Managing the Risk of Isolator Failures 2024-2028

Project Assessment Conclusions Report

25 OCTOBER 2024

EXECUTIVE SUMMARY

This Project Assessment Conclusions Report is the final stage of identifying the preferred option to address an identified need relating to replace 25 and refurbish 24 isolators at nine substations to maintain safe and reliable electricity supply to customers.

The identified need for this project is to continue to provide safe and reliable electricity transmission services in South Australia at a prudent and efficient cost.

Specifically, the identified need for this Regulatory Investment Test for Transmission (**RIT-T**) is to efficiently manage the costs associated with creating a spares inventory (i.e. the costs of removing and/or replacing the isolators identified for creating spares) are more than outweighed by cost savings compared to what would need to be incurred under the base case.

Isolators are mechanically operated switches that isolate a part of an electrical circuit under no-load conditions. They allow circuit breakers, transformers, transmission lines and customer connection points to be safely isolated for work to be performed by field staff. The failure of an isolator may prevent the safe maintenance or return to service of plant and customer connections as the isolator may be unable to open or close when required.

The isolators in question for this Project Assessment Conclusions Report (**PACR**) are selected for replacement to enable the provision of spare components, or remove a known safety risk, or remove remnant end of life isolators.

The Project Specification Consultation Report was released in June 2024 identifying a proposed solution.

The Project Specification Consultation Report (**PSCR**) for this project was published on 14 June 2024. It described the identified need and suggested that there is only one technically feasible option, which is a targeted replacement program to create isolator spares with an estimated capital cost of approximately $22.9 million.

The PSCR assessed different timings of this replacement option and concluded that replacing the instrument transformer in the current regulatory period between 2025 and 2028 is the preferred.

The PSCR also explained why non-network options are not expected to have a feasible role. This is because of the specific role that the identified isolators play in the transmission of electricity, as well as their relatively low emergency repair cost when spare components are available.

No submissions were received on the PSCR.

This PACR maintains the initial conclusion that a targeted replacement program to create isolator spares within the 2024-2028 regulatory period is the preferred option[1].

The preferred option that has been identified in this assessment for addressing the identified need is Option 1a, which is to replace the replace 25 and refurbish 24 isolators at nine substations by 2028.

Most of the benefits are attributable to reducing the associated risk costs of isolators failing and avoiding emergency corrective maintenance (functionally emergency replacement).

On a weighted basis (i.e., weighted across the three scenarios investigated), the preferred option is expected to deliver approximately $38.6 million in net market benefits.

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

Next steps

ElectraNet intends to commence work on replacing 25 isolator and refurbishing another 24 isolators in 2025.

Further details in relation to this project can be obtained from consultation@electranet.com.au.

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Glossary

AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
ALARP	As Low as Reasonably Practicable
ETC	Electricity Transmission Code
NPV	Net Present Value
NEM	National Electricity Market
NER	National Electricity Rules
PACR	Project Assessment Conclusions Report
PADR	Project Assessment Draft Report
PSCR	Project Specification Consultation Report
RIT-T	Regulatory Investment Test for Transmission
SFARP	So Far As is Reasonably Practicable
TNSP	Transmission Network Service Provider
VCR	Value of Customer Reliability

1. Introduction

This Project Assessment Conclusions Report (**PACR**) is the final step in the application of the Regulatory Investment Test for Transmission (**RIT-T**) to address the risk of failure of 49 isolator at nine substations located across the South Australian transmission network.

The Project Specification Consultation Report (**PSCR**) was released on 14 June 2024. It

- described the identified need that we are seeking to address, together with the assumptions used in identifying this need;
- set out the technical characteristics that a non-network option would be required to deliver to address this identified need;
- outlined the only credible option that we consider addresses the identified need;
- discussed specific categories of market benefit that, in the case of this RIT-T assessment, are unlikely to be material;
- presented the results of our economic assessment of the credible option and identifies the preferred option and the reasons for the preferred option; and
- set out our basis for exemption from a Project Assessment Draft Report (**PADR**).

No submissions were received on the PSCR.

1.1. Why we consider this RIT-T is necessary

The National Electricity Rules (**NER**) require the application of the RIT-T to replacement capital expenditure where there is at least one credible option costing more than $7 million.[2]

Accordingly, we have initiated this RIT-T to consult on proposed expenditure related to replacing the isolators, noting that none of the exemptions listed in NER clause 5.16.3(a) apply.

The credible option discussed in this PACR has not been foreshadowed in AEMO's Integrated System Plan (**ISP**) as the works involved do not impact on the main transmission flow paths between the NEM regions.

1.2. Next steps

ElectraNet intends to commence work on replacing 25 and refurbishing another 24 isolators in 2025.

Further details in relation to this project can be obtained from consultation@electranet.com.au

2 NER clause 5.15A.1(c) states that the purpose of the regulatory investment test for transmission in respect of its application to both types of projects is to identify the credible option that maximises the present value of net economic benefit (the preferred option). For the avoidance of doubt, a preferred option may, in the relevant circumstances, have a negative net economic benefit (that is, a net economic cost) to the extent the identified need is for reliability corrective action or the provision of inertia network services required under clause 5.20B.4..

2. The identified need for this RIT-T is to ensure safe and reliable supply of electricity in South Australia

This section outlines the identified need and the assumptions underpinning it. It first provides some background on the identified isolators and their role in the wider transmission of electricity in South Australia.

2.1. Background to the identified need

Isolators are mechanically operated switches that isolate a part of an electrical circuit under no-load conditions. They allow circuit breakers, transformers, transmission lines and customer connection points to be safely isolated for work to be performed by field staff.

Replacement of the 25 isolators by this project enables:

1. Spare componentry for each isolator 'make and model' within the transmission high voltage network where spare parts are no longer available from the manufacturer. Spare componentry significantly aids efficient emergency corrective maintenance. (13 of the 25 isolators listed to be replaced by this project).
2. Removal of a known high safety risk that is unable to be lowered by any other action apart from replacement. Refer lay of protection assessment reports. (8 of the 25 isolators listed to be replaced by this project).
3. The removal of high network risk remnant isolators identified as being at end of life. (4 of the 25 isolators listed to be replaced by this project).

An example of a high voltage 132 kV isolator at Hummocks substation that is planned to be replaced is illustrated in Figure 1.

Refurbishment of the 24 isolators by this project enables:

1. An extension of life to specific isolators that have superior primary contact components but are affected by high failure rates of the 55+ year old motor drive unit componentry. New motor drive units provide a lower cost solution to these isolators than an alternative whole of isolator replacement option that would also necessitate major switchyard modifications.
2. A safety improvement to isolators that are difficult to manually operate due to the considerable physical strength and experience required to enable a change of state from 'open' to 'closed'. The addition of a suitable new generation motor drive unit will enable safe remote operations and when required, a much lower physical act for manual operations.

An example of a high voltage 66 kV isolator at Torrens Island A substation that is planned to be refurbished is illustrated in Figure 2.

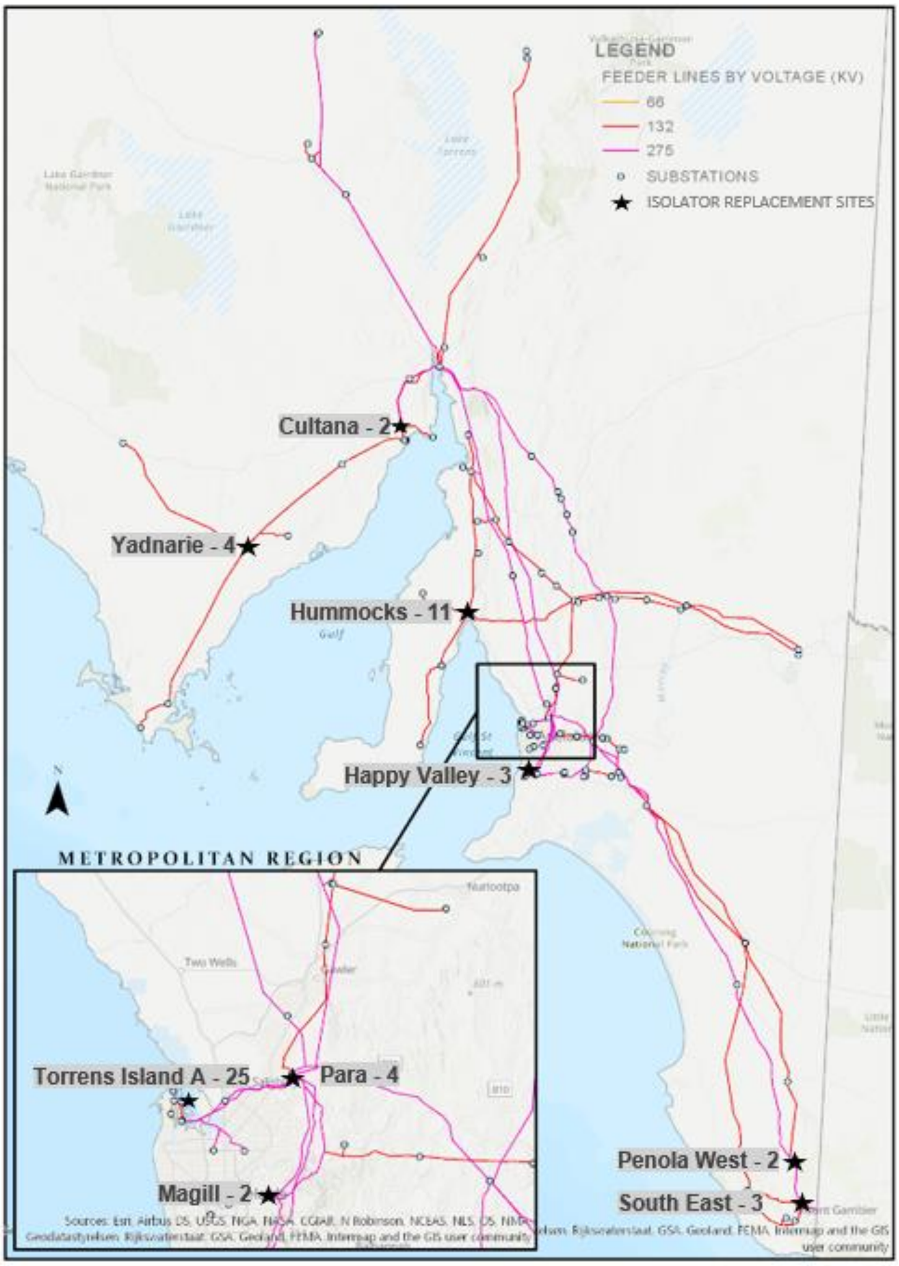
Figure 1 – 132 kV isolator at the Hummocks substation.

Figure 2 – 66 kV isolator at the Torrens Island A substation.

The failure of an isolator may prevent the safe maintenance or return to service of plant as the isolator may be unable to open or close when required. Across our transmission network, we have identified 49 isolators, and/or parts of isolators, for removal and replacement, or in some cases removal only. A selection of the removed isolators is planned to be refurbished and disassembled to create a suitable spares inventory to allow for emergency maintenance of defective isolators.

The distribution of the nine substations where isolators are being refurbished or replaced and used to create spares is illustrated in Figure 3.

Figure 3 - Location of the Isolator identified for replacement or refurbishment.



Currently, we have an ageing population of isolators that do not have any manufacturers support as they are more than 20 years old. If a spares program is not implemented, it is likely there will be increased replacement costs and outages as, absent spare components, the replacement of entire isolator assemblies will be required under emergency conditions.

Specifically, when spare components are not available, a new isolator will have to be retro fitted to the old isolator position requiring significant increased costs and longer outages. Moreover, if an isolator does not operate, maintenance cannot be undertaken at the substation, or on transformers, lines, circuit breakers and, or customers may not be able to be returned to service after maintenance has been undertaken.

The average corrective maintenance unit cost for isolators differs significantly depending on whether spare components are available or not.

Specifically:

- when spare isolator components are available, this cost is approximately $30,000 for a 275 kV isolator and approximately $25,000 for a 132 kV component of an isolator; and
- without a spare, the emergency corrective maintenance cost would involve a whole new isolator and cost approximately $450,000 for a 275 kV isolator and $350,000 for a 132 kV isolator.

The creation of a spares program for isolator equipment enables ongoing inventory support for isolators and associated equipment that remains in service, where support is no longer available from the original equipment manufacturer. Furthermore, the spare components that are created from the strategically selected isolators will be able to be used at multiple sites throughout the transmission network.

The isolators we are intending to remove and/or replace in order to create spares are from the substations identified in Table 1, which also includes the isolator models that the spare components can be used to repair.

Table 1 - Substations with affected isolators

Substation	Isolator models
Para Substation	ETSA HDB (132 kV)
Happy Valley	ETSA HDB (132 kV)
Torrens Island A Substation	Switchgear HDB (66 kV), Haycolec Isolator and Earth Switches (66 kV)
Magill Substation	ETSA HDB (66 kV)
South East Substation	Westralian DBR (275 kV)
Cultana Substation	ABB - DBRP132 Isolators and Earth Switch
Penola West Substation	ABB - R145 (132 kV)
Yadnarie Substation	Replacement
Hummock Substation	ETSA DR Isolators and Earth Switch (132 kV)

2.2. Description of the identified need for this RIT-T

As set out in the PSCR, the identified need for this project is to continue to provide reliable electricity transmission services in South Australia at a prudent and efficient level of cost.

Specifically, as set out in the PSCR, we consider that the costs associated with creating a spares inventory (i.e. the costs of removing and/ or replacing the isolators identified for creating spares) are more than outweighed by the cost savings compared to what would need to be incurred under the base case.

We have strategically identified isolators that are representative of approximately 80 per cent of the total population of isolators in the transmission network. The isolators that are being turned into spares can be used to replace the failed components of other in-service isolators and one isolator spare can be used to repair multiple failed isolators.

In its Industry Practice Note for asset replacement planning the Australian Energy Regulator says that Network Service Providers should apply the As Low as Reasonably Practicable (**ALARP**) approach to safety matters.[3] This is consistent with South Australia's Workplace Health and Safety Act, which requires us to ensure, So Far As is Reasonably Practicable (**SFARP**), the health and safety of workers at our various sites and of the public generally. It is also consistent with our Safety, Reliability and Maintenance Technical Management Plan and with the obligation in our transmission licence to ensure that we operate the network in a manner consistent with good electricity industry practice.

Further, the Electricity (General) Regulations (the Regulations) 2012 require that:

51—Substations

(1) Substations must be designed, installed, operated and maintained to be safe for the electrical service conditions and the physical environment in which they will operate.

(2) Schedule 3 applies in relation to substations installed after 1 July 1997.

These obligations have been taken in to account in quantifying the benefits of this project which is classified as a 'market benefits' RIT-T. It is being progressed to deliver positive net benefits to customers by managing the risk of asset failure.

A full cost benefit assessment has been undertaken, comparing the risk cost reduction benefits of asset replacement options with the cost of those options.

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[3] Australian Energy Regulator, "Industry practice application note Asset replacement planning", p.51, available from www.aer.gov.au, retrieved 2 April 2024.

3. Credible options to address the identified need

There is only one credible option, which is to create spare isolators from replacing current isolators in the network and to replace isolators that are remnant and at end of life.

In the PSCR we investigated different timings for this option and determined that optimal timing was Option 1a, replacing and refurbishing the identified isolators by 2028. This assessment is presented in section 4.

This option is technically and economically feasible and able to be implemented in sufficient time to meet the identified need[4].

3.1. Option 1a – Planned replacement and refurbishment of isolators by 2028

Option 1a involves replacing or refurbishing the identified isolators in the 2024-2028 period and creating and storing isolators/isolator components as spares. Of the 49 existing isolators expected to be covered by this RIT-T:

- 25 are planned to be replaced and spares created; and
- 24 are planned to be refurbished.

The creation of isolator spare components enables ongoing inventory support for the isolators that remain in service with many of the isolators currently operating throughout the network no longer supported by the original equipment manufacturer. Furthermore, the spare components that are created from the strategically selected isolators will be able to be used at multiple sites throughout the transmission network.

ElectraNet has prepared an estimate of the cost of implementing this option which is $22.9 million. This is a Class 4 estimate prepared in accordance with the Australian Association of Cost Engineer's 'class 4' estimate categorisation. As such it was produced through a desktop review based on a scope prepared by ElectraNet's asset engineering team. It has an estimating range of -30% to +50%.

Routine operating and maintenance costs are not expected to be different to the base case.

The estimated construction time is approximately 3 years. We estimate that all the isolators could be addressed by 2028 under this option.

3.2. Options considered but not progressed

In the PSCR, we didn't identify other credible options that would meet the identified need. This decision has not changed.

3.3. There is not expected to be a material inter-network impact

We have considered whether the credible option will have a material inter-regional impact.[5].

By reference to AEMO's screening test for an inter-network impact[6], a material inter-regional impact arises if the option:

- involves a series capacitor or modification near an existing series capacitor;

[4] In accordance with those identified in section **Error! Reference source not found.**.

[5] In accordance with NER clause 5.16.4(b)(6)(ii).

[6] AEMO's suggested screening test for a material inter-network impact is set out in Appendix 3 of the Inter-Regional Planning Committee's Final Determination: Criteria for Assessing Material Inter-Network Impact of Transmission Augmentations, Version 1.3, October 2004.

- is expected to result in a change in power transfer capability between South Australia and neighbouring transmission networks; or
- is expected to increase fault levels at any substation in another Transmission Network Service Providers (TNSP) network.

None of these criteria are satisfied for the project discussed here. Therefore, ElectraNet does not consider there are any associated material inter-network impacts.

4. Assessment of credible options

This section outlines the assessment we have undertaken of the credible network option and the option to delay the project by 5 years. The assessment compares these options against a ‘do nothing’ base case option.

For clarity, this section re-presents the underlying assessment in the PSCR. There were no material changes since the PSCR that would affect the finding that Option 1a is preferred.

4.1. Description of reasonable scenarios

A RIT-T analysis is required to incorporate several different reasonable scenarios, which are used to estimate expected net market benefits. The number and choice of reasonable scenarios must be appropriate to the credible options under consideration.

We have developed three scenarios for this RIT-T assessment:

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

Table 2 summarises the key assumptions making up each scenario.

Given that the low and high benefits scenarios are more unlikely to occur the scenarios have been weighted accordingly; 33% - low benefits scenario, 33% - central benefits scenario, and 33% - high benefits scenario.[7]

Table 2 - Summary of the three scenarios

Key variable/parameter	Low benefits scenario	Central scenario	High benefits scenario
Capital costs	130 per cent of base case estimate	Base case estimate	70 per cent of base case estimate
Commercial discount rate[8]	3.0%	7.0%	10.5%
Unplanned replacement cost	70 per cent of base case estimates	Base case estimates	130 per cent of base case estimates
Generation support or temporary bypass for extended outages without spares	70 per cent of base case estimates	Base case estimates	130 per cent of base case estimates
Outage cost due to isolator failure	70 per cent of base case estimates	Base case estimates	130 per cent of base case estimates

[7] In accordance with paragraph 4(a) of the RIT-T.

[8] See AEMO, Inputs, Assumptions and Scenarios Report | July 2023, Table 31 Pre-tax real discount rates on p. 123 at https://aemo.com.au/-/media/files/major-publications/isp/2023/2023-inputs-assumptions-and-scenarios-report.pdf?la=en

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Key variable/parameter	Low benefits scenario	Central scenario	High benefits scenario
Additional outages due isolator failure during transformer or line maintenance	70 per cent of base case estimates	Base case estimates	130 per cent of base case estimates
Safety of personnel working on network assets	70 per cent of base case estimates	Base case estimates	130 per cent of base case estimates

4.2. Gross benefits for each credible option

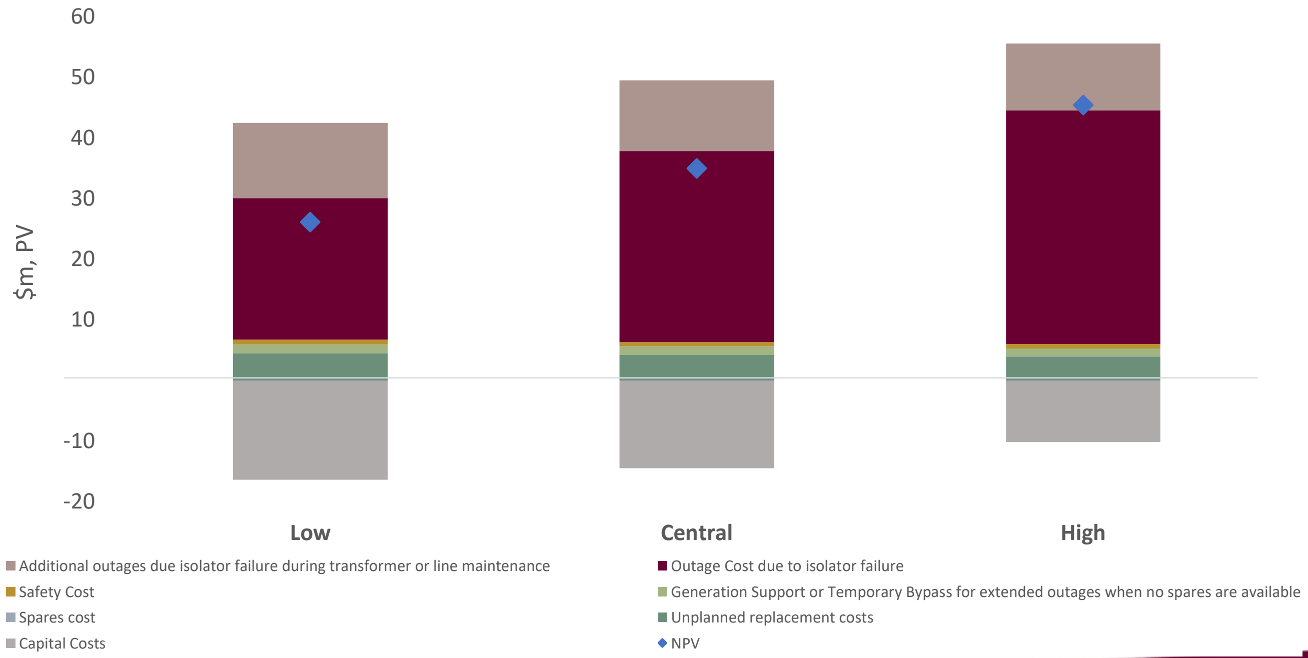
The table below summarises the gross benefit estimated for the preferred option, Option 1a, undertaking the replacement of isolators and creation of spare isolator components by 2028 to Option 1b, delaying the project by 5 years relative to the 'do nothing' base case in present value terms. The gross market benefit has been calculated for each of the three scenarios outlined in Table 2.

Table 3 - Estimated gross market benefit for each option, PV $m

Option	Low benefits scenario	Central scenario	High benefits scenario
Option 1a – Planned replacement of isolators and creation of spare isolator components by 2028	42.5	49.5	55.5
Option 1b - Delay replacement of isolators and creation of spare isolator components by 5 years	30.5	32.1	32.6

Figure 4 below provides a breakdown of benefits. It shows that the benefits are derived from the avoided risk of isolator failure and the reduced time taken to resolve such failures.

Figure 4 - Breakdown of present value gross economic benefits of the preferred option



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4.3. Estimated costs for each credible option

Table 4 summarises the capital costs of the preferred Option 1a and Option 1b, relative to the base case, in present value terms for the different scenarios as described in Table 2.

Table 4 - Estimated capital cost for each option, PV $m

Option	Low benefits scenario	Central scenario	High benefits scenario
Option 1a – Planned replacement of isolators and creation of spare isolator components by 2028	-16.4	-14.5	-10.1
Option 1b - Delay replacement of isolators and creation of spare isolator components by 5 years	-11.6	-9.2	-5.8

4.4. Net present value assessment outcomes

Table 5 summarises the net market benefit for Option 1a and Option 1b across the three scenarios, as well as on a weighted basis. The net market benefit is the gross benefit (as outlined in section 4.2) minus the cost (as outlined in section 4.2), all expressed in present value terms.

The table demonstrates that both options provide a strong expected net economic benefit on a probability-weighted basis in all scenarios as compared to the base case of 'do nothing' option.

Table 5 - Estimated net market benefit for each option, NPV $m

Option	Low benefits scenario	Central scenario	High benefits scenario	Weighted
Option 1a – Planned replacement of isolators and creation of spare isolator components by 2028	26.1	35.0	45.4	35.4
Option 1b - Delay replacement of isolators and creation of spare isolator components by 5 years	18.9	23.0	26.9	22.9

We have been conservative in our approach by not including the additional benefits of this option discussed in section 3.3.

4.5. Sensitivity testing

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

In particular, we have then tested the sensitivity of the total net market benefit to variations in the key factors underlying the assessment, such as for example the sensitivity of the project to increases in capital costs and optimal timing.

Our assessment demonstrates that undertaking the project in the 2024-2028 period has a higher NPV benefit compared to delaying the project to the 2029-2033 period. This timing enables us to manage the risk of isolator failures.

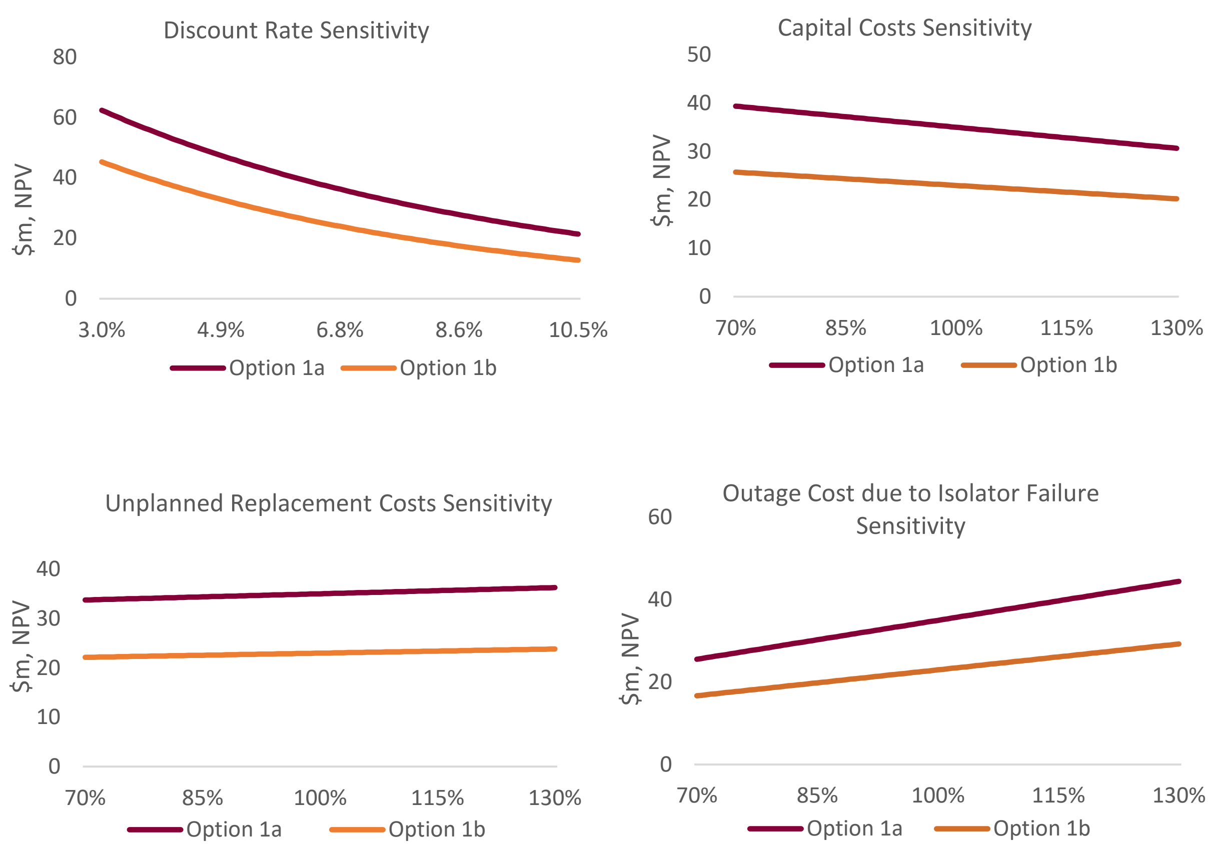
4.5.1. Sensitivity of the overall net market benefit

We have also reviewed the consequences for the preferred option of 'getting it wrong' if the key underlying input assumptions are not accurate.

The charts in Figure 5 below illustrate the estimated net market benefits for each option if the four separate key assumptions in the central scenario are varied individually. Importantly, for all sensitivity tests shown below, the estimated net market benefit of Option 1a undertaking the replacement of isolators and creation of spare isolator components by 2028 is found to be strongly positive and higher than to Option 1b, delaying the project by 5 years across all four key assumptions compared to the 'do nothing' base case option.

We do not consider that any of these threshold values can be reasonably expected and, thus, considers that the expected net market benefits have been demonstrated to be robust to a range of alternate input assumptions.

Figure 5 - Sensitivity testing of the NPV of net market benefits



For details about the economic modelling and process we followed, please refer to the following appendices:

- Appendix A defines the terms used in the economic assessment,
- Appendix B provides the process that we followed,
- Appendix C the assumptions underpinning the identified need,

- Appendix D the materiality of market benefits, and
- Appendix E the modelling methodologies used for the assessment of the options.

This information was included in the PSCR.

5. Conclusion on the preferred option

The preferred option that has been identified in this assessment for addressing the identified need is Option 1a, i.e., replacement of isolators and creation of spare isolator components by 2028. This option is described in section 3 and is estimated to have a capital cost of $22.9 million.

Option 1a is the preferred option because it is the credible option that maximises the net present value of the net economic benefit to all those who produce, consume and transport electricity in the market. In addition, Option 1a ensures ongoing compliance with a range of obligations under the NER.

We consider that the analysis undertaken and the identification of Option 1a as the preferred option satisfies the RIT-T.

The Compliance Checklist in Appendix F demonstrates that the PACR complies with section 5.16.4(v) of the NER.

We intend to commence work on replace 25 and refurbish 24 isolators at nine substations by 2025 and to have all assets replaced by 2028.

City West Substation

Appendices

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Appendix A Definitions

This appendix defines the terms used in the economic assessment.

Definitions	
AEMO	Australian Energy Market Operator
Base case	A situation in which no option is implemented by, or on behalf of the transmission network service provider.
Commercially feasible	An option is commercially feasible if a reasonable and objective operator, acting rationally in accordance with the requirements of the RIT-T, would be prepared to develop or provide the option in isolation of any substitute options. This is taken to be synonymous with 'economically feasible'.
Costs	Costs are the present value of the direct costs of a credible option.
Credible option	A credible option is an option (or group of options) that: a) address the identified need; b) is (or are) commercially and technically feasible; and c) can be implemented in sufficient time to meet the identified need.
Economically feasible	An option is likely to be economically feasible where its estimated costs are comparable to other credible options which address the identified need. One important exception to this Rules guidance applies where it is expected that a credible option or options are likely to deliver materially higher market benefits. In these circumstances the option may be "economically feasible" despite the higher expected cost. This is taken to be synonymous with 'commercially feasible'.
Identified need	The reason why the Transmission Network Service Provider proposes that a particular investment be undertaken in respect of its transmission network.
Market benefit	Market benefit must be: a) the present value of the benefits of a credible option calculated by: i) comparing, for each relevant reasonable scenario: a) the state of the world with the credible option in place to b) the state of the world in the base case, And ii) weighting the benefits derived in sub-paragraph (i) by the probability of each relevant reasonable scenario occurring. b) a benefit to those who consume, produce and transport electricity in the market, that is, the change in producer plus consumer surplus.

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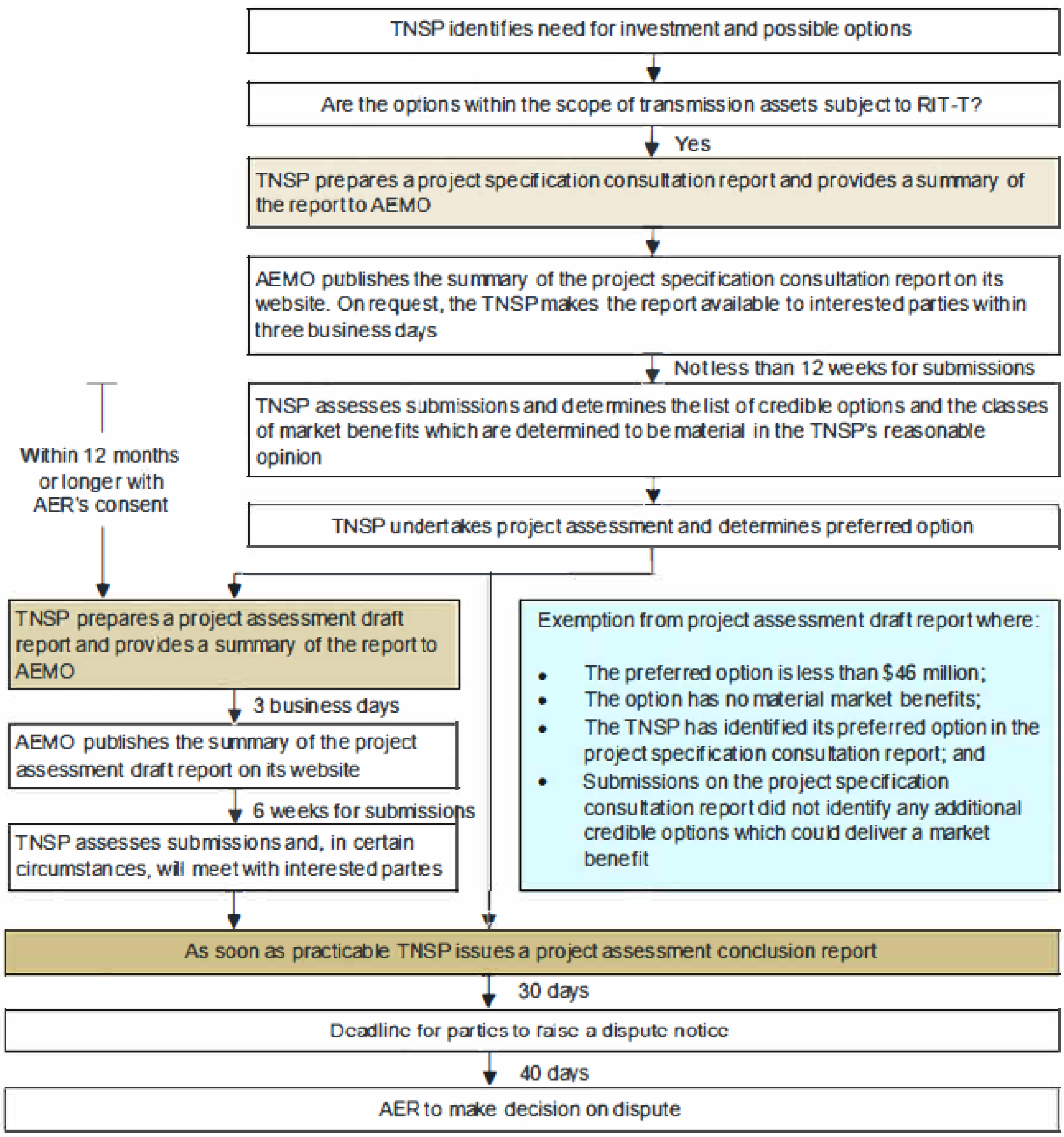
Definitions	
Net market benefit	Net market benefit equals the market benefit less costs.
Preferred option	The preferred option is the credible option that maximises the net economic benefit to all those who produce, consume and transport electricity in the market compared to all other credible options. Where the identified need is for reliability corrective action, a preferred option may have a negative net economic benefit (that is, a net economic cost).
Reasonable Scenario	Reasonable scenario means a set of variables or parameters that are not expected to change across each of the credible options or the base case.
Technically feasible	An option is technically feasible if there is a high likelihood that it will, if developed, provide the services that the RIT-T proponent has claimed it could provide for the purposes of the RIT-T assessment.

Appendix B Process for implementing the RIT-T

For the purposes of applying the RIT-T, the NER establishes a typically three stage process, i.e.: (1) the PSCR; (2) the PADR; and (3) the PACR. This process is summarised in the figure below (in gold), as well as the criteria for PADR exemption that this RIT-T is seeking to apply (in blue).

Figure 6 - The RIT-T assessment and consultation process



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Appendix C Assumptions underpinning the identified need

This appendix summarises the key assumptions that underpin the identified need for this RIT-T. Appendix E provides further details on the general modelling approaches applied, including the risk cost modelling framework.

For the purposes of this assessment, the risk cost model when an isolator fails focuses on four failure modes, being:

- contact failure – the current path (contacts, rotating heads or joints) or commutating contact components have failed on the isolator;
- control failure – the fuses, auxiliary contacts, monitoring devices (including sensors) have failed on the isolator;
- insulation failure – the main insulation to earth including support and drive insulators, pull rods, etc. have failed on the isolator; and
- operating mechanism failure – the motor drive on the isolator has failed due to a kinematic chain, motor, pump, control elements, gearbox, braking systems or mechanical transmission component failure.

Each failure mode has different characteristics and consequential likelihoods of occurring, as detailed in the sections below.

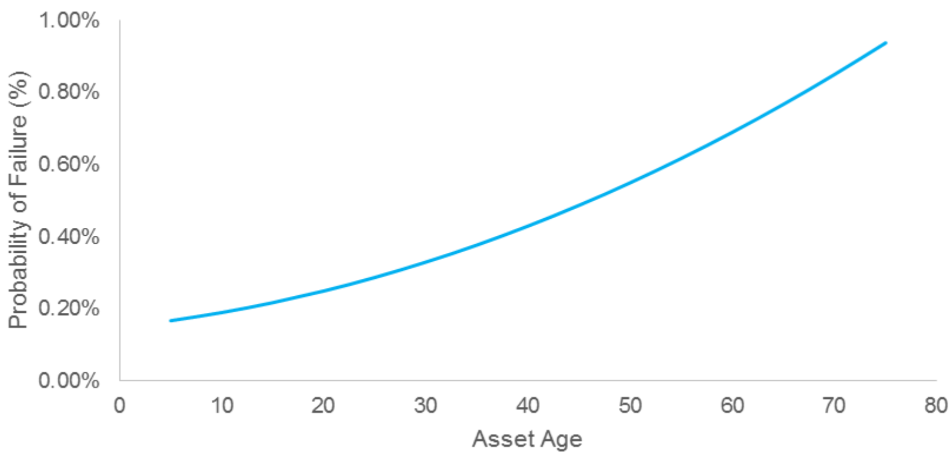
C.1. The probability of failure

The probability of isolator failure is estimated by considering the asset's age and historical asset failure data from CIGRE's Final Report of the 2004 – 2007 International Enquiry on Reliability of High Voltage Equipment, Part 3 – Disconnectors and Earthing Switches.[9]

CIGRE is a global technical forum for large electric systems and is composed of researchers, academics, engineers, technicians, suppliers, market and system operators and other decision makers.

The probability of failure is modelled based on a polynomial equation and increases as the assets age (a graph of the probability of isolator asset failures by asset age is shown in the figure below).

Figure 7 - Probability of isolator asset failures given asset age



[9] Table 3-31 in page 30 of CIGRE Technical Brochure 511 (Final Report of the 2004 – 2007 International Enquiry on Reliability of High Voltage Equipment, Part 3 - Disconnectors and Earthing Switches).

C.2. The consequences of failure and not having available spares

Our risk cost model has individually identified isolators that have the potential to cause immediate consequences. The probability of failure associated with each of these assets has been determined with the potential consequences resulting from an isolator spare being unavailable including:

- additional corrective maintenance costs associated with having to replace the entire damaged isolator and other equipment in an unplanned emergency situation, rather than components of the isolator when spare components are available (as described in section **Error! Reference source not found.**).
- prolonged periods of unserved energy for electricity customers for select isolators during the time taken to restore (or fully replace) an isolator(s) on a reactive basis in the absence of spare parts;
    - this is particularly likely to be the case for isolators located in radial substations, radial lines and some exit lines;
    - for isolators located in other parts of the network, an outage will only occur when there is also a separate outage of a transformer; and
    - generation support costs for select isolators to maintain reliability of supply to customers for extended outages greater than 48 hours;

Each of these adverse effects is incorporated in the risk model.

Outage durations for isolators are based on the typical time to change out and commission a new isolator, either with or without a spare. The time it takes for replacement with or without a spare is identified in Table 1.

Outage cost is based on the Australian Energy Regulator's (**AER**) estimated Value of Customer Reliability (**VCR**) which is expressed in dollars per kilowatt-hour (**kWh**) and reflect the value different customer types place on reliable electricity supply. All loads are based on a representative load trace taken from 2019-20 escalated to 2023 dollars based on the Consumer Price Index for that year. The average load for each substation where outages are considered is approximately 11.8 MW.

Generation support cost assumptions have been sourced from existing contracts ElectraNet has with providers of these services.

The costs associated with reducing service interruptions, network support and corrective maintenance are the material factors underlying the assessment. We have therefore included a range of sensitivity tests on these as part of the economic assessment.

The adverse effect of incurring additional costs associated with postponing planned outages for operational and capital work when an isolator fails has not been captured in our risk cost modelling but is expected to further increase the net market benefits associated with Option 1a.

Section 4 demonstrates these additional benefits would not change the preferred option and so they are not considered material in the context of this RIT-T.

Appendix D Materiality of market benefits for this RIT-T assessment

This appendix outlines the categories of market benefits prescribed in the NER and whether they are considered material for this RIT-T.

The bulk of the benefits associated with the preferred option are captured in the expected costs avoided by the option (i.e., the avoided expected costs compared to the base case). These include avoided risk costs as described above.

Of these avoided costs only unserved energy due to involuntary load shedding is considered a market benefit category under the NER

D.1. Avoided involuntary load shedding is the only relevant market benefit

The only relevant market benefit for this RIT-T relates to changes in involuntary load shedding. The expected unserved energy under the base case, which is avoided under the preferred option, has been estimated as part of our risk cost modelling.

D.2. Market benefits relating to the wholesale market are not material

The AER has recognised that a number of classes of market benefits will not be material in a RIT-T assessment if the credible options considered will not have an impact on the wholesale market. In this case the impacts do not need to be estimated.[10]

The preferred option would not affect network constraints between competing generating centres so it would not change dispatch outcomes or wholesale market prices.

Therefore, we consider the following classes of market benefits to be immaterial for this RIT-T assessment:

- changes in fuel consumption arising through different patterns of generation dispatch;
- changes in voluntary load curtailment (since there is no impact on pool price);
- changes in costs for parties, other than for ElectraNet (since there will be no deferral of generation investment);
- changes in ancillary services costs;
- competition benefits; and
- Renewable Energy Target (**RET**) penalties.

D.3. Other classes of market benefits are not expected to be material

In addition to the classes of market benefits listed above, NER clause 5.15A.2(b)(4) requires us to consider the following classes of market benefits in relation to each credible option:

- differences in the timing of transmission investment;
- option value; and
- changes in network losses.

We consider that none of these are material for this RIT-T assessment for the reasons set out in Table 6.

[10] AER, *Regulatory Investment Test for Transmission Application Guidelines*, August 2020, p. 29.

Table 6 - Reasons why non-wholesale market benefit categories are considered immaterial.

Market benefit category	Reason(s) why it is considered immaterial
Differences in the timing of transmission investment	The preferred option does not affect the timing of other unrelated transmission investments (i.e., transmission investments based on a need that falls outside the scope of that described in section 2). Consequently, the market benefits associated with differences in the timing of unrelated transmission investment are not material to the RIT-T assessment.
Option value	The AER has stated that option value is likely to arise where there is uncertainty regarding future outcomes, the information that is available in the future is likely to change and the credible options considered by the TNSP are sufficiently flexible to respond to that change.[11] None of these conditions apply to the present assessment. The AER has also stated the view that appropriate identification of credible options and reasonable scenarios captures any option value, thereby meeting the NER requirement to consider option value as a class of market benefit under the RIT-T. Changes in future demand levels are not relevant for this RIT-T since the need for and timing of the required investment is being driven by asset condition rather than future demand growth. As a result, it is not relevant to consider different future demand scenarios in undertaking the RIT-T analysis.
Changes in network losses	Given the preferred option maintains the current network capacity at the same location, there are not expected to be any differences in network losses.

11 AER, *Regulatory Investment Test for Transmission Application Guidelines*, August 2020, p. 52.

Appendix E Description of the modelling methodologies applied

This appendix outlines the methodologies and assumptions we have applied to undertake this RIT-T assessment.

E.1. Overview of the risk cost modelling analysis

We have applied an asset 'risk cost' evaluation framework to quantify the risk cost reduction associated with replacing the identified isolators.

The 'risk cost reduction' has been calculated as the product of:

- Probability of Failure, which is the probability of a failure occurring based on asset failure history information and industry data;
- Likelihood of Consequence, which is the likelihood of an adverse consequence of the failure event based on historical information and statistical factors; and
- Cost of Consequence, which is the estimated cost of the adverse consequence.

These three variables allow the expected risk cost reduction benefit to be quantified and an assessment against the cost of the project to be undertaken. The risk cost reduction benefit is the difference between risk costs incurred under the base case and the preferred option.

The approach we apply to quantifying risk was presented as part of our Revenue Proposal for the 2024-2028 regulatory control period. In its Draft Decision on that proposal, the AER found it to be consistent with good industry practice and to generally reflect reasonable inputs and assumptions.[12]

More detail on the key inputs and assumptions made for individual asset risk cost evaluations can be found in ElectraNet's asset risk cost modelling guideline.[13]

E.2. The discount rate and assessment period

The RIT-T analysis has been undertaken over a 20-year period from 2024 to 2043. This considers the size, complexity and expected life of each option to provide a reasonable indication of its cost.

While the isolators have an asset lives greater than 20 years. We have taken a terminal value approach to incorporating capital costs in the assessment, which ensures that the capital cost of each option is appropriately captured in the 20-year assessment period.

We have adopted a real, pre-tax discount rate of 7.0 percent as the central assumption for the analysis presented in this report, consistent with AEMO's most recent Inputs, Assumptions and Scenarios Report.[14] We consider that this is a reasonable contemporary approximation of a 'commercial' discount rate (a different concept to a regulatory WACC), consistent with the RIT-T.

The RIT-T requires that sensitivity testing be conducted on the discount rate and that the discount rate scenarios from AEMO's ISP Inputs Assumptions and Scenarios Report should be applied.[15]

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[12] AER, *ElectraNet transmission determination 2023 to 2028*, Draft Decision, Attachment 5 – Capital expenditure, September 2022

[13] Available at https://www.aer.gov.au/networks-pipelines/determinations-access-arrangements/electranet-determination-2018-23/proposal#step-50979.

[14] AEMO, Inputs, Assumptions and Scenarios Report, July 2023, p. 123.

[15] AER, *Regulatory Investment Test for Transmission*, August 2020 p. 6.

Appendix F Compliance Checklist

This appendix sets out a compliance checklist which demonstrates the compliance of this PACR with the requirements of clause 5.16.4(v) of the NER version 217.

Rules clause	Summary of requirements	Relevant section(s) in PACR
5.16.4(v)	The project assessment conclusions report must set out:	-
	(1) the matters detailed in the project assessment draft report as required under paragraph (k): and	See below
	(2) a summary of, and the RIT-T proponent's response to, submissions received, if any, from interested parties sought under paragraph (q)	No responses received
5.16.4(k)	The project assessment draft report must include:	-
	(1) a description of each credible option assessed;	3
	(2) a summary of, and commentary on, the submissions to the project specification consultation report;	NA
	(3) a quantification of the costs, including a breakdown of operating and capital expenditure, and classes of material market benefit for each credible option;	3, 4, Appendix D & Appendix E
	(4) a detailed description of the methodologies used in quantifying each class of material market benefit and cost;	Appendix D
	(5) reasons why the RIT-T proponent has determined that a class or classes of market benefit are not material;	Appendix D
	(6) the identification of any class of market benefit estimated to arise outside the *region* of the *Transmission Network Service Provider* affected by the RIT-T project, and quantification of the value of such market benefits (in aggregate across all regions);	NA
	(7) the results of a net present value analysis of each credible option and accompanying explanatory statements regarding the results;	4
	(8) the identification of the proposed preferred option;	5
	(9) for the proposed preferred option identified under subparagraph (8), the RIT-T proponent must provide: (i) details of the technical characteristics; (ii) the estimated construction timetable and commissioning date; (iii) if the proposed preferred option is likely to have a *material inter-network impact* and if the *Transmission Network Service Provider* affected by the RIT-T project has received an *augmentation technical report*, that report; and (iv) a statement and the accompanying detailed analysis that the preferred option satisfies the *regulatory investment test for transmission*.	3 & 5

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Rules clause	Summary of requirements	Relevant section(s) in PACR
	(10) if each of the following apply to the RIT-T project: (i) the estimated capital cost of the proposed preferred option is greater than $100 million (as varied in accordance with a cost threshold determination); and (ii) AEMO is not the sole RIT-T proponent, the RIT reopening triggers applying to the RIT-T project.	N/A

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