Investment Evaluation Summary (IES)

Project Details:

Project Name:	BFM - Replace EDOs with alternative device (ie: boric acid fuses or dropout reclosers)
Project ID:	01518
Business Segment:	Distribution
Thread:	Overhead
CAPEX/OPEX:	CAPEX
Service Classification:	Standard Control
Scope Type:	B
Work Category Code:	SIFIC
Work Category Description:	Fire mitigation projects - Conductor
Preferred Option Description:	Replace all HV EDO fuses in the HBLCA with boric acid fuses or dropout reclosers.
Preferred Option Estimate (Dollars $2016/2017):	$17,000,000

	19/20	20/21	21/22	22/23	23/24	24/25	25/26	26/27	27/28	28/29
Unit ($)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Volume	1666.00	1666.00	1666.00	333.00	333.00	333.00	333.00	333.00	333.00	333.00
Estimate ($)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total ($)	$5,000,000	$5,000,000	$5,000,000	$1,000,000	$1,000,000	$1,000,000	$1,000,000	$1,000,000	$1,000,000	$1,000,000

Governance:

Works Initiator:	Michael Cooper	Date:	29/05/2017
Team Leader Endorsed:	David Eccles	Date:	30/05/2017
Leader Endorsed:	Robert Smith	Date:	01/11/2017
General Manager Approved:		Date:	

Related Documents:

Description	URL
Bushfire Risk Mitigation Plan	http://reclink/R303735
Overhead Conductors and Hardware Asset Management Plan	http://reclink/R260427
Polemounted Transformers - Distribution	http://reclink/R260428
BFM EDO Replacement NPV	http://reclink/R732587
TasNetworks Corporate Plan - Planning period: 2017-18	http://reclink/R745475
TasNetworks Transformation Roadmap 2025	https://www.tasnetworks.com.au/customer-engagement/submissions/
TasNetworks Risk Management Framework	http://Reclink/R238142
Overhead Switchgear Asset Management Plan	http://reclink/R181933

Section 1 (Gated Investment Step 1)

1. Overview

1.1 Background

TasNetworks overhead high voltage fuses occur most commonly as expulsion drop out fuses (EDOs) and consist of a porcelain insulator with a hinged fibre tube held in place by a fusible link. When the expulsion drop out fuses experiences a fault current that exceeds the curve rating for the device, the fusible link melts, causing the fuse to drop open to isolate the equipment or section of network that it is protecting. EDO fuses are limited to operate in areas where the network fault current level is less than 8kA and are primarily located on distribution transformers and spur lines, with some located on isolating transformers on single wire earth return (SWER) lines.

TasNetworks bushfire mitigation programs are aimed to mitigate the top ten high level causes of distribution asset related fires. These programs account for approximately ninety percent of all asset related fire causes. Timeframes for each of these programs vary depending upon factors such as risk, volumes and investment requirements.

Where EDO fuse operations and failures have caused fires, they have been included within fire start data as either EDO fuse element or EDO fuse tube failure. As shown within Table 1 below, EDO fuse element and EDO fuse tube failure account for a combined total of approximately nine per cent of fires caused by distribution assets.

Table 1: Causes of fires started by distribution network assets

	Number of Ground Fire Starts						
Fire Cause	**2012/13**	**2013/14**	**2014/15**	**2015/16**	**2016/17**	**TOTAL**	**% of Total**
Vegetation outside clearance	5	6	12	10	11	**44**	31.9
Conductor clashing	4	2	2	2	0	**10**	7.2
Conductor failure	4	1	1	3	1	**10**	7.2
EDO fuse element	0	3	4	2	1	**10**	7.2
Vandalism/accidental damage	1	2	4	1	3	**11**	8.0
Insulator broken/damaged	2	1	0	1	6	**10**	7.2
Connector failure	4	1	1	2	0	**8**	5.8
Birds/animals	2	0	1	3	2	**8**	5.8
Tie broken	0	0	1	4	2	**7**	5.1
Vegetation inside clearance	0	1	3	0	0	**4**	2.9
Lightning	0	1	0	1	1	**3**	2.2
Cable termination failure	0	0	0	3	0	**3**	2.2
EDO fuse tube	0	0	1	1	0	**2**	1.4
Turret (cable fault)	0	0	1	1	0	**2**	1.4
U/G cable failure	2	0	0	0	0	**2**	1.4
Switch-gear failure (LV)	1	0	0	0	1	**2**	1.4
Windborne material	0	0	0	0	1	**1**	0.7
Pole failure	0	0	0	0	1	**1**	0.7
TOTALS	**25**	**18**	**31**	**34**	**30**	**138**	**100**

EDO failure modes rates as number three for potential asset fire cause (as detailed within the Bushfire Risk Mitigation Plan). Major fires have previously occurred interstate as a result of EDO failure modes. Key Business Risk 10 rates bushfire initiated from electrical infrastructure amongst TasNetworks' highest risks. Current risk rating is 'high' and target risk rating is 'medium'.

Distribution transformers have a set of fuses installed (one fuse device on each phase) for protection against over-current faults; which may include temporary or permanent faults. The most commonly used fuse devices in the network are expulsion drop out fuses as shown in Figure 1. EDO's are made up of a fuse holder, fuse element and mount. The fuse holder consists of a hinged fibreglass tube, the lower casting and tube top with a pull ring. The mount has a porcelain insulator, top and bottom terminals, bottom hinge and top contacts. The hinged fibre tube is held in place by a fusible link.

Figure 1. EDO fuse

In addition to EDO fuses installed on distribution transformers, TasNetworks has also installed over 7,000 EDO fuses on spur lines in the distribution system. Spur lines are single or three phase lines off the main feeder trunk. The main purpose of these fuses is to prevent feeder trunk outages in the event of a fault on a spur line.

When the EDO fuse experiences a fault current that exceeds the curve rating for the device, the fusible link melts, causing the fuse holder to drop down and interrupt supply, protecting the network asset.

Although EDO fuses are an economic solution for asset and network protection, the operation of an EDO has the potential risk of starting a bushfire. In the event of an overcurrent fault, the fuse holder drops out interrupting supply and hot molten particles are expelled from the fuse tube. Depending on the conditions, these molten particles have the potential to fall to the ground below and ignite a fire, which under some circumstances could spread into a severe bushfire.

An additional issue with the operation of an EDO fuse is its ability to become stuck, which is known as a 'Hang Up'. This results from corrosion of the parts or moisture ingress into the fibreglass caused by exposure to the elements. The danger of this situation is if the fuse element melts due to a fault or overload, the element may stick to the inside of the tube, causing the fuse holder to remain hung up and not release. If supply is not interrupted, electrical tracking can then occur, resulting in the generation of heat and, in some cases, ignition of the fiberglass fuse tube creating the potential of starting a fire at ground level (see figure 2 below). TasNetworks has experienced both of these modes of failure.

Figure 2. Failed EDO fuse tube

1.2 Investment Need

The objective of the program is to reduce fires caused by the operation (or maloperation) of EDO fuses and as a result, reduce the risks to employees, customers and the general public.

Approximately 2 per cent of 4,000 EDO operations since January 2014 caused, had the potential to cause a pole top or grass fire. These faults consisted of:

- burnt out fuses (fuse tube or holder had signs of fire damage);
- fuse hang ups (fuses became stuck causing sparking or burning of the fuse);
- grass fires (operation from an EDO fuse caused a small grass fire); and
- various other incidents including burnt off loops, connectors, and links associated with the EDO fuse installation.

As outlined within the Bushfire Risk Mitigation Plan, the operation of EDO fuses in the High Bushfire Loss Consequence Area (HBLCA) poses amongst the highest risk to TasNetworks. The approach will be to either reduce the amount of fuse operations in these areas by installing fuse saving technology (such as dropout reclosers as shown in *Figure 3*), or installing fuse devices in these areas that reduce the likelihood of starting a fire from a fuse operation (such as enclosed boric acid fuses as shown in *Figure 4*).

Figure 3. Dropout Recloser

Figure 4. Boric Acid Fuse

The decreasing investment profile beyond 2021-22 is reflective of the prioritised approach whereby highest risk sites (based on age and downstream connected load at each site) within the HBLCA are to be actioned first and lower risk sites will continue to be addressed post 2021-22.

Another progam exists to replace EDOs in other parts of the state outside the HBLCA under IES 1729 (Replace EDOs with alternative device (ie: boric acid fuses or dropout reclosers).

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); and
- 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:

(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

The objective of the program is to reduce fires caused by the operation (or maloperation) of EDO fuses. The objective of the EDO replacement program is to reduce fires caused by the operation of EDO fuses and as a result, reduce the risks to employees, customers and the general public.

The operation of fuses in the high fire risk areas poses the highest risk to TasNetworks. The approach will reduce the amount of fuse operations in these areas by either installing fault taming technology or installing boric acid fuse devices in these areas which reduces the likelihood of starting a fire from a fuse operation. This program prioitises work to start in the HBLCA followed by other high fire risk areas of the state.

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 replace current EDOs within the HBLCA there is a risk that an EDO operation or failure could lead to a severe bushfire.

TasNetworks acknowledges that there are EDO-associated risk dimensions other than bushfire. However, bushfire ignition is considered the highest order risk due to the potential consequence for a fire starting in severe bushfire weather conditions, in a location where it can spread and develop into a large uncontrollable bushfire, has the potential to result in multiple fatalities/injuries and large scale property damage. Action taken to address this highest-order EDO-related risk will serve to also reduce all other EDO-related risk dimensions to tolerable levels.

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

Accordingly, do nothing is not an acceptable option to TasNetworks'. 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 appetite and 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
Environment and Community	EDO operations pose a risk of igniting a severe bushfire which could lead to widespread damage to both the environment and community.	Unlikely	Severe	High
Reputation	The organisation reputation would be harmed if a severe bushfire was ignited from an asset.	Unlikely	Major	Medium
Safety and People	Current EDOs emit molten material and hot gasses during operation, this is hazardous to any member of the public or staff in the close vicinity, alternatively it could result in the loss of life from a bushfire.	Rare	Severe	Medium

Section 2 (Gated Investment Step 2)

5. Preferred Option:

Replace all fuses in the HBLCA with boric acid fuses or dropout reclosers is the preferred option.

Replace current EDOs with boric acid fuse devices or dropout reclosers located both within the HBCA and posing a direct risk of igniting a fire from operation (e.g. located above grass or near vegetation).

This involves replacing all fuses installed on distribution transformers and spur lines with boric acid fuses or Tripsaver reclosers under fault conditions or by scheduled work.

5.1 Scope

Replace existing EDOs on spur lines or distribution transformers with alternative devices (ie: boric acid fuses or dropout reclosers). Currently, existing EDO operations are the fourth highest cause of bushfires from TasNetworks' managed assets. By replacing them with alternative devices the risk of a fire start is greatly reduced and the function and safety of the distribution network is un-altered.

This is a continuation of an existing program that focuses on assets in the HBLCA, with another program running concurrently to manage risk in the remaining parts of the state (under IES 1729).

5.2 Expected outcomes and benefits

The benefits to TasNetworks from implementation of the preferred option will be:

- mitigate risk of starting a bushfire from an EDO operation in HBLCA;
- reduced safety risk to employees, customers and the general public; and
- reduce the risk of causing severe environmental and community damage.

5.3 Regulatory Test

A Regulatory Investment Test is not required for this program.

6. Options Analysis

6.1 Option Summary

Option description	
Option 0	Do nothing. Continue using conventional EDO fuses.
Option 1 (preferred)	Replace all HV EDO fuses in the HBLCA with boric acid fuses or dropout reclosers.
Option 2	Replace all HV EDO fuses in the HBLCA with alternate fault reducing devices.

6.2 Summary of Drivers

Option	
Option 0	Advantages: • lowest expenditure. Disadvantages: • does not mitigate risk of starting a bushfire from an EDO operation in HBLCA; • Does not reduce risk of an EDO failure causing a severe bushfire in the HBLCA; • does not reduced safety risk to employees, customers and the general public caused through the operation or of the EDO fuse; • does not reduce repair/replacement costs associated with fuses operating; and • does not reduce the risk of causing severe environmental and community damage.

Option 1 (preferred)	Advantages: • mitigate risk of starting a bushfire from an EDO operation in HBLCA; • reduced safety risk to employees, customers and the general public; • reduce the risk of causing severe environmental and community damage; and • reduce repair/replacement costs associated with fuses operating. Disadvantages: • higher expenditure, both capital and operational.
Option 2	Advantages: • reduces the likelihood of a HV fuse igniting a bushfire compared to Option 0. Disadvantages: • higher expenditure, both capital and operational; • expulsion of hot gasses still occurrs during fuse operation which does not satisfy bushfire ignition risk reduction requirements; and • The alternate devices were not favourable with field crews after a recent field trial due to operational concerns.

6.3 Summary of Costs

Option	Total Cost ($)
Option 0	$0
Option 1 (preferred)	$17,000,000
Option 2	$16,148,575

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 of bushfire ignition due to fuse operation or failure; and
- This option has the lowest upfront expenditure, however high additional costs to the business are incurred in the form of regulatory and compliance breaches. As this option does not address the risk to local communities, environments and public safety it is highly likely to involve further costs due to incidents and legal proceedings.

Option 1 - Replace all HV EDO fuses in the HBLCA with Boric Acid fuses or dropout reclosers. (Prefered Option):

By replacing conventional HV EDO fuses within the HBLCA with boric acid fuses, the risk is considered Low in accordance with the TasNetworks risk management framework. This evaluation is driven by:

- The greatly reduced likelihood of a fuse operation igniting a severe bushfire; and
- The risks to public safety from molten particles being emitted during fuse operation are removed.

Option 2 - Replace all HV EDO fuses in the HBLCA with alternate fault reducing devices:

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

- The likelihood of igniting a bushfire from a HV fuse operation or failure is lower than Option 0 but still does not adequately mitigate the risk.

6.5 Economic analysis

Option	Description	NPV
Option 0	Do nothing. Continue using conventional EDO fuses.	-$3,132,440
Option 1 (preferred)	Replace all HV EDO fuses in the HBLCA with boric acid fuses or dropout reclosers.	-$18,799,844

Option 2	Replace all HV EDO fuses in the HBLCA with alternate fault reducing devices.	-$17,933,768

6.5.1 Quantitative Risk Analysis

Not Applicable.

6.5.2 Benchmarking

A survey was conducted around other utilities in Australia to understand the technology they are adopting and the issues surrounding this new technology. This feedback has assisted TasNetworks development of strategy that aligns with similar programs implemented by other utilities to mitigate bushfire risk due to EDO operations and failures.

6.5.3 Expert findings

Not Applicable.

6.5.4 Assumptions

Related Projects

A similar program exists for EDOs outside the HBLCA under IES 1729 in the Fire mitigation projects - conductor work category (SIFIC). These are not duplicate programs and are separated mainly for work prioritisation and reporting purposes.

Material Specifications

Boric acid fuses or dropout reclosers will account for the vast majority of replacement units. These units are currently a standard store stocked item.

Program Development

The HBLCA unit volumes have been derived from total units of HV EDO fuses installed in the network within the HBCLA to determine project volumes.

Annual volumes are a derivative of total program volumes divided by program timeframes.

Unit values have been determined using historical unit costs.

Unit costs are applied to annual program volumes to determine annual costs.