces the number of unplanned outages due to conductor failures. The disadvantages are that some assets will be replaced while they still have some functional life remaining, and will not be able to identify all conductors before they fail due to other factors, so some will still fail in service.	-$31,401,411

6.5.1 Quantitative Risk Analysis

-

6.5.2 Benchmarking

-

6.5.3 Expert findings

-

6.5.4 Assumptions

- All conductor replacements 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 $58203 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.

Section 2 Approvals (Gated Investment Step 2)

Project Initiator:	Gary Carleton	**Date:**	24/03/2015
Project Manager:		**Date:**	

Actions			
Submitted for CIRT review:		**Actioned by:**	
CIRT outcome:			