ElectraNet

MANAGING THE RISK OF TRANSFORMER BUSHING FAILURE

Project Specification Consultation Report

22 August 2018

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Executive Summary

We have identified to need to replace about 100 transformer bushings on 18 power transformers across South Australia

This Project Specification Consultation Report (PSCR) identifies the need to replace 101 transformer bushings fitted on 18 power transformers across ElectraNet's transmission network based on their condition. The bushings were installed in the 1960s and 1970s and are now reaching, or past, the end of their technical lives. The bushings are now between 36 and 55 years old compared to a standard technical life of 40 years.

The identified transformer bushings are located at the following ten substations:

- Metropolitan substations – Para, Cherry Gardens and LeFevre; and
- Rural substations – Robertstown, Snuggery, Yadnarie, Murray Bridge/ Hahndorf PS1, Murray Bridge/ Hahndorf PS3, Berri and North West Bend.

The 'identified need' is to efficiently manage the risk of asset failure

The identified need for this project is to manage the risk of failure of individual transformer bushings that are reaching, or have passed, the end of their technical lives based on their condition.

We assess the condition and required timing of replacement of transformer bushings as part of our ongoing asset management processes. There is an increased likelihood that a number of these assets will fail within the next 5-10 years, which could result in unplanned outages on parts of the transmission network. Relevantly, on 3 August 2018, one of the transformer bushings identified as requiring replacement as part of this assessment suffered an explosive failure.

The potential consequences of transformer bushing failure include oil-fuelled fire with consequential damage to the transformer and other equipment, as well as safety risk to network personnel and the wider community. In a severe scenario, the failed bushing can result in significant unserved energy for electricity customers because of the transformer itself completely failing.

We have classified this RIT-T as a market benefits driven RIT-T because, while the aim is to maintain the quality, reliability and security of supply of prescribed transmission services, the economic assessment is not driven by the requirement to meet a mandated reliability standard. Rather a full cost benefit assessment has been undertaken, comparing the risk cost reduction benefits of asset replacement options with the cost of those options.

Asset replacement is the only feasible solution that can meet the identified need

There is only one technically and economically feasible option, which is to replace the end-of-life transformer bushings on a like-for-like basis. This is because bushings play a very specific role in enabling transformers to operate and, without them, transformers, and hence substations, cannot fulfil their role of transforming electrical voltages to higher or lower levels for efficient electrical power transportation to downstream transmission and distribution end-use customers.

We have investigated two credible options with different timing for the proposed replacement program:

- Option 1 – Replace identified transformer bushings between 2018-19 and 2021-22; and
- Option 2 – Defer replacement of the transformer bushings to the following regulatory period and replace them between 2023-24 and 2026-27.

Both options cost approximately $6.86 million ($2017/18) and are expected to take 2.5 to 3 years to be completed. Although Option 2 has a lower cost, in present value terms, than Option 1, it comes with a higher expected risk associated with keeping the identified bushings in-service for an additional five years.

There is no feasible role for network support solutions in addressing the identified need for this RIT-T

Network support solutions cannot credibly meet the identified need for this RIT-T. This is because of the specific role that the identified bushings play in the transmission of electricity and their relatively low replacement cost.

A network support option that avoids replacement of the identified transformer bushings would need to effectively replace the functionality, capacity and reliability of the entire transformer substation on an ongoing basis at a cost that is lower than the network option currently under consideration. The total capital cost of replacing all 101 identified bushings is estimated to be $6.86 million (approximately $686,000 per substation or $68,000 per bushing).

For completeness, this PSCR sets out in more detail the required technical characteristics for a network support solution.

Three different 'scenarios' have been modelled to deal with uncertainty

We have developed three scenarios to assess the two credible options for replacing the identified transformer bushings as shown in Table 1.

Table 1 Summary of the three scenarios

Key variable/parameter	Low benefits scenario	Central scenario	High benefits scenario
Capital costs	130 per cent of capital cost estimate	Base estimate	70 per cent of capital cost estimate
Commercial discount rate[1]	8.38 per cent	6 per cent	3.62 per cent
Avoided 'risk cost' benefit	70 per cent of base estimates	Base estimates	130 per cent of base estimates
Deferred routine bushing tests	70 per cent of base estimates	Base estimates	130 per cent of base estimates
Avoided corrective maintenance	70 per cent of base estimates	Base estimates	130 per cent of base estimates

[1] Expressed on a pre-tax real basis.

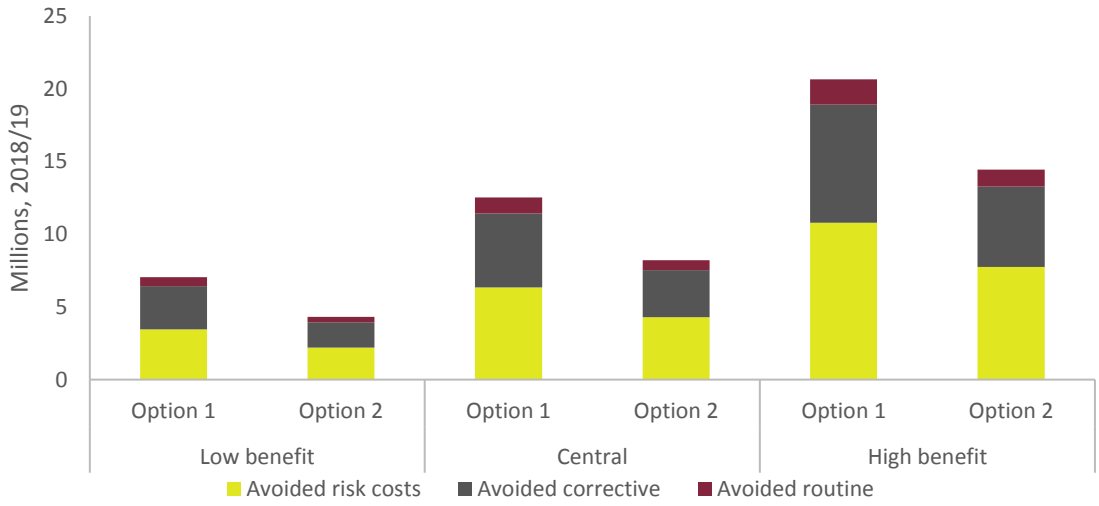
These describe:

- a ‘central’ scenario – reflecting our base set of key assumptions;
- a ‘low benefits’ scenario – reflecting a conservative set of assumptions, which represents a lower bound on potential market benefits that could be realised under each credible option; and
- a ‘high benefits’ scenario – reflecting an optimistic set of assumptions, which represents an upper bound on potential market benefits that could be realised under each credible option.

Replacing the identified bushings in the next five years is the preferred option[2]

The preferred option that has been identified in this assessment for addressing the identified need is Option 1; i.e. replacing the identified transformer bushings between 2018-19 and 2021-22. Option 1 has greater estimated gross benefits than Option 2 because the identified bushings are being replaced approximately five years earlier than under Option 2. Most of the benefits are attributable to avoiding the risk costs of transformer bushing failure and avoided corrective maintenance, while avoided routine maintenance costs (i.e. deferred routine bushing tests) contribute relatively small amounts to the estimated benefits.

Figure 1 – Breakdown of present value gross economic benefits of Option 1 and Option 2



We have also undertaken a thorough sensitivity testing exercise to understand the robustness of the RIT-T assessment to underlying assumptions about each of the key variables.

In particular, we have looked at the consequences for the credible options of ‘getting it wrong’ if the key underlying assumptions are not accurate; e.g. if avoided ‘risk costs’ are not as great as assumed.

For all sensitivity tests undertaken, the estimated net market benefit of Option 1 exceeds that for Option 2. Furthermore, the estimated net market benefits are found to be positive for both of the credible options over all of the sensitivities investigated.

[2] The preferred option is defined as the option that maximises net market benefits under the RIT-T framework.