

Voltage Control in North West Victoria

Project Specification Consultation Report
Regulatory Investment Test - Transmission

June 2020



Important notice

Purpose

AusNet Services has prepared this document to provide information about potential limitations in Victoria transmission network and options that could address these limitations.

Disclaimer

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Executive summary

AusNet Services is initiating this Regulatory Investment Test for Transmission (RIT-T) to evaluate options to provide ongoing voltage control services in North West Victoria. The Static Var Compensator (SVC) at Horsham Terminal Station (HOTS) is reaching the end of serviceable-life which is driving the timing of this investigation. Publication of this Project Specification Consultation Report (PSCR) represents the first step in the RIT-T process¹ in accordance with clause 5.16 of the National Electricity Rules (NER)² and section 4.2 of the RIT-T Application Guidelines.³

The Static Var Compensator (SVC) at HOTS is owned and operated by AusNet Services. It was commissioned in 1986 to provide dynamic voltage and reactive power control services in North West Victoria.

Identified need

The SVC at HOTS has been providing dynamic voltage and reactive power control services for an extended period (34 years) and is reaching the end of its serviceable-life. A failure of the SVC would mean that AusNet Services is unable to meet its obligation to provide voltage and reactive control capability services as outlined in the Network Agreement between AEMO and AusNet Services. Further, it would reduce the ability to maintain voltages in North West Victoria within the limits specified under clause S5.1a.4 of the NER (see extract in section 2.4.1) and clause 110.2.2(a)⁴ of the Victorian Electricity System Code. Consequently, a failed SVC would require emergency asset replacement to be undertaken.

Therefore, the ‘identified need’ this RIT-T intends to address is to: continue to provide voltage and reactive power control capability services at HOTS such that voltages in the North West transmission network can be maintained within the limits specified in the NER and Victorian Electricity System Code; and mitigate risk of increased costs associated with emergency asset replacement.

AusNet Services classifies the identified need as ‘*reliability corrective action*’⁵ to ensure continued compliance with NER clause S5.1a.4 and Victorian Electricity System Code 110.2.2(a).

Credible options

AusNet Services has identified a number of investments that may deliver more economical and reliable solutions to address the identified need, compared with the base case where the existing assets are kept in service and emergency asset replacements are implemented when the SVC fails. The credible network options considered in this report are:

- Option 1 - Replacement of the existing SVC with a modern equivalent SVC; and

¹ A RIT-T process will assess the economic efficiency and technical feasibility of proposed network and non-network options.

² Australian Energy Market Commission, “National Electricity Rule version 141,” available at <https://www.aemc.gov.au/regulation/energy-rules/national-electricity-rules/current>, viewed on 6 June 2020.

³ Australian Energy Regulator, “Application guidelines Regulatory investment test for transmission,” available at https://www.aer.gov.au/system/files/AER%20-%20Final%20RIT-T%20application%20guidelines%20-%202014%20December%202018_0.pdf, viewed on 6 June 2020.

⁴ “A transmitter must use best endeavours to maintain the normal voltage level at each point of supply with a nominal voltage at or above 100kV within a range of plus or minus 10% of the voltage level nominated by VENCORP from time to time to the relevant transmitter and the relevant Participants which are supplied at that point of supply.” Office of the Regulator-General, Victoria, ‘Electricity System Code,’ available at <https://www.esc.vic.gov.au/sites/default/files/documents/3d1fc9fd-18e0-4e10-a87a-e68ba2151a1a.pdf>, viewed on 6 June 2020.

⁵ ‘NER 5.10.2 defines reliability corrective action as a network business’ investment in its network to meet ‘the service standards linked to the technical requirements of schedule 5.1 or in applicable regulatory instruments and which may consist of network options or non-network options.’ - Australian Energy Regulator, “Application guidelines Regulatory investment test for transmission,” available at https://www.aer.gov.au/system/files/AER%20-%20Final%20RIT-T%20application%20guidelines%20-%202014%20December%202018_0.pdf, viewed on 6 June 2020.

- Option 2 - Replacement of the existing SVC with a synchronous condenser.

AusNet Services welcomes proposals from proponents for non-network options (stand-alone or in conjunction with a network solution), that may meet the identified need i.e. reactive power generation and absorption capacity to respond automatically to voltage fluctuations arising from network disturbances or contingency events.

AusNet Services is seeking proposals for proponents of non-network options with capability equivalent to the existing SVC (+50 MVar/-25 MVar).

Assessment approach

AusNet Services will investigate the costs, economic benefits, and ranking of options in this RIT-T assessment. In addition to continuation of voltage control, the expected key benefits associated with the options is the avoidance of increased risk cost resulting from the required emergency asset replacement in the event of failure of the SVC.

The net economic benefits and the optimal timing of the options will be assessed against a business-as-usual case where no proactive capital investment is made and the existing maintenance regime continues to be implemented. The study will also be implemented using:

- a scenario where the latest commercial discount rate⁶ (5.9%), the estimated capital or operating costs of the options, and the central estimate for financial risk costs are assumed;
- sensitivity analysis that involves variations of assumptions on the failure rates, financial risk costs, capital costs, and discount rate. This will test the robustness of the conclusion of the study.

The options considered are not expected to have a material impact on the National Electricity Market (NEM) outcomes, and therefore several classes of market benefits are not expected to be relevant for this RIT-T assessment.

Submissions

AusNet Services welcomes written submissions on the issues and the credible options presented in this PSCR and invites proposals from proponents of potential non-network options.

Submissions should be emailed to ritconsultations@ausnetservices.com.au on or before 3 September 2020. In the subject field, please reference 'RIT-T PSCR Horsham Terminal Station Static Var Compensator.'

Submissions will be published on AusNet Services' and AEMO's websites. If you do not wish for your submission to be made public, please clearly stipulate this at the time of lodgment.

Next steps

Assessments of the options and responses to this PSCR will be presented in the Project Assessment Draft Report (PADR) that is intended to be published before 24 December 2020.

⁶ Energy Networks Australia, "RIT-T Economic Assessment Handbook," available at <https://www.energynetworks.com.au/resources/fact-sheets/rit-t-economic-assessment-handbook/>, viewed on 6 June 2020.

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1. Introduction

AusNet Services is initiating this Regulatory Investment Test for Transmission (RIT-T) to evaluate options for ongoing voltage control in North West Victoria. The Static Var Compensator (SVC) at HOTS is reaching the end of serviceable-life which is driving the timing of this investigation.

Publication of this Project Specification Consultation Report (PSCR) represents the first step in the RIT-T process⁷ in accordance with clause 5.16 of the National Electricity Rules (NER)⁸ and section 4.2 of the RIT-T Application Guidelines⁹.

This document describes:

- identified need that AusNet Services is seeking to address, together with the assumptions used in identifying this need;
- reasons for classifying the identified need as ‘reliability corrective action;’
- credible network options that may address the identified need;
- technical characteristics that would be required of a non-network option to address the identified need;
- assessment approach and scenarios AusNet Services is intending to employ for this RIT-T assessment; and
- specific categories of market benefits that are unlikely to be material in this RIT-T.

The need for investment to address risks from deteriorating assets is included in AusNet Services’ revenue proposal for the current regulatory control period (2017 to 2022)¹⁰. This specific investment need is also identified in AusNet Services Asset Renewal Plan, published as part of AEMO’s 2019 Victorian Transmission Annual Planning Report (VAPR)¹¹.

⁷ A RIT-T process will assess the economic efficiency and technical feasibility of proposed network and non-network options.

⁸ Australian Energy Market Commission, “National Electricity Rule version 141,” available at <https://www.aemc.gov.au/regulation/energy-rules/national-electricity-rules/current>, viewed on 6 June 2020.

⁹ Australian Energy Regulator, “Application guidelines Regulatory investment test for transmission,” available at https://www.aer.gov.au/system/files/AER%20-%20Final%20RIT-T%20application%20guidelines%20-%2014%20December%202018_0.pdf, viewed on 6 June 2020.

¹⁰ Australian Energy Regulator, “AusNet Services - Determination 2017-2022,” p. 42, available at <https://www.aer.gov.au/networks-pipelines/determinations-access-arrangements/ausnet-services-determination-2017%E2%80%932022/revise-proposal>, viewed on 6 June 2020.

¹¹ Australian Energy Market Operator, “Victorian Annual Planning Report,” available at <https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Planning-and-forecasting/Victorian-transmission-network-service-provider-role/Victorian-Annual-Planning-Report>, viewed on 6 June 2020.

2. Identified need

The Static Var Compensator (SVC) at HOTS plays an important role in the ongoing voltage control in the North West Victoria 220 kV transmission network. The condition of key assets and the quantification of the risk costs associated with the deterioration of assets are discussed in this section.

2.1. Network configuration

North West Victoria transmission network

Horsham is a city in the Wimmera region of Victoria, situated approximately 300 km from Melbourne near the Grampians National Park. HOTS is located four kilometres east of Horsham.

HOTS is connected to a 220 kV single-circuit transmission loop which also supplies terminal stations at Ballarat (BATS), Bendigo (BETS), Kerang (KGTS), Wemen (WETS) and Red Cliffs (RCTS) as shown in Figure 1. The North West Victoria 220 kV transmission loop provides connections to several generators including Waubra, Ararat, Crowlands, Murra Warra and Bulgana Wind Farms.

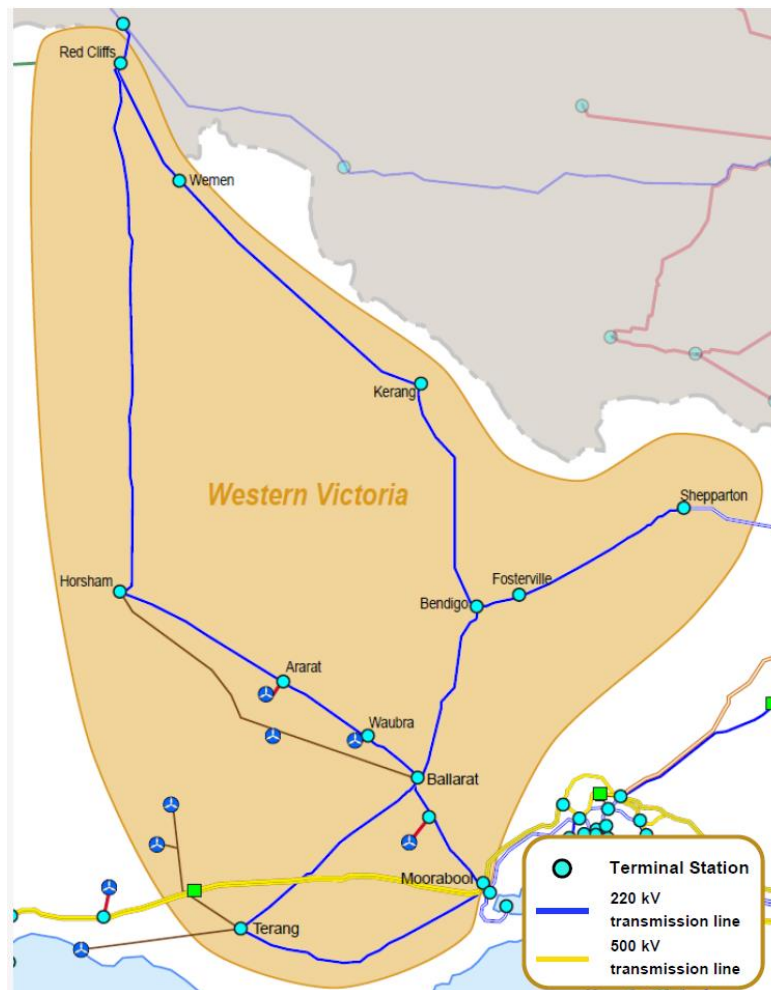


Figure 1 - North West Victoria transmission network

Horsham Terminal Station

HOTS supplies the Powercor 66 kV network via two 220/66 kV transformers. The following voltage and reactive power control assets are installed at HOTS:

- +50 MVar to -25 MVar 220 kV Static Var Compensator (SVC);
- Two 15 MVA 66 kV shunt reactors; and
- Three 15 MVA 66 kV shunt capacitors.

The shunt capacitors and reactors provide coarse and steady-state reactive support and the SVC provides dynamic voltage control at the 220 kV side of the terminal station. The switching of the shunt reactors and capacitors is managed by the SVC control so that there is always sufficient dynamic reactive reserve available to respond to network disturbances and contingency events.

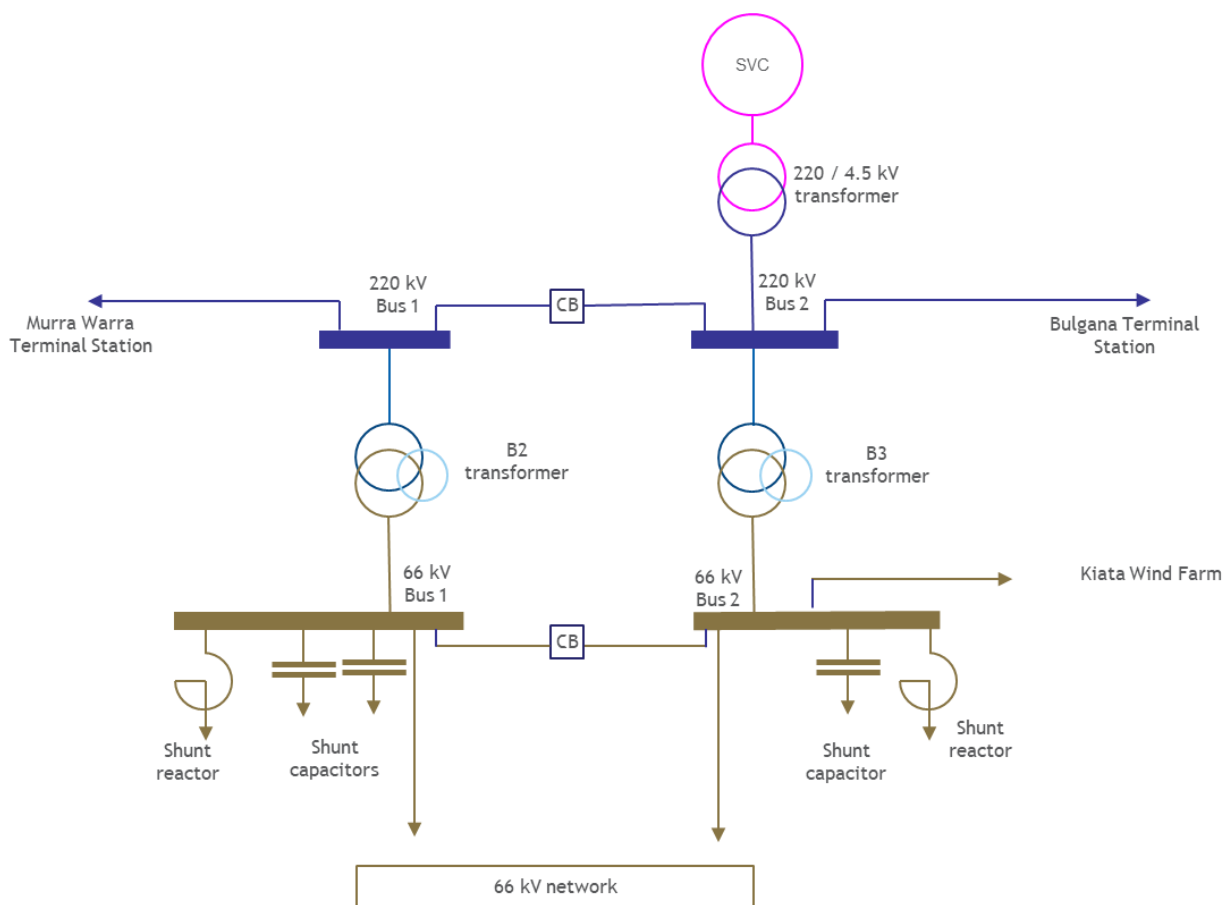


Figure 2 - HOTS single line diagram

2.2. HOTS SVC historical performance

The SVC and the capacitor banks at HOTS have been instrumental in controlling voltages to support demand in North West Victoria.

Figure 3 shows the actual reactive power generation and consumption of the HOTS SVC during calendar year 2019. The reactive power generation and absorption ranges from 26.5 MVar and -28.8 MVar during this period.

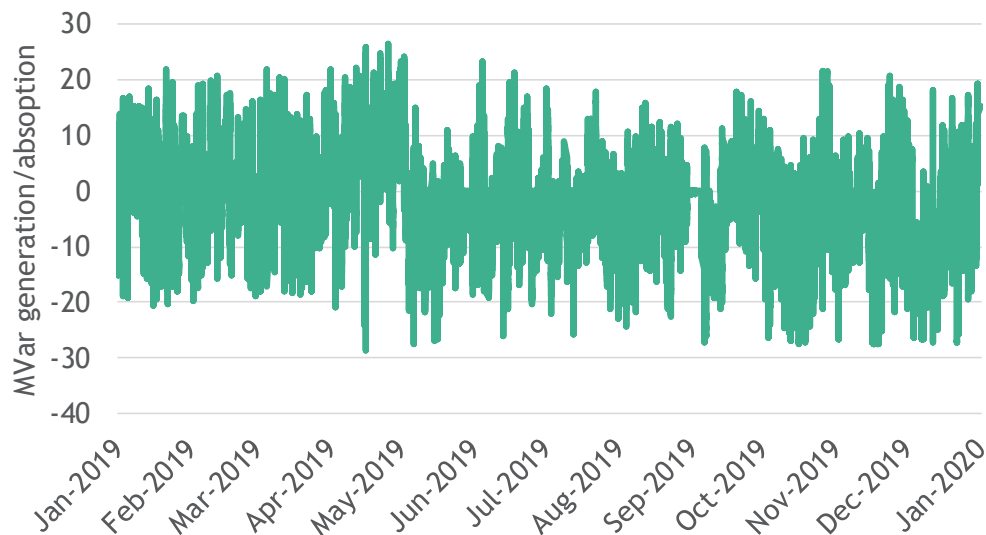


Figure 3 - Typical annual reactive power performance of SVC at HOTS

The 2019 Victorian Annual Planning Report (VAPR)¹², prepared by AEMO, assesses the network need for assets across the Victorian transmission system. AEMO reviews the network need for replacement of assets included in AusNet Services' Asset Renewal Plan and publishes the plan as an attachment to the VAPR. In relation to the HOTS SVC, AEMO notes that if this asset were to be retired, voltage could not be maintained within limits, and there would be reduced Murraylink export during outage of Western Victoria 220 kV lines.

2.3. Asset condition

In 2019, there have been two unplanned outages of the HOTS SVC with durations of 55 and 21 hours respectively. The number of forced outages is expected to rise as the SVC components continue to deteriorate with age and continued service.

AusNet Services classifies asset condition using scores that range from C1 (initial service condition) to C5 (extreme deterioration) - as set out in Appendix C.

In September 2019, AusNet Services conducted a full asset condition assessment of the SVC where all major components were evaluated across a range of criteria including: physical condition; spares availability; estimated rate of deterioration; and manufacturer support.

The assessment found that the SVC has deteriorated and most of the core components are in poor condition (C4) or in a state of extreme deterioration (C5) as expected of assets that have been in service for an extended time. Furthermore, with manufacturer support no longer available and scarcity of spare parts, the SVC is reaching the end of its serviceable life. With an overall weighted

¹² Australian Energy Market Operator, "Victorian Annual Planning Report," available at <https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Planning-and-forecasting/Victorian-transmission-network-service-provider-role/Victorian-Annual-Planning-Report>, viewed on 6 June 2020.

condition score of 4.28 out of 5, the SVC is not expected to remain in service longer than five years under the existing maintenance regime. No alternative maintenance strategies have been identified that would significantly reduce the failure rates or address the lack of manufacturer support.

For the affected components, the probabilities of failure are high, and likely to increase further if no remedial action is taken. Table 5 in Appendix D provides a summary of the condition of key components.

The overall condition score for the SVC and associated plant is presented in Table 1 and is a weighted average of the condition scores for the various components. The weighting factor for each component is derived based on the following four characteristics:

- Availability - the effect on the operation of the SVC for any component failure
- Reliability - based on the number of unplanned work orders associated with those components
- Maintainability - based on the duration of an outage to reinstate the SVC when that component fails
- Relative cost - based on the cost of the smallest element in that component.

Table 1 - Condition of the relevant SVC components

Component	Component condition score
Transformer	3
Transformer cooling	4
Primary plant - Reactors	5
Primary plant - Capacitor Cans	4
Primary plant - CTs & VTs	4
Secondary equipment	5
SVC - Thyristors	5
SVC - Controller	5
SVC - Cooling system	4
SVC - Heat exchanger	3
SVC - Building	4
Overall weighted condition score	4.28

2.4. Description of the identified need

AusNet Services has established there is an ongoing need for the dynamic voltage and reactive control services currently provided by the HOTS SVC. This support is required for ongoing voltage control as operational demand for electricity at Horsham is forecast to continue, at or above the current level, and renewable generation in North West Victoria continues to grow.

The deteriorating condition of the components of the SVC has increased the likelihood of asset failure and prolonged SVC outages resulting in:

- lack of dynamic reactive support services to respond to network disturbances and contingency events;
- voltages at HOTS and surrounding area being non-compliant with requirements outlined in the NER and Victorian Electricity System Code; and

- risk of increased costs resulting from emergency asset replacements and repairs.

Therefore, the ‘identified need’ this RIT-T intends to address is to maintain capability to control voltages and mitigate risk of increased costs resulting from an emergency asset replacement.

AusNet Services classifies the identified need as ‘reliability corrective action’¹³ to allow continued compliance with NER clause S5.1a.4.

2.4.1. Assumptions

AusNet Services has adopted several assumptions to quantify the risks associated with asset failure. These assumptions are detailed in the following subsections.

Voltage level requirements

Schedule 5.1a of the National Electricity Rules (NER) establishes system standards for the safe and reliable operation of the network including limits on changes in voltage levels at connection points during different network conditions. S5.1a.4 is reproduced below. This requirement is also reflected in Clause 110.2.2(a)¹⁴ of the Victorian Electricity System Code, which requires the same standard for voltage for levels at or above 100kV.

S5.1a.4 Power frequency voltage

Except as a consequence of a contingency event, the voltage of supply at a connection point should not vary by more than 10 percent above or below its normal voltage, provided that the reactive power flow and the power factor at the connection point is within the corresponding limits set out in the connection agreement. As a consequence of a credible contingency event, the voltage of supply at a connection point should not rise above its normal voltage by more than a given percentage of normal voltage for longer than the corresponding period shown in Figure S5.1a.1 for that percentage. As a consequence of a contingency event, the voltage of supply at a connection point could fall to zero for any period.

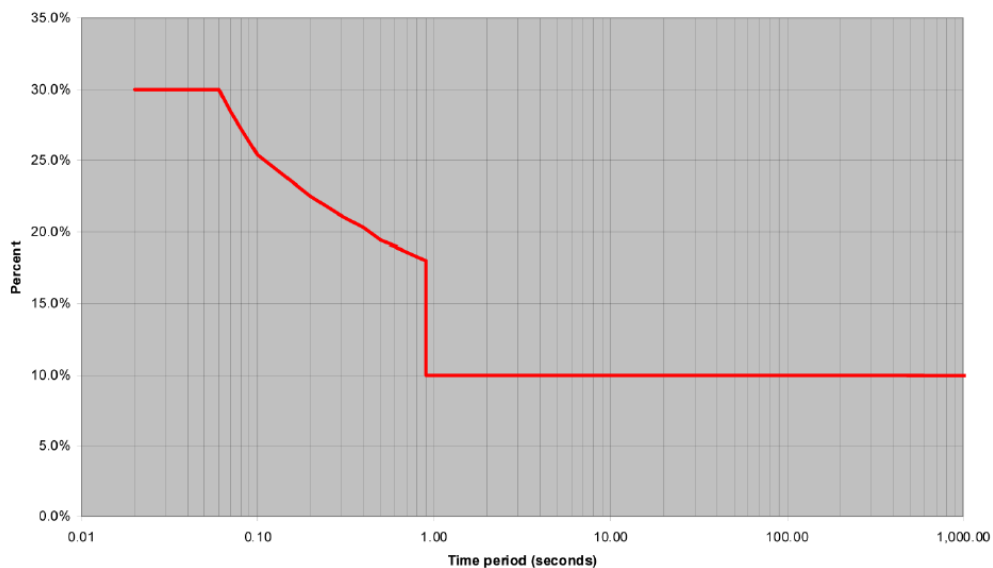


Figure 4 - Figure S5.1a.1 of NER

¹³ ‘NER 5.10.2 defines reliability corrective action as a network business’ investment in its network to meet ‘the service standards linked to the technical requirements of schedule 5.1 or in applicable regulatory instruments and which may consist of network options or non-network options.’ - Australian Energy Regulator, “Application guidelines Regulatory investment test for transmission,” available at https://www.aer.gov.au/system/files/AER%20-%20Final%20RIT-T%20application%20guidelines%20-%202014%20December%202018_0.pdf, viewed on 6 June 2020.

¹⁴ “A transmitter must use best endeavours to maintain the normal voltage level at each point of supply with a nominal voltage at or above 100kV within a range of plus or minus 10% of the voltage level nominated by VENCORP from time to time to the relevant transmitter and the relevant Participants which are supplied at that point of supply.” Office of the Regulator-General, Victoria, ‘Electricity System Code,’ available at <https://www.esc.vic.gov.au/sites/default/files/documents/3d1fc9fd-18e0-4e10-a87a-e68ba2151a1a.pdf>, viewed on 6 June 2020.

Failure rate and repair time

Condition assessment suggests that as the asset ages and deteriorates, the probability of failure and the time required to repair the asset and return to service will increase.

The SVC is a system that consists of several components including capacitors, reactors, thyristors, and secondary systems, that are operated together to dynamically generate or absorb reactive power. In an integrated system of this type, failure of one or more individual components will reduce or remove the capability of the system to provide the required service.

The Victorian transmission network contains only a few SVCs, hence, establishing an SVC-specific failure rate forecast that is statistically robust is not possible. Failure rates from the transformer asset class will be used as a proxy for this RIT-T.

Financial risk costs

There is an ongoing need for the services provided by the HOTS SVC. Hence, an emergency asset replacement would be required to continue the service should the asset fail. The emergency asset replacement would require immediate diagnosis, sourcing of spares, if available, from other sites, and mobilisation of staff on short notice, hence will involve higher costs than a planned replacement.

The failure rate-weighted emergency asset replacement cost (or undertaking reactive maintenance) has been estimated and is included in the assessment.¹⁵

Safety risk costs

The Electricity Safety Act 1998¹⁶ requires AusNet Services to design, construct, operate, maintain, and decommission its network to minimize hazards and risks to the safety of any person as far as reasonably practicable or until the costs become disproportionate to the benefits from managing those risks.

The transformer and transformer bushings associated with the SVC contains oil that is subject to explosive failure risk. AusNet Services uses the following factors to assess safety risks from explosive failure:

- a value of statistical life¹⁷ to estimate the benefits of reducing the risk of death;
- a value of lost time injury¹⁸; and
- a disproportionality factor¹⁹.

AusNet Services notes that this approach, including the use of a disproportionality factor, is consistent with the RIT-T Practice Notes²⁰ provided by the AER.

¹⁵ The assets are assumed to have survived and their condition-based age increases throughout the analysis period.

¹⁶ Victorian State Government, Victorian Legislation and Parliamentary Documents, "Energy Safe Act 1998," available at http://www.legislation.vic.gov.au/domino/Web_Notes/LDMS/LTObject_Store/ltobjst9.nsf/DDE300B846EED9C7CA257616000A3571/1D9C11F63DEBA5E2CA257E70001687F4/%24FILE/98-25aa071%20authorised.pdf, viewed on 6 June 2020.

¹⁷ Department of the Prime Minister and Cabinet, Australian Government, "Best Practice Regulation Guidance Note: Value of statistical life," available at <https://www.pmc.gov.au/resource-centre/regulation/best-practice-regulation-guidance-note-value-statistical-life>, viewed on 6 June 2020.

¹⁸ Safe Work Australia, "The Cost of Work-related Injury and Illness for Australian Employers, Workers and the Community: 2012-13," available at <https://www.safeworkaustralia.gov.au/system/files/documents/1702/cost-of-work-related-injury-and-disease-2012-13.docx.pdf>, viewed on 6 June 2020.

¹⁹ Health and Safety Executive's submission to the 1987 Sizewell B Inquiry suggesting that a factor of up to 3 (i.e. costs three times larger than benefits) would apply for risks to workers; for low risks to members of the public a factor of 2, for high risks a factor of 10. The Sizewell B Inquiry was public inquiry conducted between January 1983 and March 1985 into a proposal to construct a nuclear power station in the UK.

²⁰ Australian Energy Regulator, "Industry practice application note for asset replacement planning," available at <https://www.aer.gov.au/networks-pipelines/guidelines-schemes-models-reviews/industry-practice-application-note-for-asset-replacement-planning>, viewed on 6 June 2020.

Environmental risk costs

Environmental risks related to the potential release of transformer oil in the event of asset failure, is valued at \$30,000 per event.

3. Credible network options

AusNet Services will consider both network and non-network options to address the identified need resulting from the SVC at HOTS reaching end of serviceable life.

The two network options that AusNet Services has identified are presented below while the technical requirements that a non-network option would need to provide are detailed in the next chapter.

3.1. Option 1 - Replacement of the existing SVC with a modern equivalent SVC

Option 1 involves full replacement of all components, except for the 220/4.5 kV transformer, of the HOTS SVC in a single integrated project. The transformer will be refurbished to address rust and new radiators and cooling controls will be installed. A modern equivalent SVC is assumed in this option, with the same size at output voltage as the existing assets - i.e. (+50 MVar/-25 MVar). A new building for the new SVC is included in this option to minimise the impact on the network during installation phase.

The works will involve installing a new SVC including:

- system controllers;
- protection and control;
- primary plant;
- cooling system; and
- 415V supplies.

Implementing this option will improve the condition scores and significantly reduce the risk of asset failure.

The estimated nominal capital cost of this option is \$45.2 million (2019 dollars). AusNet Services is in the process of estimating the operating cost and will publish those assumptions as part of the PADR.

AusNet Services' preliminary analysis shows that the optimal timing to deliver this option is 2023/24.

3.2. Option 2 - Replacement of the SVC with a synchronous condenser

Option 2 involves replacing the SVC with a synchronous condenser in a new building. This option is expected to replace the current functionality of the SVC and provides additional flexible capability to control voltages.

This option could provide additional benefits by addressing the system strength gap declared by AEMO at Red Cliffs²¹, refer to section 5.4.

Implementing this option will improve the condition scores and significantly reduce the risk of asset failure.

This option is estimated to cost between \$30 to \$50 million based on publicly available information.

²¹ Australian Energy Market Operator, 'Notice of Victorian Fault Level shortfall at Red Cliffs,' available at https://www.aemo.com.au/-/media/Files/Electricity/NEM/Security_and_Reliability/System-Security-Market-Frameworks-Review/2019/Notice_of_Victorian_Fault_Level_Shortfall_at_Red_Cliffs.pdf, viewed on 6 June 2020.

ElectraNet's recent project to strengthen South Australia's Power System²² by installing four 129-MVAR new synchronous condensers at an estimated total cost of \$166 million is a source of relevant, cost information.

AusNet Services is in the process of procuring cost estimates for different sizes of synchronous condensers and will incorporate more accurate cost estimates in the next step of this RIT-T.

The optimal timing to deliver this option is not yet determined.

3.3. Options considered but not progressed

The following options are not considered credible:

- Retirement of the HOTS SVC - asset retirement would avoid emergency asset replacement cost and safety risk costs, however retiring the SVC would reduce the capability to manage ongoing requirements for voltage control as required by clause S5.1a.4 of the NER and clause 110.2.2(a) of the Victorian Electricity System Code. Therefore, the option of retiring the SVC has not been progressed.
- Options to remediate or refurbish the SVC do not materially reduce the failure rates as technology obsolescence continues to be a limiting factor, hence refurbishment option is not progressed further.
- Options utilising static capacitors and reactors are not considered credible as they do not provide the necessary dynamic support to respond to network disturbances and contingency events. Therefore, this option is not technically feasible.

3.4. Material inter-regional network impact

None of the credible network options being considered are likely to have a material inter-regional network impact. A 'material inter-regional network impact' is defined in the NER as:

"A material impact on another Transmission Network Service Provider's network, which may include (without limitation): (a) the imposition of power transfer constraints within another Transmission Network Service Provider's network; or (b) an adverse impact on the quality of supply in another Transmission Network Service Provider's network."

AEMO's screening test for material inter-network impact of a transmission investment is described as follows:²³

- a decrease in power transfer capability between transmission networks or in another TNSP's network of more than the minimum of 3% of the maximum transfer capability and 50 MW
- an increase in power transfer capability between transmission networks or in another TNSP's network of more than the minimum of 3% of the maximum transfer capability and 50 MW
- an increase in fault level by more than 10 MVA at any substation in another TNSP's network
- the investment involves either a series capacitor or modification in the vicinity of an existing series capacitor.

AusNet Services assessment of these criteria is that there is no material inter-regional network impact associated with any options considered.

²² ElectraNet, "Strengthening South Australia's power system," available at <https://www.electranet.com.au/what-we-do/projects/power-system-strength/>, viewed on 6 June 2020.

²³ Inter-Regional Planning Committee, "Final Determination: Criteria for Assessing Material Inter-Network Impact of Transmission Augmentations," available at <https://www.aemo.com.au/-/media/Files/PDF/170-0035-pdf.pdf>, viewed on 6 June 2020.

4. Non-network options

AusNet Services welcomes proposals from proponents for non-network options that could be implemented on a stand-alone basis or in conjunction with a network option to meet or contribute to meeting the identified need described in this RIT-T. AusNet Services will evaluate proposed non-network options based on their economic and technical feasibility.

4.1. Required technical characteristics of a non-network option

A credible non-network option requires the capacity to generate or absorb reactive power and respond dynamically to voltage fluctuations arising from disturbance or disruption in the network. The proposed option must be continuously available except for reasonable periods when maintenance must be carried out. Figure 5 provides the operating profile of the SVC during 2019 as an indication of the service provided by the existing assets.

AusNet Services is seeking proposals for non-network solutions with capability equivalent to the existing SVC (+50 MVar/-25 MVar). Details demonstrating the capability of the technology should be provided. Proposals may include (but are not limited to) embedded generators, or energy storage (including battery systems) that are capable of injecting or absorbing reactive power into the grid to control voltage.

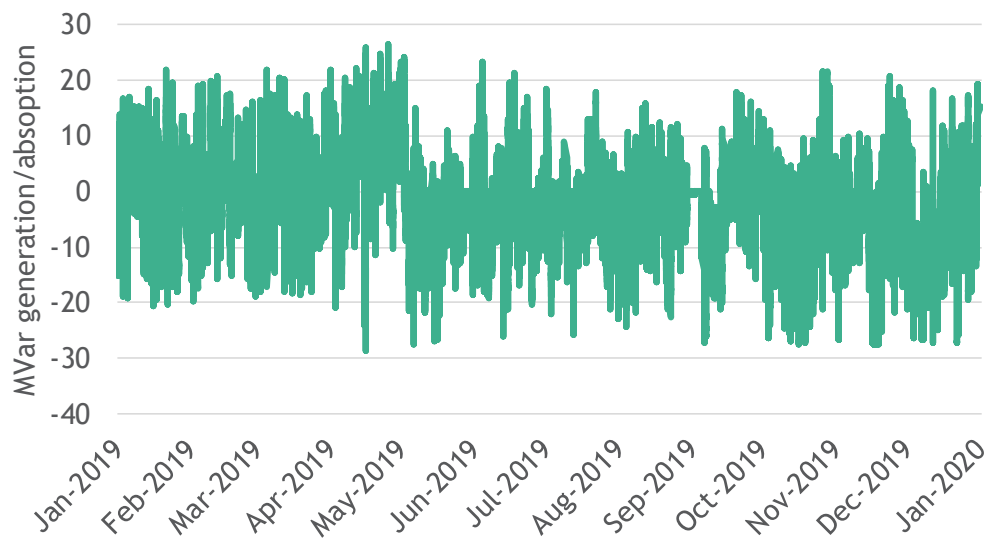


Figure 5 - Typical annual reactive power performance of SVC at HOTS

Whilst this section provides basic information that proponents of non-network solutions could use to evaluate their proposals, AusNet Services invites a collaborative approach and is open for discussions to maximise the potential benefits from non-network options.

4.2. Information to be included in non-network solution proposals

Table 2 shows the relevant parameters that must be included in any proposal for a non-network solution.

Table 2 - Required information that a proponent of non-network option must submit

Parameter	Description and requirements
Location	The non-network option is preferred to be in locations connected to HOTS. However, AusNet Services will consider other locations that proponents of non-network options may suggest.
Availability period	The non-network option is required to be continuously available except for reasonable periods when maintenance must be carried out.
Fee structure	All fees related to the establishment and operation of the proposed non-network option.
Control specification	AusNet Services prefers that the proposed non-network option is implemented under voltage control mode.
Delivery time	The proposed non-network option must be operational before 2023/24.
Any other requirements	e.g. terms of commitment and length of service.

Proposals for non-network solutions should be emailed to ritconsultations@ausnetservices.com.au by 3 September 2020.

5. Assessment approach

Consistent with the RIT-T requirements and RIT-T Practice Notes²⁴ on risk-cost assessment methodology, AusNet Services will undertake a cost-benefit analysis to evaluate and rank the net economic benefits of various credible options.

AusNet Services proposes to undertake this assessment over the 40-year²⁵ life of the proposed assets for the network options described.

All options considered will be assessed against a business-as-usual case where no proactive capital investment is made and the existing maintenance regime continues.

Optimal timing of an investment will be the year when the annual benefits from implementing the option become greater than the annualised investment costs.

5.1. Proposed input assumptions and sensitivity analysis

The investment decision will be tested using a current commercial discount rate²⁶ of 5.9%, the estimated capital and operating costs of the options, and the central estimate for financial risk costs.

Sensitivity analysis

The robustness of the net economic benefits and the optimal timing of the options considered will be tested using sensitivity analysis. This analysis involves variations of assumptions on the failure rates, financial risk costs, capital costs, and discount rate.

5.2. Materiality of classes of market benefits

The options currently identified in this RIT-T are not expected to have a material impact on the wholesale electricity market and therefore the following classes of market benefits set out in NER clause 5.16.1(c)(4) will not be included in this analysis.²⁷ Details of the high level assessment for excluding these classes of market benefits are provided in the following points:

- Changes in involuntary load shedding - The operational demand at HOTS is not sufficiently large that any of the options considered would pose material risk of load shedding due to prolonged under-voltages.
- Changes in voluntary load curtailment - There is no material impact on the wholesale electricity market prices that may trigger voluntary load curtailment.
- Changes in fuel consumption arising through different patterns of generation dispatch - The credible options considered will not differently impact the dispatch of generation in the wholesale electricity market.
- Change in network losses - Changes in network losses are estimated to be small and unlikely

²⁴ Australian Energy Regulator, "Industry practice application note for asset replacement planning," available at <https://www.aer.gov.au/networks-pipelines/guidelines-schemes-models-reviews/industry-practice-application-note-for-asset-replacement-planning>, viewed on 6 June 2020.

²⁵ Australian Energy Regulator, "ElectraNet - Main grid system strength contingent project Supporting Information - GHD Advisory - MGSS Contingent Project - Economic Life Advice - 28 June 2019," available at <https://www.aer.gov.au/networks-pipelines/determinations-access-arrangements/contingent-projects/electranet-main-grid-system-strength-contingent-project/initiation>, viewed on 6 June 2020.

²⁶ Energy Networks Australia, "RIT-T Economic Assessment Handbook," available at <https://www.energynetworks.com.au/resources/fact-sheets/rit-t-economic-assessment-handbook/>, viewed on 6 June 2020.

²⁷ Australian Energy Regulator, "Application guidelines Regulatory investment test for transmission," p32, available at https://www.aer.gov.au/system/files/AER%20-%20Final%20RIT-T%20application%20guidelines%20-%202014%20December%202018_0.pdf, viewed on 6 June 2020.

to be a material class of market benefits for any of the credible options.

- Competition benefits - Quantifying the impact of the credible options on the bidding behaviour would involve a disproportionate level of effort compared to the additional insight it would provide. Therefore, this class of market benefit will be excluded from this RIT-T.
- Option value - as any of the credible options considered does not avoid risk of stranded assets nor provide any flexibility on further investments, option value is not material to the identification of the preferred option for this RIT-T.

5.3. Other classes of benefits

AusNet Services expects that a material reduction in the risk costs from the need for emergency asset replacements and repairs will result from any of the credible options identified in this RIT-T. The treatment of this risk cost saving in the RIT-T analysis is aligned with the RIT-T Practice Notes²⁸ published by the Australian Energy Regulator (AER).

5.4. Interaction with other planning processes

In December 2019 AEMO declared a fault level shortfall²⁹ of 312 MVA at the Red Cliffs fault level node in Victoria., In the role of jurisdictional planning body for the Victorian region, AEMO has the responsibility to procure services to fill the fault level shortfall and will use reasonable endeavours to address the fault level shortfall by 1 January 2021. A process has commenced to procure short term services and AEMO has signaled the intention to issue an Invitation to Tender for longer term solutions.

Long term solutions to remediate the fault level shortfall could include installation of one or more synchronous condensers at various locations in the network including at HOTS.

AusNet Services will work closely with AEMO to understand the interactions between the identified needs in each of these processes and ensure than an efficient solution results.

²⁸ Australian Energy Regulator, "Industry practice application note for asset replacement planning," available at <https://www.aer.gov.au/networks-pipelines/guidelines-schemes-models-reviews/industry-practice-application-note-for-asset-replacement-planning>, viewed on 6 June 2020.

²⁹ Australian Energy Market Operator, 'Notice of Victorian Fault Level shortfall at Red Cliffs,' available at https://www.aemo.com.au/-/media/Files/Electricity/NEM/Security_and_Reliability/System-Security-Market-Frameworks-Review/2019/Notice_of_Victorian_Fault_Level_Shortfall_at_Red_Cliffs.pdf, viewed on 6 June 2020.

Appendix A - RIT-T assessment and consultation process

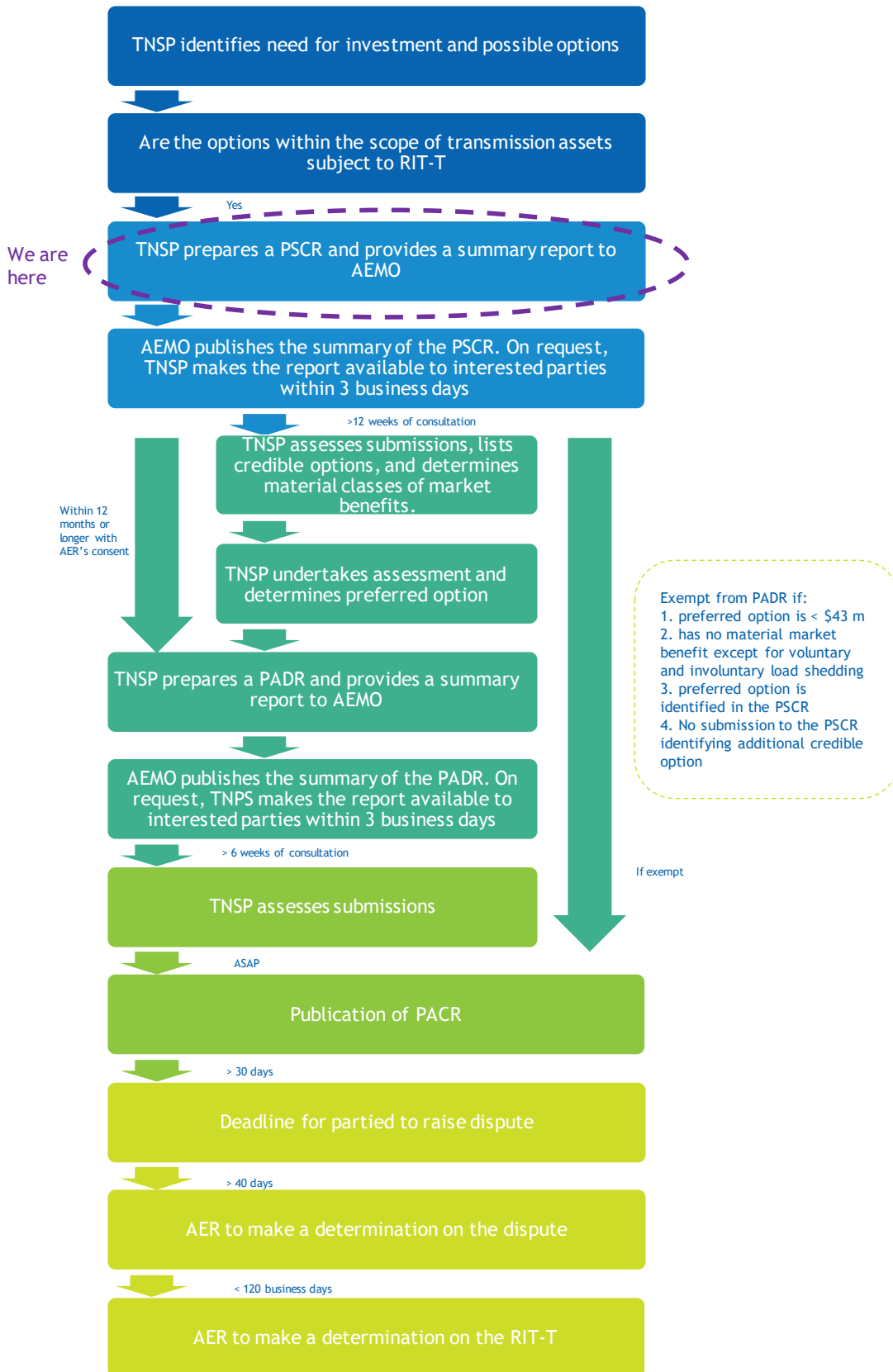


Figure 6 - RIT-T process

Appendix B - Checklist of compliance clauses

The table below demonstrates the compliance of this PSCR with the requirements of clause 5.16.4(b) of the National Electricity Rules version 135³⁰, which states that a RIT-T proponent must prepare a PSCR which must include:

Table 3 - Summary of requirements

Requirement	Relevant section
(1) a description of the identified need;	2
(2) the assumptions used in identifying the identified need (including, in the case of proposed reliability corrective action, why the RIT-T proponent considers reliability corrective action is necessary);	2
(3) the technical characteristics of the identified need that a non-network option would be required to deliver, such as: (i) the size of load reduction of additional supply; (ii) location; and (iii) operating profile;	4
(4) if applicable, reference to any discussion on the description of the identified need or the credible options in respect of that identified need in the most recent National Transmission Network Development Plan;	5
(5) a description of all credible options of which the RIT-T proponent is aware that address the identified need, which may include, without limitation, alternative transmission options, interconnectors, generation, demand side management, market network services or other network options;	3
(6) for each credible option identified in accordance with subparagraph (5), information about: (i) the technical characteristics of the credible option; (ii) whether the credible option is reasonably likely to have a material inter-network impact; (iii) the classes of market benefits that the RIT-T proponent considers are likely not to be material in accordance with clause 5.16.1(c)(6), together with reasons of why the RIT-T proponent considers that these classes of market benefit are not likely to be material; (iv) the estimated construction timetable and commissioning date; and (v) to the extent practicable, the total indicative capital and operating and maintenance costs.	3 and 5
A RIT-T proponent is exempt from paragraphs (j) to (s) if: 1. the estimated capital cost of the proposed preferred option is less than \$43 million (as varied in accordance with a cost threshold determination); 2. the relevant Network Service Provider has identified in its project specification consultation report: (i) its proposed preferred option; (ii) its reasons for the proposed preferred option; and (iii) that its RIT-T project has the benefit of this exemption;	Not applicable

³⁰ Australian Energy Market Commission, "National Electricity Rule version 141," available at <https://www.aemc.gov.au/regulation/energy-rules/national-electricity-rules/current>, viewed on 6 June 2020.

Requirement	Relevant section
<p>3. the RIT-T proponent considers, in accordance with clause 5.16.1(c)(6), that the proposed preferred option and any other credible option in respect of the identified need will not have a material market benefit for the classes of market benefit specified in clause 5.16.1(c)(4) except those classes specified in clauses 5.16.1(c)(4)(ii) and (iii), and has stated this in its project specification consultation report; and</p> <p>4. the RIT-T proponent forms the view that no submissions were received on the project specification consultation report which identified additional credible options that could deliver a material market benefit.</p>	

Appendix C - Asset condition framework

AusNet Services uses an asset health index, on a scale of C1 to C5, to describe asset condition. The condition range is consistent across asset types and relates to the remaining service potential. The table below provides an explanation of the asset condition scores used.

Table 4 - Condition scores framework

Condition score	Likert scale	Condition description	Recommended action	Remaining service potential (%)
C1	Very Good	Initial service condition	No additional specific actions required, continue routine maintenance and condition monitoring	95
C2	Good	Better than normal for age		70
C3	Average	Normal condition for age		45
C4	Poor	Advanced deterioration	Remedial action or replacement within 2-10 years	25
C5	Very Poor	Extreme deterioration and approaching end of life	Remedial action or replacement within 1-5 years	15

Asset failure rates

AusNet Services uses the hazard function of a Weibull two-parameter distribution to estimate the probability of failure of an asset in a given year. The asset condition scores are used to establish a condition-based age which is used to calculate the asset failure rates using a two-parameter Weibull Hazard function ($h(t)$), as presented below.

$$h(t) = \beta \cdot \frac{t^{\beta-1}}{\eta^\beta}$$

Equation 1: Weibull Hazard Function

where:

t = Condition-based age (in years)

η = Characteristic life (Eta)

β = Shape Parameter (Beta)

Hazard functions are defined for the major asset classes including power transformers, circuit breakers, and instrument transformers. All assets in the substation risk-cost model use a Beta (β) value of 3.5 to calculate the failure rates. The characteristic life represents that average asset age at which 63% of the asset class population is expected to have failed.

The condition-based age (t) depends on the specific asset's condition and characteristic life (η).

Appendix D - Summary of major component condition

Table 5 - Summary of major component condition

Component	Condition
Capacitor cans	Several cans have signs of bulging due to electrical stress and ageing
Current transformers	The current transformer on the 3rd harmonic filter is suffering from leakage and is at C4 condition. There are limited spares from other sites.
Voltage transformers	There is no VT voltage monitoring to pre-determine failure
Cable insulations	Cable insulations have signs of deep cracks and need replacement as soon as practicable
Switchyard marshalling boxes	Rusting switchyard marshalling boxes
Reactor	Three reactors are in a developed state of deterioration due to: <ul style="list-style-type: none"> • Degradation of the surface coating of the reactors • Reactors are no longer supported by the manufacturer, Spiezelektra which was bought out by Trench in the 1990s • Limited access between layers prevents repairs to reactors • 9 to 12 months replacement time for damaged air-core reactors.
Insulator support	Cracks on insulator support, Thyristor-switched Capacitor (TSC) wall bushings, and Thyristor-controlled Reactor (TCR) wall bushings are evident
Transformers and cooling system	Rust and oil spill observed in transformers and cooling system
Filter circuit breakers	Obsolete but replaceable Filter circuit breakers
Thyristors and capacitor banks	Thyristors and the capacitor banks are in very poor and deteriorating condition (C5). Replacements at other SVC installations have been completed recently. Reasonable spares are available but will take time to install.
Cooling system equipment	Obsolete cooling system equipment, some motor control components may be replaceable.
Controller cubicle cards	The electronic card supports are brittle due to age and exposure to high temperature. When these supports fail, the thyristor controls can short out between groups and cause more damage and failures. There is no spare for SVC controller cubicle cards.
Thyristor relays	Rotating spares from Thyristor relays
Thyristor building	Thyristor building requires extensive refurbishment