AusNet Electricity Services Pty Ltd

Contingent Project Application – Tranche 3

Bushfire Mitigation

Submitted: 31 May 2019

About AusNet Services

AusNet Services is a major energy network business that owns and operates key regulated electricity transmission and electricity and gas distribution assets located in Victoria, Australia. These assets include:

- An electricity transmission network that services all electricity consumers across Victoria. We do this via 55 terminal stations, 13,000 transmission towers and 6,600 kilometres of high-voltage transmission powerlines.;
- An electricity distribution network delivering electricity to more than 740,000 customers in eastern Victoria. We do this via more than 45,000 kilometres of overhead and underground powerlines and 335,000 power poles; and
- A gas distribution network delivering gas to approximately 690,000 customer supply points in central and western Victoria. We do this via 11,400 kilometres of underground gas pipelines.

AusNet Services' purpose is 'to provide our customers with superior network and energy solutions.' The AusNet Services company values are:

- We work safely
- We do what's right
- We're one team
- We deliver

For more information visit: www.ausnetservices.com.au

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1 Executive summary

1.1 Overview

The installation of Rapid Earth Fault Current Limiters (**REFCL**) technology is delivering bushfire mitigation benefits to Victoria and our customers. The program is a world first in using REFCL technology to mitigate bushfire risk, in accordance with the bushfire mitigation regulations (the **Regulations**)[1].

The REFCL Program is being delivered in three Tranches to align with compliance dates of 1 May 2019, 1 May 2021 and 1 May 2023, as set out in the Regulations.

Our understanding of the technical and operational challenges of the REFCL technology continues to improve as the Tranche 1 compliance deadline has been achieved, [C-I-C

C-I-C] Updates on Tranche 1 and 2 are set out in section 5.

We continue to work closely with Energy Safe Victoria (**ESV**) to mitigate bushfire risk and appropriately address the technical issues encountered in Tranche 1.

1.2 Tranche 3 contingent project application

This document is AusNet Services' contingent project application in relation to Tranche 3 of the REFCL Program and provides a detailed explanation of the expenditure required to complete this final tranche of the program. The application is being made to the Australian Energy Regulator (**AER**) in accordance with the National Electricity Rules (**Rules**) and the AER's 2016-2020 regulatory determination for AusNet Services.

AusNet Services submits that capital expenditure (**capex**) of $105.5 million (real $2015) and operating expenditure (**opex**) of $3.3 million (real $2015) is the prudent and efficient cost of undertaking this program of works over the remainder of the current regulatory control period and into the 2021-25 period. This contingent project application explains the measures AusNet Services has taken to ensure the project scope and costings comply with the prudency and efficiency requirements in the Rules.

The lessons learnt to date from Tranches 1 and 2 have been reflected in the scope of works and costing for the Tranche 3 zone substations and their respective networks. As explained in our contingent project applications for Tranches 1 and 2, the scope of work varies according to the particular characteristics at each zone substation and their associated network. This remains the case for the remaining 5 zone substations that comprise Tranche 3. The functional scope of work for each zone substation is summarised in the attachments that accompany this contingent project application.

Tranche 3 costs are higher, per zone substation, than in Tranche 1 and 2 due to a number of factors including single REFCL zone substations compared to dual REFCL zone substations, incorporation of learnings from Tranche 1 and 2 and the unique characteristics of the Tranche 3 zone substations and their associated networks. In particular, Kalkallo zone substation presents challenges in terms of the network capacitance levels and the implications for the operation of REFCLs.

[1] *Electricity Safety (Bushfire Mitigation) Regulations 2013* as amended on 1 May 2016 by the *Electricity Safety (Bushfire Mitigation) Amendment Regulations 2016*

AusNet Services is actively managing the costs of the REFCL program to ensure it is delivered in a prudent and efficient manner. In relation to the scope of work for Tranche 3, our forecasts include savings from technical scope exemption requests that we propose to submit. These exemptions ensure that the necessary safety and bushfire mitigation benefits are achieved while minimising required expenditure.

As explained in our contingent project applications for Tranches 1 and 2, AusNet Services is continuing to work closely with Powercor Australia (**Powercor**) so that both companies can benefit from an improved understanding of the technology and its operation on the network, together with efficient practice. This cooperative approach delivers customer benefits by achieving the benefits of bushfire risk reduction as efficiently as possible.

AusNet Services is confident the expenditure forecasts in this contingent project application comply with the requirements of the Rules. Accordingly, these expenditure forecasts are recommended for acceptance by the AER for the purpose of amending the 2016-20 revenue determination to enable AusNet Services to recover the cost of this contingent project. As Tranche 3 will not be completed until 2023, the AER's decision in relation to this contingent project application will also be reflected in AusNet Services' revenue proposal for the 2021-25 regulatory control period.

1.3 Summary of expenditure and revenue requirements

The amended revenue requirements reflect the expenditure forecasts set out in Table 1 below.

Table 1 Expenditure summary – Current Period ($m, 2015)

	2016	2017	2018	2019	2020	Total
Capital Expenditure	-	-	0.2	9.5	32.1	41.9
Operating Expenditure	-	-	-	-	0.03	0.03

Source: AusNet Services

Table 2 below shows the expenditure forecasts for the 2021-25 regulatory control period.

Table 2 Expenditure summary – 2021-25 Period ($m, 2015)

	2021	2022	2023	2024	2025	Total
Capital Expenditure	39.0	24.6	-	-	-	63.6
Operating Expenditure	0.4	0.4	0.8	0.8	0.8	3.3

Source: AusNet Services

The table below shows the building block elements that comprise the incremental revenue requirement for the contingent project over the 2016-20 regulatory control period.

Table 3 Contingent project revenue requirement, 2016-20 ($m, nominal)

	2016	2017	2018	2019	2020	Total
Return on capital	-	0.0	0.0	0.0	0.7	0.8
Regulatory depreciation	-	-0.0	-0.0	-0.1	0.1	0.1
Operating expenditure	-	0.0	0.0	0.0	0.0	0.0
Revenue adjustments	-	-	-	-	-	-
Net tax allowance	-	-0.0	-0.0	-0.0	-0.0	-0.1
Annual revenue requirement (unsmoothed)	**-**	**0.01**	**0.01**	**-0.1**	**0.8**	**0.8**
Annual revenue requirement (smoothed)	**-**	**-**	**-**	**-**	**0.8**	**0.8**

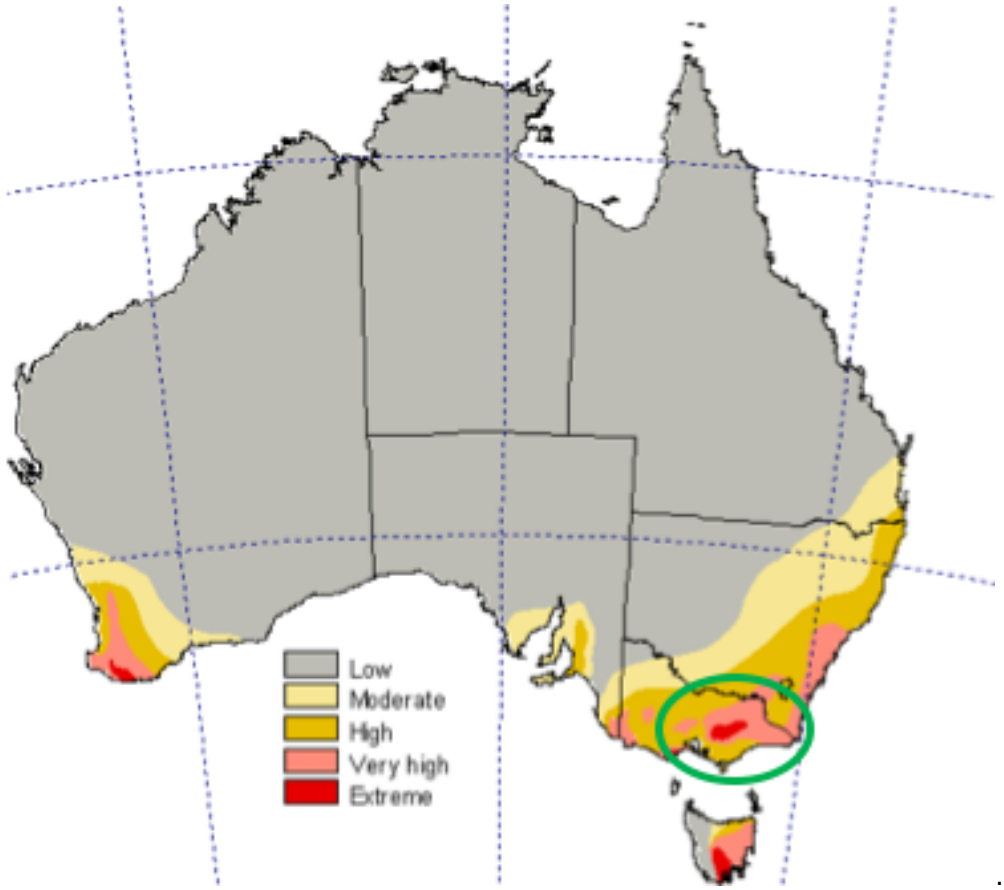
Source: AusNet Services PTRM

2 Background and regulatory framework

2.1 Bushfire risk

AusNet Services' network operates in a geographical location which is exposed to extreme bushfire risk. These conditions warrant significant investment to mitigate the bushfire risk.

Figure 1: AusNet Services' extreme bushfire risk



Following the 2009 bushfires, the Victorian Bushfire Royal Commission (**VBRC**) was established and the recommendations made by the VBRC drove changes to the Regulatory Regime (as described below) that ultimately have led to the roll-out of the REFCL technology.

2.2 Regulatory Regime

The AusNet Services REFCL program is necessary to comply with the bushfire safety obligations imposed by the Victorian Government (**Government**) and is governed by a number of regulatory instruments. The regulatory framework has evolved and has become increasingly prescriptive over time and strict penalties for non-compliance are in place.

Each of the key regulatory instruments is described below.

2.2.1 Victorian Bushfire Royal Commission

The 2009 VBRC made several recommendations with respect to fires originating from electricity networks. Recommendation 27 called for new technology that delivered greatly reduced

bushfire risk, being applied to all overhead conductors (Single Wire Earth Return (**SWER**) and 22kV powerlines) in hazardous bushfire risk areas. The VBRC also suggested an expert taskforce be established to advise on the best means of achieving the intent of this recommendation. The Powerline Bushfire Safety Taskforce (**PBST**) was established for this purpose.

2.2.2 Powerline Bushfire Safety Taskforce

The PBST made its report to Government in September 2011 in which it recommended that the risk of powerlines starting bushfires could be reduced by:

- Installing REFCLs on selected 22kV powerlines to reduce the risk of polyphase powerlines starting fires by automatically reducing the electric current in some types of powerline faults;
- Installing remotely controlled Automatic Circuit Reclosers (**ACRs**) on SWER lines to reduce the risk of SWER lines starting fires by enabling the devices to be set remotely so that they turn off those powerlines quickly when faults occur; and
- Putting powerlines underground or insulating conductors in the areas of highest bushfire risk.

The PBST also indicated the need for further research and development, noting REFCLs had not previously been used for bushfire suppression. In December 2011, the Government accepted the Taskforce's recommendations and established the Powerline Bushfire Safety Program to determine the optimal method for deploying REFCLs for bushfire prevention. REFCL trials were subsequently conducted at Frankston South and Kilmore South zone substations.

2.2.3 REFCL – Regulatory impact statement

A Regulatory Impact Statement (**RIS**) was prepared by the consulting firm, ACIL Allen, on behalf of the Victorian Department of Economic Development, Jobs, Transport and Resources,[2] on the Government's proposal to mandate new fault suppression standards through the *Electricity Safety (Bushfire Mitigation) Regulations 2013*. The RIS assessment incorporated a cost-benefit analysis indicating that the estimated costs of deploying REFCLs would be more than outweighed by the reliability and bushfire risk reduction benefits.

The RIS recommended the installation of REFCLs at 45 zone substations across Victoria of which 22 zone substations form part of AusNet Services' network.

2.2.4 Electricity Safety (Bushfire Mitigation) Amendment Regulations 2016

Following the completion of the RIS process, the Government made the *Electricity Safety (Bushfire Mitigation) Amendment Regulations 2016* which amend the *Electrical Safety (Bushfire Mitigation) Regulations 2013*.

The amended Regulations require that each polyphase electric line originating from the 45 specified zone substations must have the following capability in the event of a phase to ground fault:

[2] ACIL Allen Consulting, *Regulatory Impact Statement – Bushfire Mitigation Regulations Amendment*, 17 November 2015. Available at http://www.acilallen.com.au/cms_files/ACILAllen_BushfireMitigationRIS_2015.pdf

a) reduce the voltage on the faulted conductor in relation to the station earth when measured at the corresponding zone substation for high impedance faults to 250 volts within 2 seconds; and

b) reduce the voltage on the faulted conductor in relation to the station earth when measured at the corresponding zone substation for low impedance faults to —

(i) 1,900 volts within 85 milliseconds; and

(ii) 750 volts within 500 milliseconds; and

(iii) 250 volts within 2 seconds; and

c) during diagnostic tests for high impedance faults, limit —

(i) fault current to 0.5 amps or less; and

(ii) the thermal energy on the electric line to a maximum I^2t value of 0.1. [3]

The practical effect of the amendment is to impose an obligation on AusNet Services to install REFCLs (or equivalent technology) at the 22 zone substations specified in the regulations by 1 May 2023.

The Regulations use a scoring system to establish milestones for completing the required works. Each zone substation is attributed a point score from 1 to 5, with the highest value attributed to those zone substations where fire mitigation measures would provide the greatest benefit.

AusNet Services is required to complete the works necessary in order to accumulate:

- 30 points by 1 May 2019;
- 55 points by 1 May 2021; and
- 64 points by 1 May 2023.

2.2.5 Electricity Safety Amendment (Bushfire Mitigation Civil Penalties Scheme) Act 2017

The Victorian Government subsequently introduced legislation[4] which amended the *Electricity Safety Act 1998* (Vic) (**ESA**) to provide for significant financial penalties if AusNet Services fails to achieve the number of points prescribed by the Regulations by the applicable deadline.

The Act fixes a maximum penalty of $2,000,000 per point that AusNet Services falls short of the prescribed number of points. Each zone substation is assigned a number of points (up to 5) depending on the degree of bushfire risk. Accordingly, penalties of up to $10 million per zone substation can apply if AusNet Services fails to achieve the Required Capacity by the prescribed dates. Additionally, a daily penalty of $5,500 can be applied for each day AusNet Services remains non-compliant.

AusNet Services could incur significant financial penalties if it fails to meet its obligations under the ESA. Additionally, the ESA:

- Requires AusNet Services to prepare annual compliance reporting and associated independent audit; and
- Empowers ESV to request audits and information.

[3] Other performance requirements are also specified in the definition of 'required capacity' in the *Electricity Safety (Bushfire Mitigation) Amendment Regulations 2016*.

[4] *Electricity Safety Amendment (Bushfire Mitigation Civil Penalties Scheme) Act 2017* (Vic).

2.2.6 Electricity Safety (Bushfire Mitigation Duties) Regulations 2017

The *Electricity Safety (Bushfire Mitigation Duties) Regulations 2017* supports the amendments made to the ESA by prescribing:

- The performance ability that every polyphase electric line originating from a prescribed zone substation is required to have;
- The zone substations at which the required capacity is to be installed; and
- The points allocated to each substation for the purpose of meeting the milestones for installation.

2.2.7 Energy Safe Victoria's Administration Policy

ESV has a policy[5], outlining how it intends to administer its audit and information gathering powers to ensure that appropriate regulatory oversight and assurance is achieved. The policy also outlines the penalty scheme associated with failing to comply with the additional bushfire mitigation duties. The topics covered include:

- The exemption request process;
- The modification of later dates and periods for compliance;
- Information notices; and
- Audit by ESV.

2.2.8 Exemptions and extensions

The ESA allows for exemptions or extensions to be granted in relation to certain obligations set out in the Act and the Regulations. In September 2017, ESV clarified its expectations for applications for an exemption. ESV has outlined a rigorous set of requirements for any exemption request, including:[6]

- The applicant must demonstrate the risk of granting the exemption to be equivalent to or less than the risk without the exemption;
- In deciding whether to grant an exemption, ESV will be informed by the Risk Reduction Model;
- Safety outcome under an exemption must be maintained or enhanced compared to strict compliance; and
- The application must be specific (no blanket exemptions) and set out:
    - Zone substation and feeders highest level;
    - Design philosophy to be applied; and
    - Specific technologies to be deployed.

Exemptions

During 2018, AusNet Services utilised the exemption process to obtain technical scope exemptions in relation to the installation of isolating transformers to isolate certain High Voltage

[5] Electricity Safety Amendment (Bushfire Mitigation Civil Penalties Scheme) Act 2017 – Energy Safe Victoria's Administration Policy.

[6] Process for the Administration of Exemption Requests, Powerpoint Presentation, ESV, September 2017.

(**HV**) customers from REFCL operations on certain feeders. The technical scope exemptions were granted by the Governor in Council on the short sections of underground cable (polyphase electric line) between the isolating transformer and the HV customer's connection point as these polyphase electric lines are not REFCL enabled.

Tranche 2 & 3 exemptions

AusNet Services anticipates submitting further exemption requests to ESV. These are intended to ensure a cost effective delivery of the REFCL program whilst still achieving the safety improvements necessary to mitigate bushfire risk.

The scope of Tranche 3 includes the installation of a number of isolating transformers to isolate sections of the network from REFCL operations in order to reduce network capacitance. Technical exemptions will be prepared to support the installation of these isolating transformers.

Deferral of commencement of Initial Period

On 15 April 2019, AusNet Services wrote to ESV to request that ESV specify a later date for the commencement of the Initial Period, being the date by which AusNet Services must achieve the prescribed number of points for complying substations (the 'extension of time' request). ESV is still considering AusNet Services' request.

2.2.9 Victorian Electricity Distribution Code

In 2018, the Essential Services Commission (**ESC**) reviewed the voltage standards specified in the Victorian Electricity Distribution Code (**EDC**). The purpose of the review was to ensure that the EDC was fit for purpose in light of the introduction of REFCL equipment. In particular, it was recognised that when REFCLs are commissioned, tested or used to respond to a fault, they are likely to increase voltage levels at High Voltage (**HV**) customers' connection points beyond the allowable range specified in the EDC.

The ESC's final decision[7] on its voltage review introduced a new table of voltage variation limits in the EDC that are only applicable when REFCLs operate in accordance with an approved mode, which includes the commissioning, testing and maintenance of a REFCL. The ESC retained the previous phase-to- earth and phase-to-phase voltage variation limits when REFCLs are not operating.

As a result of the new EDC provisions, HV customers are now responsible for upgrading their HV electrical assets to accommodate the permitted voltage variations when REFCLs operate in approved mode. It is noted that the Victorian Government has developed a High Voltage Customer Assistance Program (**HCAP**) that includes assistance measures for affected high voltage customers.

AusNet Services is also providing support to HV customers to ensure that their HV electrical assets can either withstand, or be isolated from, REFCL operations.. Whilst we recognise the need to manage the costs of providing support to HV customers, it is prudent and efficient to ensure that customers have a good understanding of the required works and the actions required in order to be EDC compliant.

[7] Essential Services Commission, Electricity Distribution Code – Review of voltage standards for bushfire mitigation, Final Decision 14 August 2018.

3 Contingent project regulatory requirements

Under the Rules, a distributor may apply to the AER during a regulatory control period to amend its distribution determination where a trigger event for a contingent project has occurred. It is not until the pre-defined trigger event occurs, and the application is made, that the AER undertakes a detailed examination of the efficient costs required to satisfy the capital expenditure factors.

The Regulations were not settled prior to the AER finalising its 2016-20 Electricity Distribution Price Review (**EDPR**) for the Victorian distributors. At that time, there was considerable uncertainty regarding the likely costs of meeting the proposed regulations. Accordingly, the AER approved a contingent project to enable AusNet Services to obtain a cost allowance if the regulations were enacted and a project scope completed.

The AER defined three Tranches of projects, each with its own 'trigger event'. AusNet Services considers that the trigger event for Tranche 3 has now been satisfied.

3.1 Trigger event

The AER's final decision set the trigger event for the third Tranche as follows:

Bushfire Mitigation contingent project 3[8]

In circumstances where a new or changed regulatory obligation or requirement (within the meaning given to that term by section 2D of the National Electricity Law) ("relevant regulatory obligation or requirement") in respect of earth fault standards and/or standards for asset construction and replacement in a prescribed area of the State is imposed on AusNet Services during the 2016–20 regulatory control period, the trigger event in respect of bushfire mitigation contingent project 3 occurs when all of the following occur:

1. *AusNet Services has identified the proposed capital works forming a part of the project, which must relate to earth fault standards and/or standards for asset construction and replacement in a prescribed area of the State and which are required for complying with the relevant regulatory obligation or requirement. The proposed capital works must be listed for commencement in the 2016–20 regulatory control period in regulations or legislation, or in a project plan or bushfire mitigation plan, accepted or provisionally accepted or determined by Energy Safe Victoria;*
2. *for each of the proposed capital works forming a part of the project AusNet Services has completed a forecast of capital expenditure required for complying with the relevant regulatory obligation or requirement;*
3. *for each of the proposed capital works forming a part of the project that relate to earth fault standards, AusNet Services has completed a project scope which identifies the scope of the work and proposed costings;*
4. *The AER has made a determination under clause 6.6A.2(e)(1) of the National Electricity Rules in respect of bushfire mitigation contingent project 2."*[9]

[8] Similar provisions apply to the first and second Tranches.

[9] AER, Final Decision, AusNet Services distribution determination 2016 to 2020, Attachment 6 – Capital expenditure May 2016, page 6-127.

3.1.1 Assessment of the Trigger Event

AusNet Services is lodging this contingent project application for Bushfire Mitigation Project 3 as the trigger event has occurred in relation to the introduction of earth fault standards. In particular:

- As previously noted, the Victorian Government has introduced regulations in respect of earth fault standards.
- A revised Bushfire Mitigation Plan (**BFM Plan**) was provided to ESV on 20 April 2018. The BFM Plan details the required Tranche 3 capital works and their location in accordance with the AER's approved trigger event. The BFM Plan, which has received provisional acceptance from ESV[10], updated the REFCL Program activities, compliance testing and operating modes. A copy of the BFM Plan is provided to the AER alongside this contingent project application.
- AusNet Services has prepared forecast capital expenditure for Tranche 3, as described in Section 8.
- The capital works for Tranche 3 are fully scoped and costed, as described in the attachments, models and supporting documents.
- The AER made a determination under clause 6.6A.2(e)(1) of the National Electricity Rules in respect of bushfire mitigation contingent project 2 on 31 August 2018.[11]

3.2 Materiality threshold

The Rules[12] require the contingent project application to demonstrate that proposed capital expenditure exceeds either:

- $30 million; or
- 5 per cent of value of the *annual revenue requirement* for the relevant *Distribution Network Service Provider* for the first year of the relevant *regulatory control period*, whichever is the larger amount[13]

AusNet Services' maximum allowed revenue in the first year of the current regulatory period is $586.0 million (real $2015), 5 per cent being $29.3 million. Therefore, the applicable threshold in relation to this contingent project is $30 million, being the larger amount.

As shown in Section 8, the total forecast capital expenditure is $41.9 million (real $2015) in the 2016-2020 regulatory period for this contingent project, and therefore the threshold has been met.

As such AusNet Services is seeking approval of the incremental capital and operating expenditure arising from Tranche 3 of the REFCL Program, which we propose to recover through our distribution network tariffs from 1 January 2020.

10 Letter from ESV to Tom Hallam, dated 28 November 2018.

11 AER, Final Decision, AusNet Services Contingent Project Installation of Rapid Earth Fault Current Limiters (REFCLs) – Tranche two, August 2018.

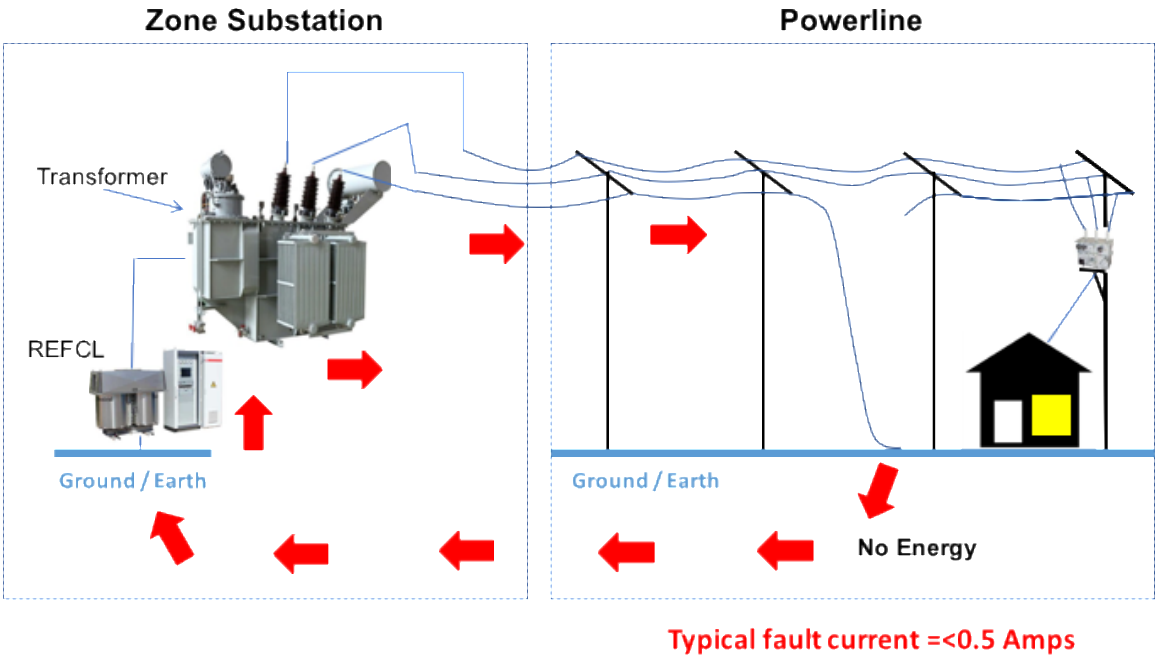
12 Clause 6.6A.2(b)(iv).

13 Clause 6.6A.1(b)(2)(iii).

4 What is REFCL technology?

A REFCL is a type of electricity network protection device, which is designed to minimise the fault current (energy) dissipated from phase to earth (wire to ground) faults on the 22kV network in order to reduce the risk of fire ignition associated with network incidents, as shown below.

Figure 2: How does REFCL technology work?



Source: AusNet Services

There are various types of technology that fall under the REFCL umbrella, however the only type of REFCL currently considered suitable by the Victorian Electric Supply Industry (**VESI**) for bushfire safety is known as the Ground Fault Neutraliser (**GFN**), a proprietary product by Swedish Neutral. Presently, the GFN is the only device that can meet the performance criteria of the Regulations.[14]

REFCL technology operating at the required performance standard will minimise the risk of fire ignition associated with phase to ground faults on days of heightened fire danger, such as those experienced on Ash Wednesday and Black Saturday. Based upon a sample period of network fault data, analysis undertaken by the Government and CSIRO predict network fire related incidents associated with the nominated zone substations may be reduced by between 50-55%.

A REFCL operates when a single phase-to-earth fault occurs. Its operation causes the phase to ground voltage of the faulted phase to be reduced to near earth potential (zero volts), thereby working to eliminate the flow of fault current. To achieve this outcome, the REFCL is tuned to the capacitance of the electrical network and a current injected into the transformer neutral that cancels the residual active fault current. This compensation results in phase to ground voltage on the faulted phase reducing to near 0 volts and the fault current being reduced to a very low value. The healthy phases could rise from 12.7 kilo Volts (**kV**) to 24.2kV, being 22kV plus 10 per cent.

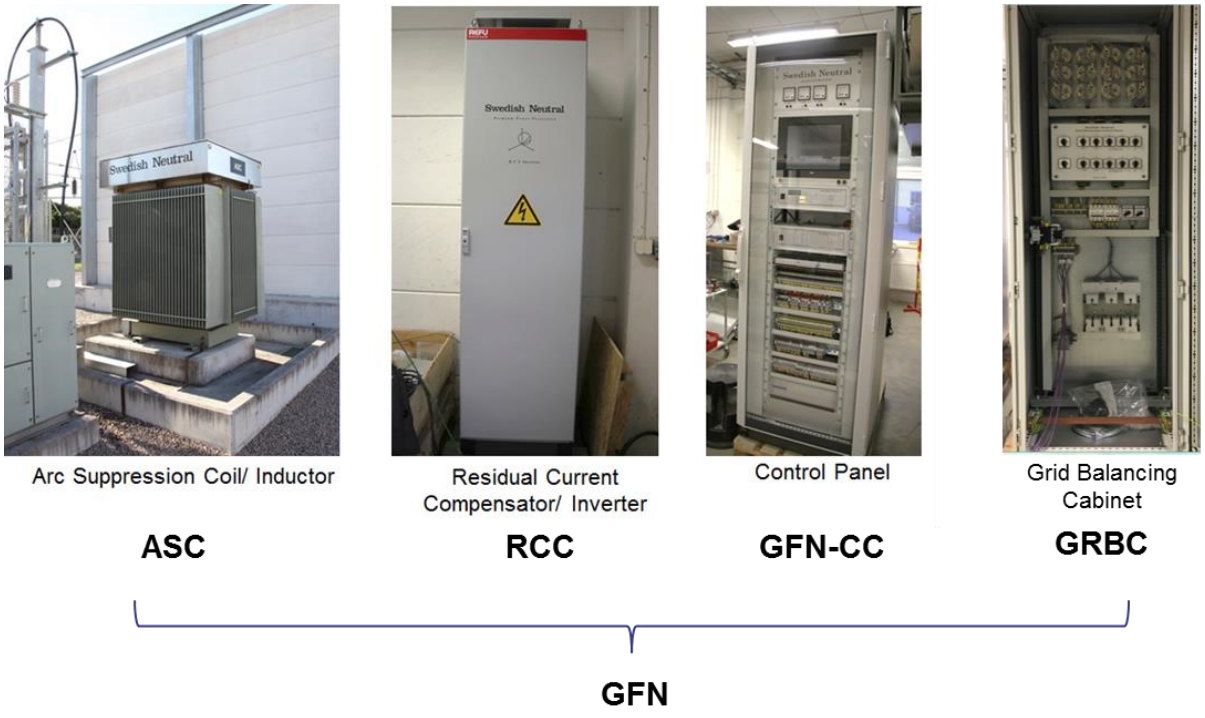
[14] As noted elsewhere in this application, AusNet Services is working with alternative providers to develop alternative solutions.

While the REFCL is compensating for a fault, the healthy phases remain energised and customers remain on supply. However, there remains a risk the energised phases may be in an unsafe condition depending on the nature of the network fault. Accordingly, a maximum compensating period will apply, which may be varied subject to a detailed risk assessment.

The REFCL technology is made up of 4 main components:

- Arc Suppression Coil (**ASC**) , also known as a large inductor, which compensates for the leakage current during an earth fault;
- Residual Current Compensator (**RCC**), also referred to as the inverter, which is located in the zone substation control building or switchroom. It is used to reduce fault current by compensating for the active current during an earth fault;
- Control Cubicles (**CC**), which controls the equipment; and
- Grid Balancing Cabinet (**GRBC**), which fine tunes capacitive imbalance from the zone substation to achieve better detection sensitivity.

Figure 3: Four components to REFCL technology



Source: AusNet Services

As explained in further detail below, the scope of the required works is much broader than the four components described above. This is because the installation of REFCLs requires a paradigm shift in how our network is designed, operated and maintained. As such, all components of the affected 22kV distribution network need to be reviewed to ensure that the REFCL-enabled network continues to operate safely and reliably.

4.1 Alternative technologies

The Regulations prescribe a performance standard that must be met, rather than specifying a particular technological solution. However, in this instance, the mandated performance standard was based on REFCL trials conducted by the Powerline Bushfire Safety Program (**PBSP**), as explained below:

> *"PBSP conducted a series of world-first trials of Rapid Earth Fault Current Limiter (REFCL) technology for use on electricity networks to reduce fire risks on bare-wire overhead powerlines.*
>
> *[…]*
>
> *Through this research, the Victorian Government and electricity distribution businesses identified and confirmed new fault detection and suppression standards required to significantly lower the risks that 22kV powerlines will start bushfires in worst bushfire risk conditions. These standards are now in force from the 1 May 2016 commencement of the Electricity Safety (Bushfire Mitigation) Amendment Regulations."* [15]

The Victorian Government also highlighted the superior performance of the REFCL technology in its factsheet 'REFCL – Introducing best knowledge and technology':

> *"In a series of world-first trials, the Victorian Government together with the electricity distribution businesses and research experts demonstrated that REFCLs can suppress arc-induced bushfire ignitions from wire-to-earth faults on 22kV powerlines.*
>
> *The technology was successfully tested under worst-case bushfire conditions, confirming critical fault detection and suppression standards, which are necessary to stop downed powerlines from starting bushfires, and further determining the optimal safety settings of these devices to reduce the risk of powerlines-started fires.*
>
> *The test program demonstrated that REFCLs provide over 10-times better protection than the current best network protection technology.*
>
> *These standards were mandated for 22 kV powerlines proceeding from 45 zone substations by the Government's 1 May 2016 amendments to the Electricity Safety (Bushfire Mitigation) Regulations."*[16]

At the time the Regulations were made, the REFCL technology was the only technology available to meet the performance requirements. This remains the case. In Tranche 1, the AER approved an allowance to assist AusNet Services to explore alternative technologies and manage its sole supplier risk. However, the AER did not provide any such allowance in relation to Tranche 2 on the basis that[17]:

- The project is now substantially underway and any benefits of identifying an alternative supply source are likely to be minimal; and
- If an alternative source of supply were identified this cost could be funded from the savings achieved on the allowances granted in this decision.

Although the AER did not provide any allowance in relation to Tranche 2, AusNet Services has continued to incur costs as technical issues associated with GFN performance remain unresolved. [C-I-C

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15、 Department of Environment, Land, Water and Planning, Investing in new technology, research and development.

16、 Department of Environment, Land, Water and Planning, REFCL – Introducing best knowledge and technology.

17 AER, Final Decision, AusNet Services Contingent Project Installation of Rapid Earth Fault Current Limiters (REFCLs) – Tranche two, August 2018, page 19.

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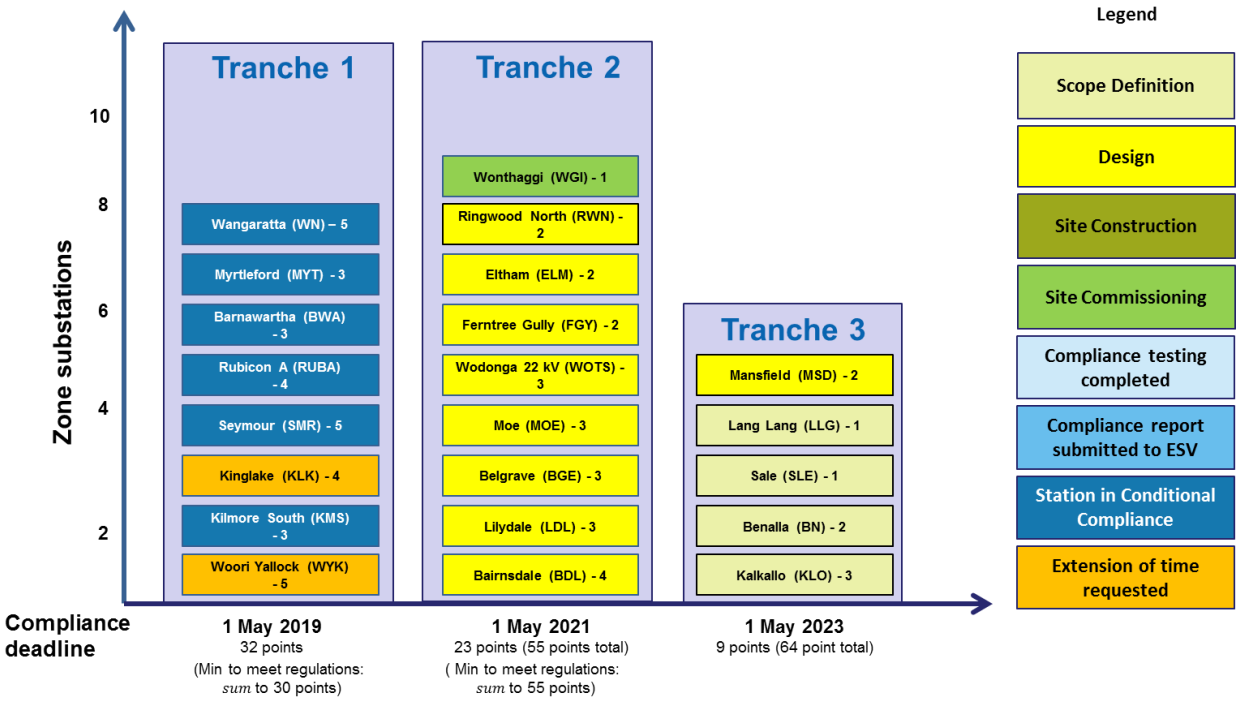
5 REFCL Program Progress Update

5.1 Overview

The figure below shows the current status for each Tranche of the REFCL program as at end May 2019.

Figure 4: REFCL Program Overview



Source: AusNet Services

Tranche 1 of the REFCL Program has been delivered in accordance with the mandatory compliance deadline of 1 May 2019. However, a number of technical issues, as discussed in the next section, have resulted in ESV providing conditional compliance on six (6) of the eight (8) Tranche 1 zone substations and an extension of time request has been submitted to ESV for two (2) of the eight (8) Tranche 1 zone substations.

It is noted that Wonthaggi (**WGI**) zone substation was originally expected to be completed as part of the Tranche 1 REFCL Program. As a result of delays encountered in the replacement of an underground feeder cable due to cultural heritage management plan requirements, this zone substation will now be delivered in the Tranche 2 timeframe. This timing change does not preclude AusNet Services from achieving the prescribed points for Tranche 1 because the remaining eight (8) zone substations meet the required 30 compliance points. It is noted that the Wonthaggi zone substation continues to be treated as a Tranche 1 project for the purpose of the AER's contingent project determination.

A further change in the program delivery timing is that the delivery of the Mansfield (**MSD**) zone substation, which falls within Tranche 3, has been brought forward so that it will be completed by the Tranche 2 compliance deadline of 1 May 2021. The MSD delivery has been brought forward as a risk mitigation measure to provide additional assurance that 55 points will be achieved by the Tranche 2 compliance date. Similar to WGI, although the delivery timing of this project now falls within the Tranche 2 timeframe, this does not affect the regulatory arrangements for remunerating this zone substation. In particular, for the purposes of the cost recovery arrangements, MSD will continue to be treated as a Tranche 3 zone substation.

5.2 Financial performance against budget

Our contingent project applications for Tranches 1 and 2 emphasised the unique and complex nature of the REFCL program. One consequence of this world first project is that AusNet Services is exposed to asymmetric budgeting risks. This risk is asymmetric because unexpected technical and delivery issues are likely to arise, whilst unexpected cost savings are much less likely to occur.

5.2.1 Tranche 1

For Tranche 1, the majority of zone substation projects are forecasting overspends compared to budget primarily as a result of rework, remediation activities and further testing requirements as described below:

- At Kinglake (**KLK**), a drum of faulty cable required AusNet Services to remove and re-install cable which resulted in a 3 month delay to the installation of a new supply transformer. The faulty cable was identified during the partial discharge (**PD**) testing which is carried out on all newly installed cable. The faulty cable was as a result of a manufacturing defect.
- At four (4) of the zone substations, the performance of the Current Transformers (**CTs**) was identified during primary earth fault and compliance testing as not being sufficiently sensitive to meet the required compliance performance criteria. CT remediation works were carried out at these zone substations in early 2019.
- As a result of GFN software defects, a number of versions of the software have been installed and tested. As an example, testing of the first two (2) GFN zone substations on the AusNet Services network at Woori Yallock (**WYK**) in November 2017 identified a number of software defects with operating the REFCLs in the required 'split bus' mode. This mode is used to meet the performance criteria in the Regulations. Testing of the updated software in late May 2018 identified further software defects which prevented the planned ESV-observed compliance testing occurring in June 2018 at WYK. Following the installation of further updated software, ESV compliance testing conducted at the Rubicon A (**RUBA**) zone substation in August 2018 identified new software issues, a number of which were resolved by new code being written by the Swedish Neutral (**SN**) resources at location (SN resources were onsite during August 2018 to support testing activities). Due to the issues identified, together with CT performance issues, ESV-observed compliance testing was again cancelled and primary earth fault testing undertaken to assist with technical issue identification and resolution.
- The effort involved in commissioning and testing of the REFCLs is significantly greater than assumed and budgeted for. There are a number of steps in the commissioning and testing process including conducting:
    - Insulation (also referred to as stress) testing – this is where the voltage on the zone substation network is increased for a period of time. The purpose of the testing is to identify any assets which are unable to withstand REFCL operations. This testing may be completed in a single day or, if there are asset failures encountered, may take a number of days to successfully complete.
    - Primary earth fault (**PEF**) testing – this is where a fault is introduced onto the REFCL-protected network to test whether the REFCL can identify the fault and compensate for the fault in accordance with the performance criteria in the Regulations. The allowance of one (1) day PEF testing per feeder is a minimum requirement. During Tranche 1 commissioning, PEF testing may need to be repeated a number of times on the same feeder over multiple days due to

network faults, the requirement to obtain multiple setting data (particular at dual GFN zone substations) and adverse weather conditions.

- ESV-observed compliance testing – this is where representatives from ESV observe the testing of each REFCL-enabled feeder against the performance criteria in the Regulations. This is very similar to primary earth fault testing with the exception that the purpose of the testing is to execute a pre-agreed test plan to demonstrate compliance with the performance criteria and is observed by ESV representatives. A minimum allowance of one (1) day per feeder is assumed from a planning perspective, together with a number of contingency days in the event of delays to testing. Delays can occur due to network faults and adverse weather conditions, in addition to other factors.

- Underground cable failures as a result of REFCL testing have been encountered which, in addition to impacting the reliability of the network for customers, has resulted in additional costs to repair and, in some cases, replace the cable. No allowance was included in the Tranche 1 contingent project application for the testing and replacement of underground cable.
- A each of the eight (8) Tranche 1 zone substations, different challenges were encountered which have resulted in increased costs and, in order to meet the 1 May 2019 compliance deadline, an extremely compressed delivery schedule was established. The completion of zone substation projects has been much later than originally budgeted.

The total projected capex for Tranche 1 now exceeds the AER approved capex forecast. It is noted that the current Tranche 1 forecasts do not include costs which may be incurred to resolve the current technical issues.

5.2.2 Tranche 2

For Tranche 2, whilst the zone substations works are currently in the design phase, the latest forecasts indicate that the capex will exceed the AER's allowance due a number of factors including:

- Higher than budgeted design costs – designing for REFCLs is complex and the number of zone substations in Tranche 2 has resulted in four (4) design teams from different organisations being responsible for producing the designs. Design learnings from Tranche 1 are being incorporated into Tranche 2 designs however, as previously mentioned, each zone substation presents its own unique challenges. A number of the Tranche 2 zone substations are located in residential areas with no space for expansion to accommodate the REFCL equipment. In addition, seven (7) of the Tranche 2 zone substations require two (2) GFNs to be installed. This is compared to three (3) zone substations in Tranche 1;
- Improved network capacitance forecasts have identified higher network capacitance than was assumed in the Tranche 2 contingent project application, particularly in the central region which includes the following zone substations: Belgrave (**BGE**), Ferntree Gully (**FGY**), Ringwood North (**RWN**), Eltham (**ELM**) and Lilydale (**LDL**). Options to address the increased capacitance to ensure the performance criteria in the Regulations is met include feeder switching, installation of a 3rd GFN at FGY and/or the isolation of underground residential developments from REFCL operations;
- Significant volumes of underground cable need to be PD tested and/or replaced. Due to the location of the majority of the Tranche 2 zone substations, cable testing and/or replacement requires council permits, additional reinstatement requirements enforeced by councils and traffic management which increases the cable repair cost and can delay the completion of the works. In addition, a number of large residential developments built

in the 1980s have been identified as having underground cable which is unlikely to be able to withstand REFCL operations. These underground cables will be isolated, subject to obtaining the required technical scope exemption approvals;

- PD testing of feeder exit cables has identified a larger number of replacements than was budgeted. To date, of the PD testing undertaken in Tranche 2, 44% of the feeder exit cables have failed PD testing resulting in the replacement of feeder exit cables being required. Furthermore, as a result of capacitive balancing requiring the relocation of feeders to alternate buses and the replacement of outdoor switchgear with indoor switchboards, 36% of additional feeder exit cables are to be replaced in Tranche 2. In total, 80% of the feeder exit cables are currently requiring replacement;
- An additional 22kV capacitor (cap) bank is required at Bairnsdale (**BDL**) to address both voltage regulation and harmonics. As BDL is a two (2) GFN ZSS, the GFNs will operate with the bus tie open on Total Fire Ban (TFB) days. This means that each bus needs to be able to operate independently of the other bus in terms of voltage regulation and harmonics; and
- Removal of fuses on network segments with excessive capacitive current as single phase fuse operation will cause excessive imbalance causing the GFN to trip the feeder. Therefore, to solve the excessive imbalance, replacement of the existing fuses on the network with solid links is planned. As a result of protection studies performed, it has been concluded that the installation of fuse savers are required for network protection. These costs were not considered in the previous contingent project applications.

It is important to note that the contingent project provisions place strong financial incentives on AusNet Services to minimise the costs of delivering the REFCL program. The projected cost overruns for Tranche 1 and 2 therefore highlight the challenges of forecasting the required expenditure given the newness of the technology and the demanding performance requirements in the Regulations.

5.3 Technical Issues

[C-I-C

C-I-C

[C-I-C]

Table 4 Principal technical Issues

Issue	Description and current status
[C-I-C]	[C-I-C] [C-I-C]
[C-I-C]	[C-I-C] [C-I-C]
[C-I-C]	[C-I-C] [C-I-C]
[C-I-C]	[C-I-C] [C-I-C]

[C-I-C]

[C-I-C]

5.4 HV customers solutions

As explained in section 2.2, the Victorian Electricity Distribution Code has been amended so that Tranche 2 and 3 HV customers are now responsible for ensuring their HV electrical assets are either able to withstand, or be isolated from, REFCL operations.

For Tranche 2 HV Customers, the AER accepted that AusNet Services would incur expenditure in relation to:

- installation of ACRs at all HV customer sites to mitigate the risk of a cross-country fault;
- protection investigation;
- consultant reports to assess the current condition of the HV assets to withstand REFCL operations and, where applicable, recommend required works to either harden to withstand, or isolate the HV assets, from REFLC operations;
- backup generation to isolate customers during commissioning;
- project oversight;
- updating schematics for hardening.

For Tranche 3, equivalent expenditure in relation to HV Customers is proposed.

5.5 Key Learnings

Learnings from Tranche 1 are being factored into the delivery of Tranche 2 and the scoping of Tranche 3.

Key learnings include:

- The importance of integrated schedules – two dedicated schedulers will support the REFCL Program post 1 May 2019 and Primavera P6 is being implemented, replacing reliance on MS Project which has limitations in relation to resource management and integrated schedule management.
- Confirmation of scope of works – the implementation of REFCLs is complex and each zone substation and its respective network is unique in terms of how many REFCLs are to be implemented and the associated works. The timely confirmation of the condition of existing assets and whether they can withstand REFCL operations is essential to avoid the late identification of the replacement of long lead assets including supply transformers, replacement of feeder exit cables and critical underground cables. A Tranche 2 Program Manager commenced in early October 2018 with a key objective to confirm the Tranche 2 scope of works. A Tranche 3 Program Manager commenced in early March 2019 with the key objective of developing the scope, budget and schedule for Tranche 3.
- Timely procurement of assets, including spares – The lead time for REFCL equipment including GFNs from Swedish Neutral, supply transformers and isolating transformers can be up to 12 months. If orders are not placed with suppliers on a timely basis, the risk of being unable to complete construction activities increases. In addition, issues have been encountered with defective equipment which has required the use of spare equipment. An increased number of spares of key/long lead equipment will be available for the remaining tranches to avoid unnecessary delays in commissioning.
- Access to the network – As part of a REFCL Prioritisation Review conducted in early February 2019, amended network access protocols were identified and implemented to provide the commissioning and testing teams with greater flexibility to undertake the required commissioning and testing activities. For example, rather than network access

having to be requested on a feeder by feeder basis, network access is requested at a zone substation level so that, in the event testing is unable to be conducted on a particular feeder due to a network fault or other issue, the testing effort can be redirected to an alternate feeder on the network. This also allows for multiple feeders to be tested in one day in the event the testing on the initial feeder is completed without issues being encountered. These amended network access protocols enabled the recent ESV-observed compliance testing to be undertaken quicker than scheduled.

- Integrated works governance – following the REFCL Prioritisation Review, an integrated works governance working group was established to review, prioritise where required and manage outages required to undertake bushfire mitigation, REFCL, other maintenance and customer-initiated works. This integrated and co-ordinated approach to managing network access resulted in fewer works being cancelled due to job clashes and, as this process continues, should result in fewer customer outages and outage cancellations.
- Community engagement – whilst community engagement activities were undertaken during Tranche 1, they were often reactive rather than proactive and did not promote benefits of the REFCL Program. A more holistic, proactive community engagement approach is under development for Tranche 2.

A formal post implementation review of Tranche 1 commenced in May 2019 to identify areas for further improvement in the remaining tranches.

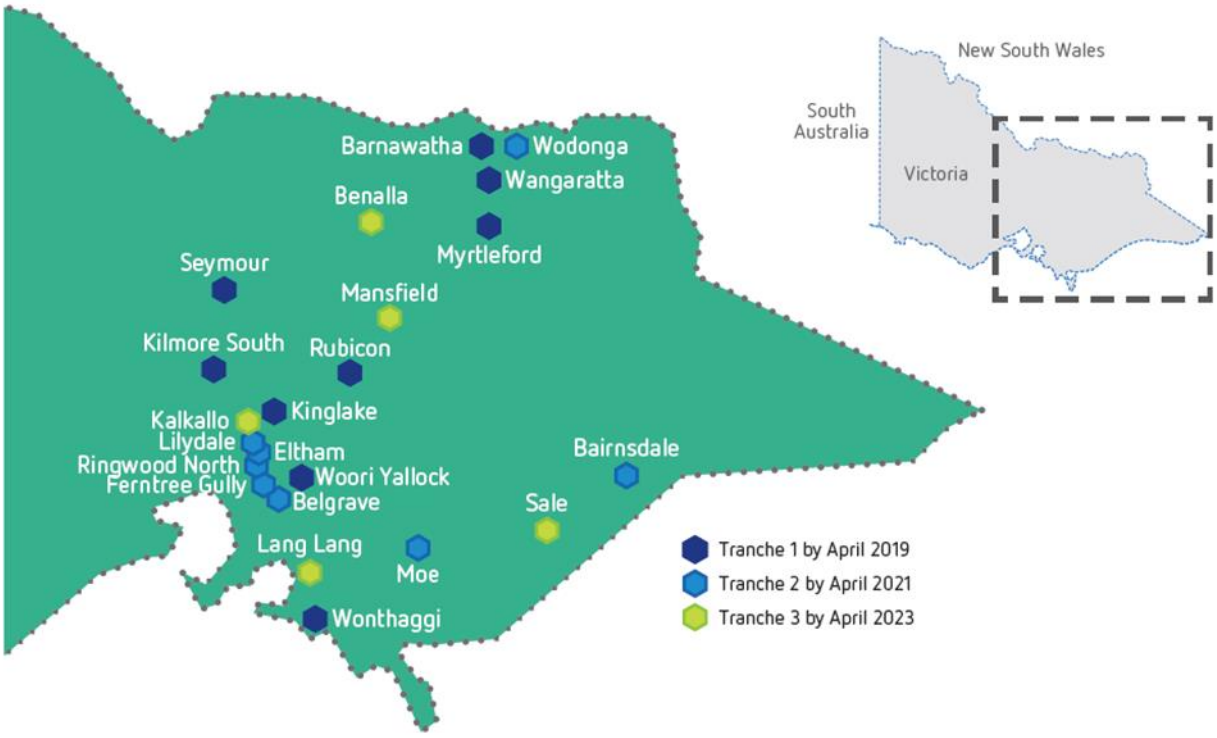
6 Tranche 3 Overview

Each of the three Tranches have different characteristics and challenges, reflecting the different nature of the substations and their respective supply networks progressed in each Tranche.

- Tranche 1 – the majority of zone substations are situated in rural locations;
- Tranche 2 – apart from 3 zone substations, the zone substations are situated in peri-urban location – locations between urban and rural areas; and
- Tranche 3 – the zone substations are predominately situated in rural locations, apart from Kalkallo (**KLO**) which is located in a peri-urban area in an area of significant growth.

Figure 5 below shows the substations that are being undertaken in each Tranche.

Figure 5 REFCL Program Overview



Source: AusNet Services

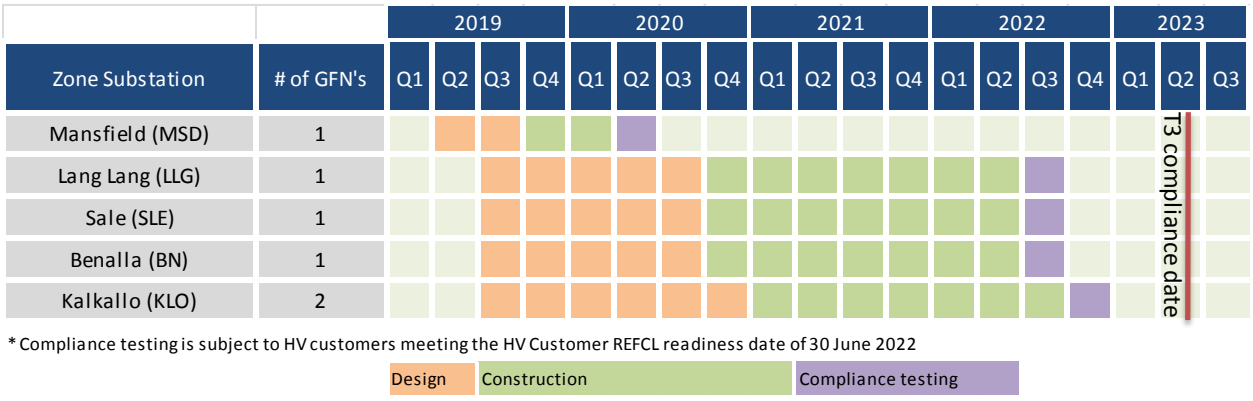
The different locations and characteristics of the zone substations, and their respective supply networks, give rise to several key aspects of the Tranche 3 program including:

- Kalkallo (**KLO**) zone substation supplies the Jemena network in addition to the AusNet network. KLO is located in an area of high residential growth and a number of the feeders are predominantly underground cable. The network capacitance forecasts for KLO indicate a large growth in capacitance over the next ten year period. Increasing the number of GFNs to cater for this capacitance growth is not a sustainable solution from either a technical or economic perspective. AusNet Services and Jemena have jointly engaged an independent consultant to assess the potential REFCL solutions and to recommend the preferred solution covering compliance with the Regulations, technical and economic perspectives. For the purposes of this contingent project application, the most likely solution has been included which is the installation of 2 GFNs, 5 isolating substations and the development of a new zone substation;

- Aside from KLO, the other zone substations in Tranche 3 are single GFN zone substations with a higher proportion of overhead lines compared to underground cable;
- The number of HV customers is significantly lower than that of Tranche 2, with no HV Customers on the Mansfield (**MSD**) network, single HV Customers on the Sale (**SLE**) and Lang Lang (**LLG**) networks and two (2) HV Customers on the Benalla (**BN**) network; and
- Complexity in the delivery of Tranche 3 program includes the requirement to avoid outages during the snow season on the MSD network and to minimise outages during school holidays/peak holiday seasons at a number of zone substations.

The proposed delivery schedule for each Tranche 3 zone substation is set out in Figure 6 below.

Figure 6: REFCL Tranche 3 timeline



Key characteristics of each Tranche 3 Zone Substation are set out in Table 5 below.

Table 5 Summary of zone substations

Zone substation	22kV Network Size (km)	Customers	22kV Insulated Network Size (km)	22kV Feeders	22kV Transfer Feeders (to zone substations that will not be fitted with a REFCL in Tranche 3.)	Automatic switchable sections	Single phase km requiring balancing capacitors or line balancing	HV connection points
MSD	619.4	6,448	8.5	3	0	12	321.1	0
LLG	498	6,585	11.7	4	1	24	204	1
SLE	677	12,755	29	4	1	33	240	1
BN	1,383.1	12,134	12	5	0	33	915.4	2
KLO	301.9	9,406	50.9	4	1	7	118.9	3
Total	**3,479.4**	**47,328**	**112.1**	**20**	**3**	**109**	**1,799.4**	**7**

Source: AusNet Services

6.1 Necessary works

As explained in our contingent project applications for Tranches 1 and 2, significant work is required at each zone substation to accommodate the installation of the REFCL equipment. For example, the speed and sensitivity at which the REFCLs operate means traditional protection schemes distributed along a feeder will not operate as they normally would, to detect and isolate a faulted section of the network. In addition, the operation of the network with REFCLs in service imposes higher electrical stresses on the network.

As a consequence, capital works extend beyond the immediate confines of the zone substation to ensure that the network continues to operate safely and reliably and AusNet Services maintains compliance with its obligations. The REFCL project therefore involves five capital expenditure workstreams, described below:

- **Zone substation works**

  Includes: REFCL installation (being the GFN) and associated equipment within the zone substation. It also includes the replacement of assets that fail during network hardening tests of the relevant high voltage network.

  Reason: In addition to installing the REFCL, additional works are required because the REFCL technology is based on a different earthing philosophy. It is essential that the zone substation operates safety and reliability in the new environment.

- **Network Balancing**

  Includes: Initial desktop and field modelling work following by: low voltage (**LV**) capacitor bank installations, third phase installations and re-phasing long single phase lines.

  Reason: Long single phase (two-wire) spurs teed off three-phase lines can create significant capacitive imbalance. Fire risk reduction relies on minimal capacitive imbalance on switchable sections of the network.

- **Line and Cable Hardening**

  Includes: Surge Arrestor replacement and underground cable testing and/or replacements

  Reason: When an earth fault occurs, the REFCL response creates increased voltage stresses (compared to without REFCLs) on line equipment connected to un-faulted phases, which can lead to a second fault. In the absence of line hardening, the REFCL installation would increase fire risk and decrease network reliability. Increased voltage levels can also lead to cable failures.

- **Compatible Equipment**

  Includes: Automatic Circuit Reclosers (**ACR**), Voltage Regulators, sectionalisers and Capacitor Bank replacements.

  Reason: Some widely utilised line equipment cannot be used with REFCLs due to the reduced fault currents. This is separate to line hardening, which is solely concerned with the ability of line equipment to withstand over-voltage events.

- **Assisting HV customers to achieve Electricity Distribution Code (EDC) compliance**

  Includes: The costs of working with HV customers to ensure that the appropriate works are undertaken to achieve EDC compliance in readiness for the REFCL program.

  Reason: The timely completion of HV customers works is essential to the successful implementation of the REFCL program. It is therefore prudent and efficient for AusNet Services to provide support to HV customers to ensure that the lowest cost, effective options are adopted to achieve EDC compliance in a timely manner.

In addition to these capital works, the project will also entail expenditure for an incremental increase in AusNet Services' operating expenditure. This contingent project application and attachments provide a detailed explanation of the proposed expenditure. In accordance with the contingent project provisions in the Rules, only the incremental costs associated with the trigger event are included in this contingent project application.

7 Project management process

7.1 Program Governance Framework

AusNet Services' REFCL Program Governance Framework will continue to apply throughout Tranche 3 of the REFCL Program. The governance framework aligns with AusNet Services' values and commitment to safety with:

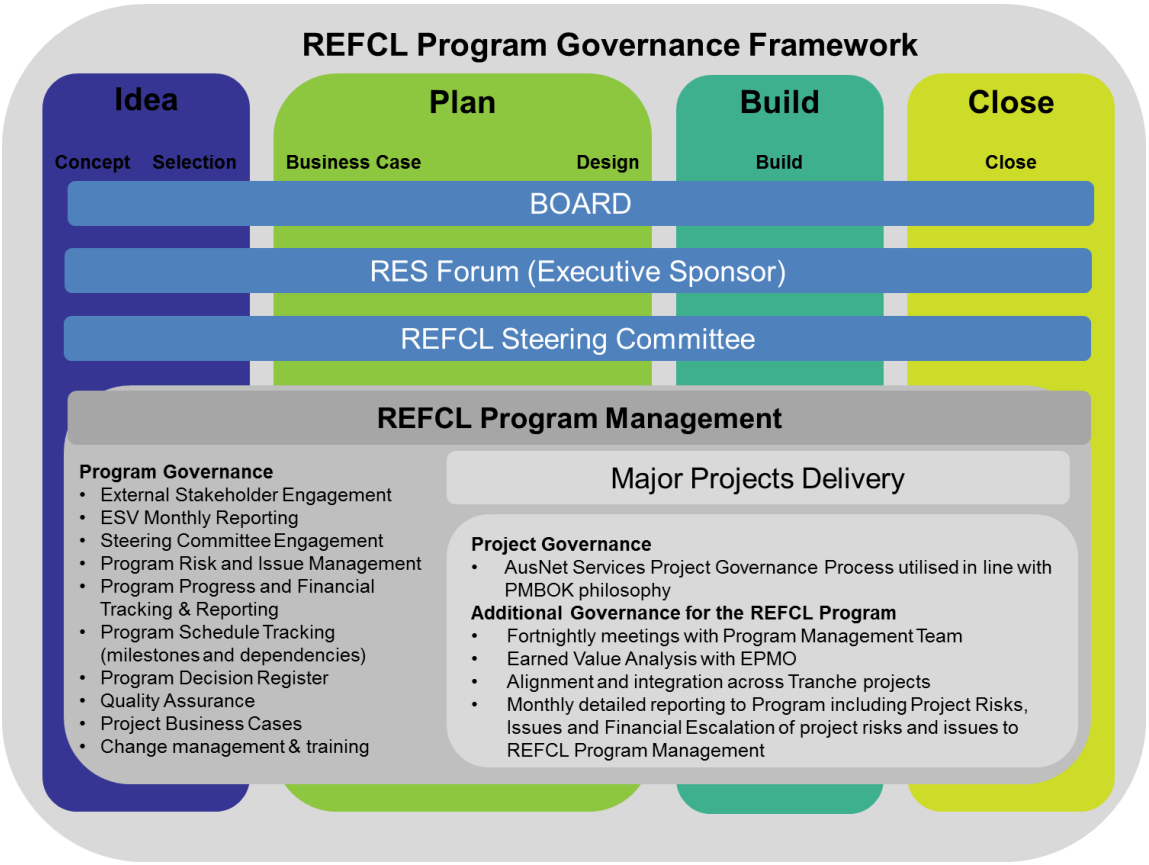
- Clear accountabilities, reporting and robust risk and issue management;
- Sustainable, long term, reliable, economical and workable whole of life designs;
- Delivery as per agreed timelines without compromising reliability and other service standards;
- Integration with the rest of AusNet Services' work program;
- Compliance with required obligations;
- Strong relationships with all stakeholders in order to successfully manage change;
- Development of internal capability in order to facilitate the transition to business as usual (**BAU**); and
- Use of BAU processes and resources where possible.

Risk management is an important aspect of the governance framework, as the REFCL technology has never been operationalised at the performance standard required by the Regulations. The potential exposure is therefore significant and must be proactively managed.

The Program Management team includes a dedicated risk management resource who works proactively with the work stream leaders, project managers and the program management team to identify and assess risks and to develop and monitor risk mitigation measures and controls and to monitor their implementation and effectiveness.

The following figure depicts the REFCL Program Governance Framework.

Figure 7: REFCL Program Governance Framework



Source: AusNet Services

A REFCL Steering Committee was established in early 2016. Its members include key Executive General Managers, General Managers and key program management team representatives.

The Steering Committee is accountable for the successful delivery of a functioning REFCL system across the affected 22 zone substations in AusNet Services 22kV electricity distribution network, in accordance with the regulated schedule and performance criteria.

The Steering Committee:

- Provides strategic and operational direction and support;
- Acts as an escalation point for issue resolution; and
- Actively monitors the Program's critical risks and their mitigations, issues, budget and schedule.

The Steering Committee has met regularly since March 2016.

As noted in our contingent project applications for Tranches 1 and 2, the governance framework provides strong evidence that the REFCL program is well managed with program and delivery project risks identified and managed effectively. Further information on our REFCL governance arrangements can be provided to the AER on request.

7.2 Efficient Delivery

AusNet Services' objective is to ensure that the forecast expenditure for this contingent project is prudent and efficient[18]. For the purposes of this contingent project, we consider expenditure is:

- *Prudent* if it is necessary to ensure AusNet Services' compliance with the mandated earth fault standards and mitigates bushfire risk to the maximum extent possible without compromising safety.
- *Efficient* if it delivers the scope of works at the least possible cost to customers, including the expected costs of unserved energy during construction and following the establishment of the REFCL.

To ensure the expenditure forecast for AusNet Services' project scope is expenditure that would be incurred by a prudent and efficient Distribution Network Service Provider (**DNSP**), a specific cost-benefit analysis is conducted for each workstream which:

- Describes the investment need;
- Identifies the alternative credible engineering options at that location;
- Determines the costs and risks associated with each option; and
- Selects the least cost, prudent option having regard to safety and performance risks.

The cost-benefit assessment described above is consistent with the Regulatory Investment Test for distribution (**RIT-D**)[19]. In accordance with the RIT-D principles specified in the Rules[20], AusNet Services' cost-benefit analysis:

- Is proportionate to the scale and likely impact of each option; and
- Is applied in a predictable, transparent and consistent manner.

The cost-benefit analysis determines AusNet Services' strategy for each workstream, ensuring that the preferred option will deliver the most prudent and efficient outcome. The possibility of non-network options or operating and capital expenditure substitution are also considered.

AusNet Services is confident our approach ensures the scope of work and the resulting expenditure forecasts are prudent and efficient, in accordance with the capital and operating expenditure criteria in the Rules, which are addressed in Chapters 8 and 9 respectively[21].

7.3 Project cost estimates and unit rates

As explained in our contingent project applications for Tranches 1 and 2, project cost estimates are prepared as part of AusNet Services' standard approach to developing, managing and reporting projects and programs of works in accordance with defined project execution procedures and practices. AusNet Services' estimates are founded on the following five key principles:

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18 Clause 6.6A.2(f)(2) refers to the *capital expenditure criteria*, which refer to the efficient and prudent costs of meeting the *capital expenditure objectives*.

19 The REFCL project is also subject to a separate RIT-D process, although it relies on the costs benefit analysis presented in this contingent project application and supporting documents.

20 Clause 5.17.1(c).

21 Clause 6.6A.2(f).

1. All projects are to be project managed in accordance with AusNet Services' project execution procedures and practices.
2. For business case investment approval and implementation, P90[22] estimates provide confidence in processes of project priority, affordability and strategic fit. However, the costs presented in this contingent project application are P(50) estimates[23], i.e. expected cost, which excludes project risk and uncertainty covered by management reserve provision in a business case.
3. Estimates are subject to reviews and a sign-off process based on consistent clear lines of responsibility and accountability that will ensure costing standards and controls are applied.
4. Regular system reviews are conducted to encourage and facilitate continuous improvement.
5. Project learnings are shared to increase corporate knowledge.

The unit costs assumed for GFNs reflect a quotation provided by the manufacturer, Swedish Neutral.

Unit rates for other works are primarily based on the rates incurred in recently completed work or where possible, updated based on experience from Tranches 1 and 2. These unit rates therefore reflect the efficient costs of delivering similar projects in AusNet Services' network area.

Work is delivered utilising an efficient combination of competitively tendered and internal resources. Pre-qualified panels of design and installation service providers have been established by competitive tender and ensure that providers have the skills and resources to undertake the required work in a safe and competent manner and can comply with works management processes.

Further information on AusNet Services' cost estimating process are provided in the supporting document, *Cost Estimating, Program Delivery & Unit Rates*, which accompanies this contingent project application. AusNet Services' actual unit rates are confidential, and are provided to the AER on that basis.

7.4 Efficient delivery

As explained in our contingent project applications for Tranches 1 and 2, AusNet Services has implemented a number of initiatives to ensure that the REFCL Program is delivered efficiently, as discussed below.

Standard Designs

AusNet Services utilises a number of standard designs and modular constructions to aid the delivery of zone substation projects. For example, a standard modular 22 kV switchboard has been utilised in zone substation construction and rebuild projects. This switchboard has a number of advantages over the installation of stand-alone switchgear, including the ability to fabricate and fit-out the building off-site in a factory and to readily relocate the switchboard should it no longer be required in its current location.

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22 A detailed cost estimate that has a 90% confidence factor of not being exceeded by cost at project completion.

23 The costs presented in this application also exclude the written down value of assets that need to be replaced prior to end of life. While the written down value of these assets are project costs, and included in the business case,

To deliver the REFCL Program, the standard switchboard has been modified to ensure all the equipment is rated for REFCL operation and to include measuring transformers capable of detecting low fault currents. The use of a pre-assembled switchboard speeds delivery of the REFCL Program because the switchboard utilises a standard design and is assembled off-site by a supplier and delivered complete to site (already fitted with all the components and accessories such as air-conditioning). This reduces the design and on-site construction effort leading to more efficient and faster project delivery.

Shared experience

The operation of REFCLs to mitigate bushfire risk has not been undertaken other than in Victoria and so, at the start of the Tranche 1 project, no knowledge relating to the installation or operation of the REFCL existed. AusNet Services and Powercor are both required to achieve the required capacity mandated in the Regulations. The businesses have therefore been sharing information on the installation and operation of their respective units to increase expertise and reduce the probability of unplanned customer interruptions.

In addition, AusNet Services and Powercor have shared the results of tests such as surge arrestor testing to reduce the time and cost of testing a statistically significant sample. A key learning from Tranche 1 has been the need for proactive cable testing and, where necessary, cable replacement. Cable failure data, and cable testing results to date, has been shared between AusNet Services and Powercor.

Leveraging existing contracts and relationships

Delivery of the REFCL program in the required timeframe would not be possible without using existing contracts and relationships. The procurement of equipment relies on established contracts with suppliers and enables the use of standard equipment such as the 22 kV switchboards. Additionally, the pre-qualified service providers (described below) will be used to deliver on-site work.

Resourcing

Our approach is to employ a combination of in-house and outsourced resources to optimise the overall program costs while meeting the delivery timetable. Additional external resources have been, and will continue to be engaged to meet the peak workload. These additional resources are not retained when the volume of work reduces, following the completion of the REFCL program, ensuring that internal resources are always fully occupied.

The establishment of pre-qualified panels of service providers using a competitive process ensures efficient costs and that appropriate quality services are provided. In addition, the cost and time taken to engage resources is reduced. The use of different labour sources also allows benchmarking comparisons to reduce the risk of cost blowouts, which are not uncommon for large capital projects such the REFCL program, especially given the nature of the technology.

7.5 Change management

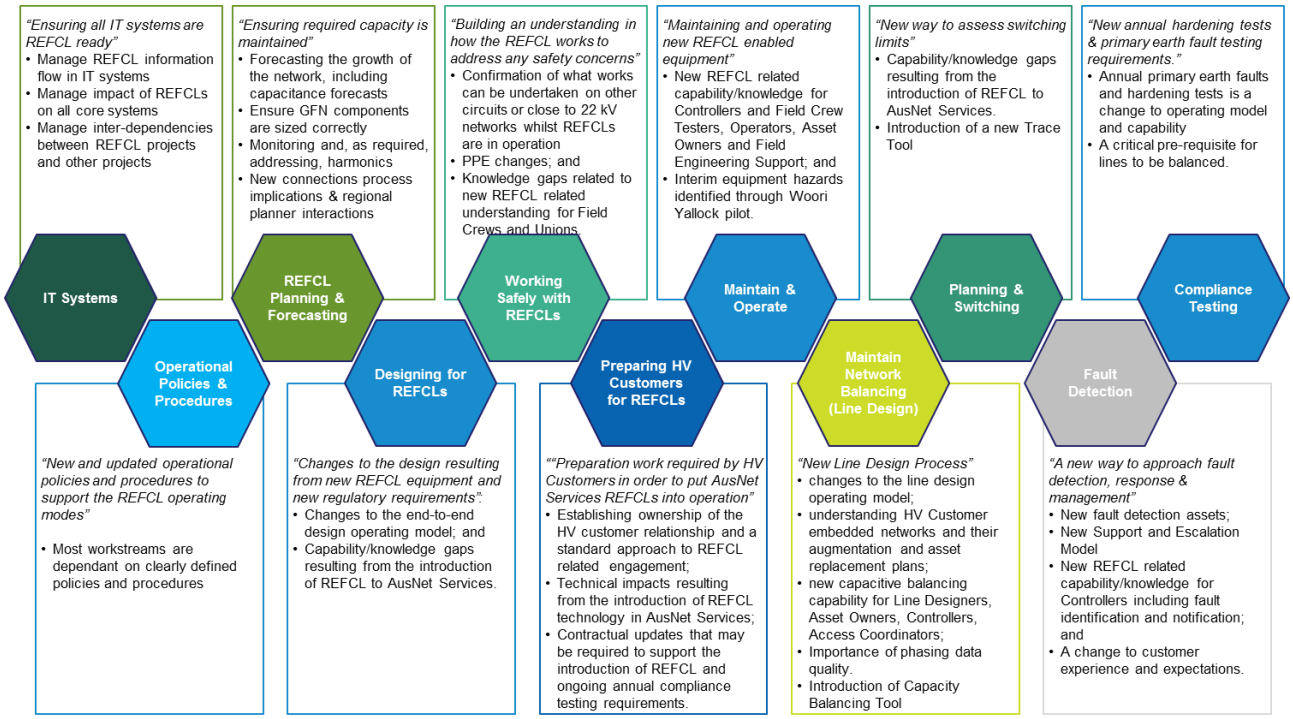
Our approach to change management and training continues to evolve as we better understand the impacts of introducing REFCLs on existing business processes, systems and teams. The scale of change is significant and complex when considering the following key factors:

- We are installing new assets on our network that have never been used for bushfire mitigation before anywhere in the world.

- The transition from low resistive to enhanced resonant earthing represents a paradigm shift in how we design, maintain and operate the affected parts of our electricity distribution network. Processes that are new or are changing significantly include:
    - Fault detection and location (change);
    - Planning and switching (change);
    - Annual compliance testing (new); and
    - Maintain network balance (new).
- Network capacitive balancing, one of our critical dependencies, is a new concept to AusNet Services.
- Safety practices have been enhanced to recognise the network has the potential to operate at higher voltages. No glove and barrier work is to be undertaken with REFCLs in service, however live line stick work will be allowed. Further investigation into safety practices and appropriate personal protection equipment (**PPE**) is continuing.
- When REFCLs are operating, more customers might experience outages on Total Fire Ban (**TFB**) days or Code Red days as a result of the technology shutting down sections of the network where a fault is detected.

Change management is a fundamental element of the REFCL program implementation, as illustrated in Figure 8 below.

Figure 8: Internal change impacts for implementation of the REFCL Program



Source: AusNet Services

AusNet Services' REFCL Program Change Management Strategy provides the framework to address how we are managing and integrating each of the eleven change impacts. The framework details how we:

- Conduct the overall change management approach for the REFCL Program;
- Optimise audience buy-in;
- Embed the change and ownership;

- Build capability;
- Minimise business disruption; and
- Manage and mitigate change resistance.

This is achieved by using the following strategies:

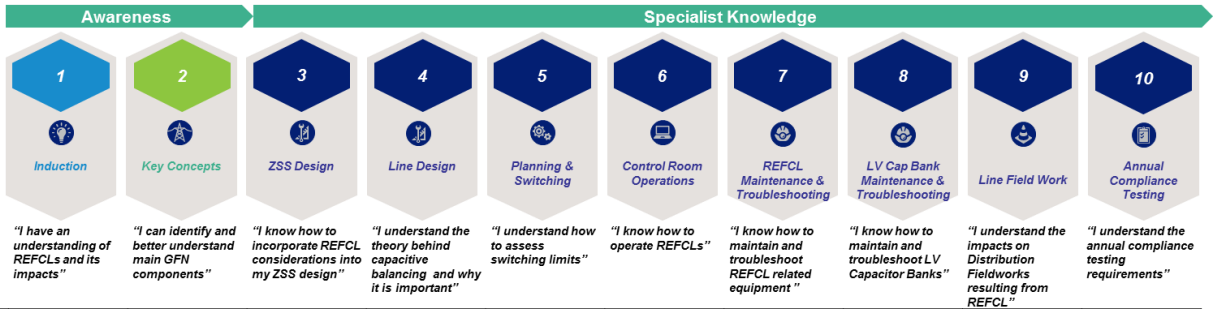
- **Stakeholder Engagement:** Involve stakeholders in problem solving or decision making and listening to what they need, then incorporating that into the Change Management plan in order to increase their commitment to the change;
- **Training:** Understand what learning and performance support is needed to enable users to confidently perform their job in the new environment to enable knowledge, confidence and adoption;
- **Business Readiness:** Prepare the business for the change to enable a successful transition from project activities to Business As Usual (**BAU**) and continuous improvement;
- **Communication:** Effectively and consistently communicating information using the appropriate channels to stakeholders to build awareness and understanding of the change; and
- **Measuring Change Effectiveness:** Outline how we will measure the effectiveness of the change management strategy.

Whilst it is anticipated that the majority of change management activities will be completed and embedded into BAU by the end of Tranche 2, there is the possibility new change impacts will be identified, given the complex nature of the Program. These changes will need to be managed on an ongoing basis, using the same framework.

7.6 Training

A key component of our change management activities is training. Figure 9 provides an overview of the training modules for the REFCL Program.

Figure 9: Training plan for the REFCL Program



# of people trained (as of April'19)	784	525	-	101	46	30	6	286	288	-

Source: AusNet Services

Employees from across AusNet Services, together with external service providers, have been identified as requiring the REFCL induction training either for awareness or because they play a specialist REFCL related role.

For those resources who perform a specialist REFCL related role, the training curriculum is targeted depending on the role the resource performs. Various delivery mechanisms are used to deliver these modules. The training plan will be reviewed regularly and updated as needed.

8 Forecast capital expenditure

8.1 Introduction

As explained in our contingent project applications for Tranches 1 and 2, there are five categories of direct capital expenditure in the REFCL installation Program:

- Zone substation works;
- Network balancing;
- Line and cable hardening;
- Compatible equipment; and
- Assisting HV Customers to achieve Code compliance.

In addition to these five categories, capital expenditure is required for program management expenses incurred in overseeing the project.

The purpose of this section is to provide a high level description of the required work for each of the five categories. Additional detailed information can be found in:

- Functional scopes for each zone substation, which explain the zone substation works in detail.
- The relevant strategy documents, which explain our approach to network balancing, line and cable hardening and compatible equipment.
- The Total Cost model, which sets out the volumes and unit rates for work to be carried out on each element of the program.

A more technical summary of the impact of the REFCL installation on the existing network is provided in the REFCL Equipment Building Block Functional Description, which is provided as a supporting document to this contingent project application.

8.2 Prudent and efficient – satisfying the capital expenditure criteria

AusNet Services recognises that the AER must consider whether the forecast expenditure in relation to this contingent project is prudent and efficient, in accordance with the capital expenditure criteria in the Rules[24], taking into account the capital expenditure factors in the context of the contingent project.

In the context of this project, we consider capital expenditure is:

- Prudent if it is necessary to ensure AusNet Services' compliance with the mandated earth fault standards and mitigates bushfire risk to the maximum extent possible without compromising safety.
- Efficient if it delivers the scope of works at the least possible cost to customers, including the expected costs of unserved energy during construction and following the establishment of the REFCL.

As explained in section 7 of this contingent project application, our approach to managing this project ensures that the required works are efficiently scoped and costed. AusNet Services has

[24] Clause 6.6A.2(f)(2).

sought opportunities to reduce the cost of the REFCL program wherever possible. This is demonstrated by the following work:

- AusNet Services plans to submit an exemption request to ESV relating to the isolation of underground cable on the KLO network.
- AusNet Services has conducted a comprehensive review of transfer feeders (which are connectable to both a REFCL protected zone substation and a non-REFCL protected zone substation). This process has identified opportunities to change the existing transfer arrangements and hence allowed AusNet Services to remove a number feeders from Tranche 3 works, with no expected change in reliability performance. In doing so, AusNet Services has avoided costs associated with line hardening and compatible equipment.
- AusNet Services is undertaking an extensive cable testing program to ensure that it identifies and replaces critical cables that are prone to failure. However, we are taking a risk-based approach and non-critical cables will not be tested and will be replaced on failure. This is a prudent and efficient approach to managing the risk of failure of these assets overall against the cost of replacement.

As already explained, we draw on the lessons from our current work to inform and improve our management of the REFCL program. Project risks have been identified and processes put in place to manage them effectively. We have also examined the change management implications of the project to ensure that the project impacts on the business are properly understood and included in the project costings. In terms of program management, we have a comprehensive program governance arrangement in place.

The project scopes have been developed by considering the alternative engineering solutions that are available to address the identified investment need, while costs are determined using our standard project costing approach. In summary, AusNet Services is confident that it has adopted a comprehensive and rigorous approach to this project which will ensure that the resulting expenditure forecasts '*reasonably reflect the capital expenditure criteria*' in the Rules, as required by clause 6.6A.2(f)(2).

8.3 RIS Comparison

In our contingent project applications for Tranches 1 and 2 of the REFCL program, we compared the costs at each zone substation with the estimates in the Government's Regulatory Impact Statement (**RIS**)[25]. A key difference between the RIS estimates and the actual project costs is that the RIS assumed that one GFN would be sufficient at most sites, whereas this has not been the case. In addition, a program of cable replacements has been necessary, which was not anticipated in the RIS.

In addition to these differences, our previous analysis also identified the following works that were either not included or under-estimated in the RIS cost assessment:

- **Neutral bus switchboard** – This is required for effective year-round protection of the network. Balancing bushfire risk reduction with network reliability requires multiple operating modes with differing earthing arrangements. A neutral bus switchboard facilitates these arrangements.
- **REFCL backup protection and interface control systems** – Protection and control equipment must operate in several earthing fault modes. Additional control systems are required to provide the interface between the GFN and AusNet Services' equipment.

[25] http://www.acilallen.com.au/cms_files/ACILAllen_BushfireMitigationRIS_2015.pdf

New protection devices are also needed to provide an adequate backup for the GFN for the instances of mal-operation.

- **Testing the REFCL** – As part of the project commissioning it will be necessary to fully test the functionality of the REFCL to ensure that it is capable of operating to meet the Regulations. The capital cost of REFCL installation includes the first instance of stress (insulation) and compliance tests to demonstrate the correct operation of the device.
- **Community engagement plan** – This is required due to the number of outages forecast for the community and the new network insulation tests, which in the short term are expected to produce unfavourable reliability outcomes for customers.
- **Work required to achieve the performance criteria in each automatic switching zone** – This involves a combination of additional capital works including adding balancing capacitors and adding a third phase conductor to balance each section. The RIS included phase rotations alone as the only network balancing cost, and this will not achieve the performance required by the Regulations.
- **Works needed to maintain balance** – These include replacing fuses with solid links where fuse operation will lead to out of balance, potential non-compliance with the Regulations, and possible REFCL mal operation. Furthermore, fuse savers are required either where fuses cannot be replaced with solid links because the fault level at a particular location on the network is too high or where fuses are required to provide protection reach for the network.

Subsequently, the AER has undertaken detailed reviews of our capex forecasts for Tranche 1 and Tranche 2 in accordance with the Rules requirements. With the exception of relatively minor adjustments, the AER concluded that our capex forecasts were prudent and efficient. Section 5.1 of this contingent project application shows that our actual capex is likely to exceed the AER's allowance for Tranche 1 and 2, despite the strong incentives we face to minimise the costs of delivering the REFCL program.

In summary, whilst the RIS cost estimates were reasonable given the state of knowledge at that time, we now have much better information for the purpose of developing capex forecasts for Tranche 3 works. In contrast to our earlier contingent project applications, therefore, we have not provided a substation by substation analysis of the cost differences between the RIS and this contingent project application. However, we would be pleased to provide this analysis if requested by the AER.

8.4 Zone substation works

The following type of work is typical of the investment required at most Tranche 3 zone substations:

- Specification, procurement and installation of a GFN, including an Arc Suppression Coil, Residual Current Compensation, Grid Balancing Cabinet and control system.
- Specification, procurement and installation of a neutral bus switchboard. The introduction of the GFN requires a neutral bus which enables different earthing arrangements to be automatically configured. This enables remote earthing and protection scheme selection depending on network and weather conditions.
- Upgrade of the existing station service transformers and changeover boards. This work is required because the AC auxiliary supply requirement dramatically increases due to the GFN installation.
- Testing and potential replacement of cables and equipment incapable of operating at elevated voltages.

- Replacement and extension of existing protection and control equipment with equipment capable of operating in several modes including resonant earthing and traditional earth fault modes. Additional protection and control systems are also required to protect the newly installed REFCL equipment.
- Prior to commissioning the GFN, network hardening tests involve the process of lifting voltages (using the GFN) in a healthy three phase powerline network (phase by phase) to check network readiness for future states of REFCL operation. During this activity, there is an increased likelihood of asset failures. These tests are necessary to ensure the GFN can operate without causing line and station equipment to fail, potentially resulting in a fire start. We would replace any assets that fail during the testing process, and a forecast cost has been included in the zone substation works.

In addition to the above, location-specific work may be required. The project scopes set out the zone substation works required at each Tranche 3 zone substation.

Table 6 Summary of required zone substation works

Zone substation	GFN (including neutral bus)	Battery Set	Auxiliary Transformer	Capacitance reducing Isolation Transformer	22Kv Capacitor Banks	Cables zone substation (metres)	2016-20 Cost ($000 2015 direct)	2021-25 Cost ($000 2015 direct)
MSD	1	0	2	0	1	680	8,057	-
LLG	1	0	2	0	0	2,210	2,088	6,438
SLE	1	1	2	0	1	810	3,879	5,229
BN	1	0	2	0	0	3,008	5,189	6,222
KLO	2	0	2	5	1	2,530	2,694	12,797
KLO2	0	1	0	0	1	900	6,248	10,517
Total	**6**	**2**	**10**	**5**	**4**	**10,138**	**28,154**	**41,202**

Source: AusNet Services

To demonstrate the efficiency and prudency of our proposed expenditure, we have regard to available benchmark information. Attachment 20 shows a comparison of the proposed unit rates against the Tranche 1 and 2 applications. Generally, the cost differences are attributed to the reflection of actual cost information, as explained in Attachment 20.

8.5 Network balancing

In order to meet the performance standards in the Regulations, capacitive balance must be achieved and maintained. Capacitive imbalance will negatively affect REFCL performance because:

1. It increases residual earth fault current, i.e. fire ignition risk; and
2. It increases the standing level of neutral voltage, i.e. it constrains fault detection sensitivity.

As fire risk reduction relies on low residual fault current, capacitive imbalance can pose a risk to fire safety and so must be managed. In Victoria, long single phase (two-wire) spurs teed off three-phase lines can create significant capacitive imbalance.

In broad terms, the potential actions to balance network capacitance include:

- Two-wire spur lines must be connected to the three phase network in a way that limits capacitive imbalance, i.e. the phases to which each spur line is connected must be selected for capacitive balance, not just load balance.
- Balancing capacitance can be added by installing pole-mounted capacitors along feeders, e.g. on the third phase at a tee-off pole where a long two-wire spur leaves a feeder.
- Improved fault detection algorithms with increased tolerance to imbalance also have a potential role in addressing the potential impact of imbalance.

To satisfy the legislated performance criteria the network leakage current will need to be at a minimum under normal operating conditions. The leakage current required will vary site to site however the target is less than 0.1A. Our approach is to achieve this outcome through a combination of:

- Performing single-phase spur and distribution substation phase transpositions;
- Installing a balancing capacitor bank at the beginning of single phase spur sections;
- Installing LV balancing capacitor banks on the three-phase backbone;
- In a small number of cases adding a third conductor to the beginning of a single-phase spur section and converting that section to three-phase; and
- Removal of fuses on network segments with excessive capacitive current as single phase fuse operation will cause excessive imbalance causing the GFN to trip the feeder. Therefore, to solve the excessive imbalance, it is essential AusNet Services remove the existing fuses and replace the fuse elements with solid links and to install fuse savers where required for network protection.

As explained in our Network Balancing Strategy, we tested three alternative options before selecting the preferred approach, which is also the lowest cost solution. The volume of work is site specific, dependant on total 22kV line length and the degree that it is out of balance. The required volumes and costs of work for network balancing is set out in the following table.

Table 7 Summary of required balancing works

Zone substation	Phase Transpositions	Single Phase Balancing Caps	Three Phase Balancing Caps	Unbond Third Phase	Install Third Phase of conductor	Fuse replacement with solid links	Fusesaver installation – no of sites	Phase Plate Correction	2016-20 Cost ($000 2015 direct)	2021-25 Cost ($000 2015 direct)
MSD	33	3	15	1	0	13	12	15	1,817	-
LLG	43	3	11	1	0	13	20	29	810	1,154
SLE	67	4	21	1	0	15	15	38	1,026	1,548
BN	57	17	20	0	18	29	27	38	1,552	2,349
KLO	24	1	14	0	0	2	9	11	517	917
Total	**224**	**28**	**81**	**3**	**18**	**72**	**83**	**131**	**5,722**	**5,968**

Source: AusNet Services

We note that the AER accepted our approach to balancing works in Tranche 1 and 2 of the REFCL program. We have incorporated the learnings from Tranche 1 and Tranche 2 and now included the replacement of fuse savers in Tranche 3. We have determined that fuse savers are

required either where fuses cannot be replaced with solid links because the fault level at a particular location on the network is too high or where fuses are required to provide protection reach for the network. Otherwise, this program is consistent with previous approach. An analysis of the unit costs for Tranche 3 is provided in Attachment 20.

8.6 Line hardening

When an earth fault occurs on a REFCL-protected network, over-voltage on un-faulted phases occurs and can lead to failure of equipment installed on the network. Such equipment failure constitutes a second earth fault on the network, termed a 'cross-country fault' because it is usually remote from the initial fault and always occurs on one of the un-faulted phases.

REFCLs can only deal with multiple earth faults if they all occur on a single phase. With a cross-country fault, the network has two phase-to-earth faults at different locations and high currents will flow in both fault locations. To minimise the risks arising from cross-country faults, equipment that is liable to fail under REFCL voltages must be replaced. Our line hardening program covers two key pieces of equipment: surge arrestors and cables, which are discussed below.

Surge Arrestors

In preparation for Tranche 1, Powercor and AusNet Services jointly conducted tests to determine the whether some existing types of surge arrestors are capable of withstanding 24.2kV. Testing has concluded that two particular types of line surge arrestors that make up 60% of the population of AusNet Services' line surge arrestor fleet do not need replacing as they are capable of withstanding the increased voltages associated with the operation of a REFCL.

AusNet Services' Tranche 3 total line surge arrestor population is 15,673 units. Out of this population, 4,529 units at 1,934 sites need to be replaced to withstand over-voltage events. This is 29% of the surge arrestor population and is less than the overall proportion of 40% that must be replaced. The costs of replacing surge arrestors in relation to each zone substation installation will depend on the number and type of surge arrestors at that location.

Table 8 Summary of required surge arrestor replacements

Zone substation	Unacceptable Surge Arrestor Sites Requiring Replacement	Unacceptable Surge Arrestor Units Requiring Replacement	2016-20 Cost ($000 2015 direct)	2021-25 Cost ($000 2015 direct)
MSD	429	977	1,021	-
LLG	214	511	218	317
SLE	529	1,281	545	793
BN	682	1,559	664	966
KLO	80	201	86	125
Total	**1,934**	**4,529**	**2,533**	**2,200**

Source: AusNet Services

We note that the AER accepted our approach to surge arrestor replacements in Tranche 1 and 2 of the REFCL Program. The approach in this contingent project application is unchanged. An analysis of the unit costs for Tranche 3 is provided in Attachment 20.

Cable Replacement

As noted above, the REFCLs increase the risk that 22kV cables may fail, as they will experience elevated phase-to ground-voltages when a REFCL operates. Following cable failures when testing at the Woori Yallock (**WYK**) zone substation, AusNet Services concluded that a proactive approach is required to identify and repair or replace critical cables in poor condition or insufficiently rated cables prior to operating a REFCL protected network.

As explained in our contingent project application for Tranche 2, following an examination of alternative options, we developed the following approach to address this risk:

1. Desktop and field identification of critical cable types and population currently on the network; and
2. Targeted on-line and off-line testing to confirm if the cables cannot withstand elevated voltages.
    - On-line tests ranging from visual inspection, spot Partial Discharge (PD) measurements using on-line PD measurement devices and non-invasive inspection methods (RF scanners, Ultrasonic and Corona cameras); and
    - Off-line tests ranging from sheath integrity, Dielectric Spectroscopy (DS), Dielectric Dissipation Factor (DDF) and Capacitance, Partial Discharge (PD) and High Voltage (HV) withstand.

Targeted testing ensures all critical feeder cables in a REFCL protected network are appropriately rated and with a sound condition score minimising the risk of failure during REFCL operation. Based on this approach, AusNet Services has proposed a program of:

- proactive cable repair and replacement; and
- reactive cable repair and replacement.

Cables that are identified as being unable to sustain REFCL operation will be either repaired or replaced using a proactive replacement program prior to commissioning the REFCLs. However, not all cables will be tested and testing may fail to identify some cables that could fail under REFCL operation. Accordingly, we anticipate some cables will need to be repaired or replaced on a reactive basis.

The forecasts presented in the table below reflects the updated information obtained during Tranche 1 and, to date, in Tranche 2.

Table 9 Summary of required cable replacements

Zone substation	On-line Tests	Off-line Tests	Repairs	Replacement (m)	2016-20 Cost ($000 2015 direct)	2021-25 Cost ($000 2015 direct)
MSD	5	5	6	0	175	-
LLG	4	4	4	395	79	245
SLE	5	5	6	3,224	359	1,447
BN	8	8	6	2,774	329	1,280
KLO	6	6	4	540	100	317
Total	**28**	**28**	**26**	**6,933**	**1,043**	**3,288**

Source: AusNet Services

In its decision for Tranche 2, the AER accepted our forecasts for cable replacements following a detailed review. As noted above, our assessment for this contingent project application reflects the latest available information, but our approach is unchanged. Further information on the cost analysis is provided in Attachment 20.

8.7 Compatible equipment

Some network equipment is not compatible with REFCL operation and must be upgraded or replaced with equipment that is compatible. This is a separate issue to the network hardening testing, described in section 8.4 above, which is solely concerned with the capability of the equipment to withstand the increased voltage. In contrast, incompatible equipment can prevent correct REFCL operation, prevents the operation of the DFA scheme, or may produce dangerous network conditions with a REFCL in service.

ACRs and sectionalisers will need to be replaced or altered due to their incompatibility with REFCLs.

8.7.1 Automatic Circuit Reclosers (ACRs)

A significant issue arises in relation to existing earth fault protections, which are non-directional. The devices act when they detect earth fault current flow without information on its direction, i.e. whether the fault is 'upstream' or 'downstream' of them. This is not a problem in non-REFCL networks, since all earth fault currents flow only one way – from the zone substation to the fault.

With a REFCL in service, however, earth fault current flows back into the zone substation from un-faulted feeders before a portion (the uncompensated residual current) flows out along the faulted feeder to the fault. Using non-directional feeder earth fault relays with a REFCL in service will lead to tripping of healthy feeders or whole groups of feeders.

To address this issue, AusNet Services will replace or upgrade unsuitable ACRs on feeders connected to REFCLs with new ACRs that have reverse power flow capability. In addition, the new ACRs have more sensitive earth fault detection capability to assist in locating faults when a REFCL operates. AusNet Services' Automatic Circuit Recloser Strategy provides further information on the rationale for the planned scope of work and the alternative options that were considered.

The general DFA and sectionaliser algorithm will require an ACR or equivalent to be present at key points on each feeder to allow the DFA/Sectionalisers to locate a fault with the GFN in service. Without these additional devices, the DFA/Sectionaliser algorithm will not be able to identify which feeder is faulted. As a result, additional ACRs are required to be installed.

Furthermore, as part of the fuse review detailed above in section 8.5, additional ACRs are required as a least cost alternative to the replacement of many fuse sites within a network segment and utilising the much larger protection coverage of the ACR. There is also considerable labour cost savings to be gained from adapting this method. As a result, additional ACRs are required to be installed.

The proposed costs are set out in the following table.

Table 10 Summary of required ACR compatible equipment costs

	Units requiring upgrade	Units requiring replacement	2016-20 Cost ($000s 2015 direct)	2021-25 Cost ($000s 2015 direct)
MSD	1	4	302	-
LLG	1	5	180	156
SLE	5	6	510	187
BN	5	9	396	281
KLO	3	1	98	32
Total	**15**	**25**	**1,486**	**656**

Source: AusNet Services

In its decisions for Tranches 1 and 2, the AER accepted our forecasts for ACR replacements, noting that the costs were lower than the RIS estimates. Our strategy remains unchanged for this contingent project application. Further information on the cost analysis is provided in Attachment 20.

Sectionalisers

Our existing 22kV feeder fault treatment scheme, Distribution Feeder Automation (**DFA**) involves a combination of sectionalising switches, ACR operations plus the use of adjacent feeders to supply feeder sections downstream of a faulted section. The DFA philosophy and technology developed by AusNet Services is unique and plays an important role in maintaining network reliability.

The introduction of REFCLs affects the operation of DFA, such that each 'automated switching zone' in a DFA scheme must be both capacitively balanced and able to detect faults (this capability is impacted by the much lower fault currents as a result of the installation of REFCLs). The existing sectionalisers are unable to detect the low fault current and as such, need to be upgraded to restore the DFA functionality. Additionally, the DFA algorithm operating within the SCADA system is not compatible with REFCL technology, and needs to be rewritten.

The use of DFA significantly increases the number of automated switching zones, which is a feeder section delineated by sectionalising switches. As a consequence, AusNet Services' total network balancing and switch upgrade costs are affected by AusNet Services' historic investment decision to implement DFA in order to improve reliability.

Unless DFA capability is restored, customers will suffer a degradation in reliability outcomes as a result of the REFCL program. In our contingent project applications for Tranches 1 and 2, the AER examined the case for including the costs of rectifying the DFA scheme. In both cases, the AER concluded that the costs should be allowed. In relation to Tranche 2, the AER gave particular consideration to the appropriate regulatory treatment, given the importance of

providing appropriate incentives and promoting the National Electricity Objective. The AER commented as follows:[26]

> *Our investigation of this issue concluded that in periods outside the peak bushfire season, the REFCL cannot operate without the DFA scheme being modified or it will adversely affect customer reliability. This is because a REFCL operating in "reliability mode" will maintain supply into a fault that the DFA scheme cannot identify and isolate without modification. Moreover, AusNet Services invested in DFA to gain a reward under the STPIS which funds its investment in DFA. If the DFA works were not funded, AusNet Services would suffer penalties under the STPIS that exceed the cost of the upgrade, which is not an equitable or efficient outcome. However, compared to compensating AusNet Services for the cost of upgrading the DFA system, we do not consider a direct compensation payment desirable or preferable. This is because a compensation payment would have an equal or greater impact on customer prices but reliability would be reduced compared to our preferred alternative. This would not satisfy the NEO.*

We agree with the AER's reasoning for including the costs of the DFA rectification in Tranche 2. The rationale for the inclusion of the DFA costs are unchanged in relation to Tranche 3 and therefore we have included the costs of the following work:

- Replacement of sectionalisers - these are switches designed to interrupt load current, but not fault current. Similarly to the ACRs (which are designed to interrupt fault current), these sectionalisers do not have the requisite detection sensitivity to support the DFA scheme when a REFCL is in operation and will need to be replaced; and
- DFA algorithm design - the DFA algorithm interprets real time network status data and devises the switching sequence to isolate a faulted switching zone and restore supply to the maximum number of customers achievable, typically within a period of 1 minute.

The estimated number of switches requiring change and total costs to rectify the DFA schemes to ensure reliability is maintained are set out in the table below. The costs reflect the latest available information obtained from Tranches 1 and 2.

Table 11 Reliability expenditure and units required, ($m, $2015 direct)

	2016-2020 Units	2021-2025 Units	2016-20 Cost ($000s 2015 direct)	2021-25 Cost ($000s 2015 direct)
Forecast no. of switches	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]
New ACR units & control box	[C-I-C]	[C-I-C]	[C-I-C]	[C-I-C]

Source: AusNet Services

8.8 Assisting HV customers to achieve Code compliance

Whilst the ESV's amendments to the EDC have clarified that HV customers are responsible for hardening works on their assets, the delivery of the REFCL program depends on the timely completion of this work. It is therefore appropriate for AusNet Services to work with HV customers to provide assistance in relation to understanding the works required and identifying the preferred solution.

[26] AER final decision, AusNet Services Contingent Project, Installation of Rapid Earth Fault Current Limiters (REFCLs) – tranche two, 31 August 2018, page 42.

For example, AusNet Services reimburses the costs of independent consultants engaged by the HV customers to assess the current condition of the HV electrical assets and to recommend the preferred solution. Given the significant dependence of the REFCL Program on the timely remedial work to enable HV customers to comply with the EDC, it is prudent and efficient for the costs of assisting HV customers to be included in this contingent project application.

In addition, to ensure AusNet Services can detect faults and safely operate its network, we will install an ACR at HV customer's site, where they undertake asset hardening works (as opposed to AusNet Services installing an isolating transformer). This is critical for our staff when patrolling lines to identify faults. We consider this is prudent and efficient expenditure and necessary to enable an overall cheaper solution to be implemented at these customers sites. The cost of installing new ACRs reflects the latest available information. The ACR will be owned and operated by AusNet Services and is distinct from work undertaken on the customers' premises.

In its decision on our Tranche 2 contingent project application, the AER accepted the need for ACRs at HV customers' site to mitigate significant risk of a cross-country fault. Our approach in relation to this contingent project application is unchanged, with the exception of adopting the latest cost information.

A summary of the estimated costs in assisting HV customers at each of the Tranche 3 zone substations is set out in the table below.

Table 12 Costs associated with HV customers ($m, $2015 direct)

Zone substation	HV connection points	2016-20 Cost ($000 2015 direct)	2021-25 Cost ($000 2015 direct)
MSD	n/a	n/a	n/a
LLG	1	45	45
SLE	1	45	45
BN	2	91	91
KLO	3	133	133
Total	**7**	**314**	**314**

Source: AusNet Services

8.9 Program management costs

The AER examined our program management office costs in its decision for Tranche 2. The AER noted that on average total per zone substation, AusNet Services' costs of $858 000 (real, $2016) were within 1% of Powercor's costs. The AER also concluded that the respective accounting treatments are reasonable, having regard to the approved Cost Allocation Methodologies.

In this contingent project application, we have adopted the same approach to estimating Program Management Costs.

8.10 Capital Expenditure in the 2021-25 Regulatory Control Period

Clause 6.5.7(f) of the NER describes how capital expenditure for a contingent project, which is expected to be incurred in a subsequent regulatory period, is to be treated. These provisions

are operative where the AER determines under clause 6.6A.2(e)(1)(iii) that the likely completion date for a contingent project is a date which occurs in the immediately following regulatory control period.

AusNet Services is required to complete the Tranche 3 zone substations by 1 May 2023, which is approximately half way through the forthcoming regulatory period. Accordingly, we request that the AER determine pursuant to clause 6.6A.2(e)(1)(iii) that the likely completion date for this contingent project is a date which occurs in the immediately following regulatory control period.

A forecast of the capital expenditure in the 2021-25 regulatory period is set out in Table 15 below.

Table 13 Capex in subsequent regulatory period ($000s 2015 direct)

	2021	2022	2023	2024	2025	Total
Capex in subsequent regulatory period	38,960	24,627	-	-	-	63,587

Source: AusNet Services

8.11 Summary of forecasts

The table below summarises our capital expenditure for each of the six workstreams.

Table 14 Summary of Direct capital expenditure requirements ($000s 2015, direct)

	2016	2017	2018	2019	2020	Total
Zone Substations	-	-	-	6,001	22,153	28,154
Network Balancing	-	-	-	1,392	4,330	5,722
Line and Cable Hardening	-	-	226	850	1,457	2,533
HV customers	-	-	-	16	299	314
Compatible Equipment	-	-	-	495	990	1,486
Other	-	-	-	215	488	703
Total	-	-	**226**	**9,095**	**30,634**	**39,956**

Source: AusNet Services

9 Forecast incremental operating expenditure

9.1 Expenditure categories and drivers

In addition to the capital works, AusNet Services will incur incremental operating expenditure as a result of the installation of REFCLs, requiring additional specialist planning resources and resources to deliver the following activities:

- **Annual testing**

  Annual tests take the form of Primary Earth Fault Testing and Insulation Testing at each site. The first of these tests will be performed as part of the capital installation project for that site. However, annual testing is an on-going operating cost, and has been included in the forecast incremental operating expenditure.

- **Network Balancing**

  This involves monitoring capacitive balance and initiating corrective action where balance is outside range. Forecasting capacitive balance is necessary to ensure that material changes to the network (such as conductor replacement or retirement, and changes in loads or generation) are known in sufficient time to rebalance the network.

- **Fault response and analysis**

  It is expected the time spent on fault response and analysis will increase due to the complexities of the resonant earthing network. A small incremental operating expenditure allowance has been included to address this new activity. It is noted that each Tranche increases the number of REFCLs installed and the requirement for additional analysis on effected feeders.

- **Equipment maintenance**

  Following the installation of the REFCL devices, routine maintenance is required, similar to any other plant and equipment in the zone substation. A small incremental cost has been included in the forecast operating expenditure to perform this routine maintenance.

- **Line equipment purchases**

  The introduction of the REFCL devices imposes higher voltage conditions on existing installed lines infrastructure. Some of the equipment that AusNet Services uses for operating and maintaining the network is not rated to handle these higher voltages. Many of these items are capitalised, but insulated hard covers do not meet the unit cost requirements for capitalization. Therefore the cost of these items has been included as an incremental operating cost.

9.2 Forecasting efficient and prudent operating expenditure

AusNet Services has adopted a 'bottom up' forecasting approach for each of the activities described in section 9.1. The objective of the forecasting method is to determine the efficient and prudent incremental operating expenditure associated with each activity. This forecasting approach is unchanged from Tranche 2.

AusNet Services has adopted 'global' assumptions in relation to the REFCL installation timetable and labour rates, which apply across each of the operating expenditure activities. The labour rates are consistent with the rates adopted by the AER in its 2016-20 EDPR Final Decision. AusNet Services is not seeking to amend these rates or the rate of escalation during the current regulatory control period.

In addition to these global assumptions, AusNet Services has developed specific assumptions regarding the resource requirements for each activity. These assumptions are explained in the relevant supporting documents. In each case, the resource requirements reflect AusNet Services' estimate of the efficient and prudent level of activity.

The AER must accept AusNet Services' operating expenditure forecast if it is satisfied that the forecast reasonably reflects the operating expenditure criteria in the Rules[27], taking into account the expenditure factors in the context of the contingent project. The application of the expenditure factors to this contingent project is discussed in Section 10. For the reasons outlined in the REFCL Program *Operational Requirements* supporting document, AusNet Services considers that the application of its forecasting methodology produces operating expenditure forecasts that comply with the Rules requirements.

9.3 Summary of forecasts

The annual incremental operating expenditure is set out in Table 15 below.

Table 15: Forecast incremental operational costs, $000's, $2015

	2016	2017	2018	2019	2020	Total
Fault response & analysis	-	-	-	-	11.0	11.0
Operating, maintenance and testing instructions	-	-	-	-	-	-
Routine maintenance of zone substation assets	-	-	-	-	-	-
Network Balancing	-	-	-	-	22.3	22.3
Annual Testing	-	-	-	-	-	-
HV Customers	-	-	-	-	-	-
Live line equipment purchases	-	-	-	-	-	-
Training & Change Management	-	-	-	-	-	-
Total	-	-	-	-	**33.4**	**33.4**

Source: AusNet Services

As shown in the above table, in relation to the REFCL devices installed in Tranche 3 of the REFCL Program, incremental operating expenditure of $0.03 million is required in 2020. The operating expenditure for Tranche 3 is all incremental to the operating expenditure already included in Tranche 1 and 2.

For the reasons outlined in section 9.1, each of the operating expenditure activities is required in order to ensure that the network operates safely and reliably during REFCL implementation and the subsequent operation of REFCL equipment.

[27] Clause 6.6A.2(f)(2).

AusNet Services will propose an opex step changes as part of the 2021-25 regulatory proposal to cover the step change required to operate all three tranches of the REFCL program in the 2021-25 period. This consolidated approach to handling all three tranches should make assessment easier for the AER and ensure a consistent approach is applied.

10 Expenditure factors to be considered by the AER

The NER requires the AER to consider a number of operating and capital expenditure factors in its assessment of the forecast expenditure in the contingent project application. These expenditure factors include:

- The substitution possibilities between operating and capital expenditure;
- Whether the expenditure forecast is consistent with any incentive schemes that apply to the distributor;
- The extent the expenditure forecast is referable to arrangements with a person other than the distributor that do not reflect arm's length terms; and
- The extent the distributor has considered, and made provision for, efficient and prudent non-network alternatives.

The following paragraphs comment on each of these factors in turn.

10.1.1 Substitution possibilities between operating and capital expenditure

The capital works are driven by an obligation to comply with new performance standards that apply to each polyphase electric line originating from a list of specified zone substations. As explained in section 4, the installation of REFCL technology is the only feasible method that is capable of complying with the Regulations. At this highest level, there are no substitution possibilities in relation to the proposed project.

However, feasible alternative options are available in determining the strategies for the particular workstreams (such as network balancing) and the scope of the station works as we move beyond the immediate task of installing the GFNs. In some instances, the feasible options include different mixes of operating and capital expenditure, and therefore reflect substitution possibilities.

The incremental operating expenditure activities in relation to the contingent project application are discussed in section 9 and the supporting document, *Operational Requirements*. The nature of many of these activities (such as testing, document updates and reporting) is such that there are no substitution opportunities between operating and capital expenditure.

10.1.2 Consistency with the incentive schemes – reliability impacts

As already noted, the impact of REFCL installation on network reliability was examined in the AER's final decisions on our contingent project applications for Tranches 1 and 2. The Victorian Government queried whether modification of the DFA system is a valid project cost to be included. For the reasons already outlined, however, these matters have been considered by the AER.

The operation of the other economic regulatory regime incentive schemes are unaffected by the contingent project. The implications of REFCL operation on the Victorian Government F-Factor Scheme has been accounted for through the F-Factor Scheme Order in Council gazetted on 22 December 2016. This amends the target ignition risk units for financial year 2019/20.

10.1.3 Related parties

The AER is required to consider the extent the expenditure forecast is referable to arrangements with a person other than the distributor that do not reflect arm's length terms. AusNet Services' related party arrangements were described in detail in Appendix 1C of the Regulatory Proposal for the 2016-20 period. AusNet Services confirms that there are no related party margins in the capital expenditure forecasts presented in this contingent project application.

10.1.4 Non-network alternatives

The nature of the capital expenditure workstreams – being station works, network balancing, line and cable hardening and compatible equipment – is such that there are no practical opportunities for non-network alternatives. In particular, much of the work is focused on ensuring that AusNet Services' network is capable of continuing to provide safe and reliable distribution services with REFCLs in service. Inevitably, the issues to be resolved necessitate capital works in relation to AusNet Services' network assets, rather than non-network solutions.

11 Accelerated Depreciation of Retired Assets

AusNet Services proposes to accelerate depreciation of certain network assets that will be removed from service over the current regulatory period. The nature of the assets and asset classes is such that they will be replaced ahead of the end of their expected economic and/or technical lives. The AER has approved AusNet Services' proposal to accelerate depreciation of certain high bushfire risk assets which have been, or are forecast to be replaced as part of our safety programs and approved this approach in our Tranche 1 and 2 contingent project applications.[28]

AusNet Services' proposal to apply accelerated depreciation to the identified assets in this contingent project application accurately reflects changes to the remaining economic lives of those assets. Accordingly, AusNet Services' proposal conforms to the requirement in NER clause 6.5.5(b)(1)[29].

The methodology undertaken by AusNet Services to determine the proposed accelerated depreciation is unchanged from our approach used in the 2016-20 EDPR proposal and Tranche 2 contingent project application. For this contingent project application AusNet Services has used the following methodology:

1. Identify assets that are to be removed in both the current period (2016-20) and next regulatory control period (2021-25).
2. Estimate opening RAB value of relevant asset classes (as at January 2015).
3. Determine portion of asset class to be accelerated (i.e. proportion removed from asset base).
4. Roll forward the estimated 2015 opening RAB values:-
    a. For assets removed in the current period roll forward the estimated 2015 opening RAB values to January 2019 using a nominal RAB roll forward approach.
    b. For assets to be removed in the following period (2021-25) roll forward the estimated 2015 opening RAB values to January 2021 using a nominal RAB roll forward approach.

Step 1 – Identify assets

The assets considered in AusNet Services' accelerated depreciation proposal include:

- Protection Relays within Zone Substations
- Surge Arrestors;
- Automatic Circuit Reclosers (ACRs);
- Sectionalisers; and
- 22kV HV overhead cables

The proposed protection relay replacements form part of protection and control systems replacement and extension works within zone substations as outlined in section 8.4. The proposed surge arrestor replacement program and proactive 22kV cable replacement program

[28] AER - Final decision, AusNet distribution determination - Attachment 5 - Regulatory depreciation - May 2016, p.5-13

[29] NER clause 6.5.5(b)(1) requires that "the schedules must depreciate using a profile that reflects the nature of the assets or category of assets over the economic life of that asset or category of assets".

each form part of the Line hardening outlined in sections 8.6. ACR replacements and sectionaliser replacements are under compatible equipment investments in section 8.7.

Step 2 – Estimate RAB value of identified asset class

AusNet Services has relied on data within its 2015 Repex Model[30] to establish each asset class's share of the total RAB value. The Repex model contains Electricity Distribution system assets including Network SCADA assets and does not contain IT or Non Network assets. The proportion obtained from the Repex model for each asset class was then separately applied to the 2015 opening RAB values[31] (excluding assets not modelled in the Repex model, such as IT assets) to derive estimated 2015 opening RAB values for each asset class.

In the case of surge arrestors and protection relays the respective shares of total RAB value were determined using the current replacement unit rate multiplied by total volume multiplied by an average remaining life factor (average remaining life / standard life). This depreciated replacement value was then divided into the total depreciated replacement value for all asset classes consistent with the approach used for the other assets identified in step 1 above. The Repex model does not separately track surge arrestors or protection relay systems in zone substations. Instead, they are either incorporated within an aggregated benchmark asset category or allocated across multiple benchmark categories. Therefore this alternate approach was used and is considered management's best estimate of the 2015 opening RAB values.

Step 3 – Determine proportion of identified RAB value to be depreciated

The portion of the asset class that is to be included in the accelerated depreciation proposal is calculated based on forecast replacement volumes included in this contingent project application, as a share of the total volume of assets in each asset class as at January 2015.

The total volume of assets within the identified asset classes are obtained from the 2015 Repex model. In the case of surge arrestors the total volume was taken from AusNet Services' 2016 RIN in lieu of available data within the Repex model. As noted in step 2 above, surge arrestors and protection relays are not captured in a single benchmark asset category within the Repex model, rather they are spread across multiple categories.

Step 4 - Roll forward the estimated 2015 opening RAB values to 1 January 2019

Since the approach described above established the opening RAB values as at January 2015, there is a requirement to roll forward the RAB values to 31 December 2020 to align with the end of the current regulatory period. AusNet Services has applied the AER's standard nominal RAB roll forward approach to establish the January 2019 opening RAB values[32].

AusNet Services therefore proposes to accelerate depreciation over 2019 and 2020 in line with expected timing of certain asset replacements to be undertaken at Mansfield (MSD) Zone Substation and along three MSD feeders. To facilitate this in the Proposed Amended Post Tax Revenue Model ("PTRM") we have established a new asset class 'Accelerated Depr - Distr assets (Contingent Project 3)'. The calculations are provided in the amended RAB depreciation model[33] which is provided as a supporting attachment to this contingent project application.

In summary, AusNet Services' proposed accelerated depreciation allowance for selected assets in the current control period is $0.32 million ($Nominal) as shown in the table below.

30 2015 Repex Model owned and maintained by the Regulatory & Network Strategy team within AusNet Services.

31 Opening RAB values obtained from the AER Final Decision Roll Forward Model, May 2016.

32 Using forecast inflation consistent with the AER's Amended Final Decision for 2016-20 period.

33 AusNet Services' Amended RAB Depreciation model. The PTRM depreciation schedule for the opening RAB has been updated accordingly.

Table 16 Proposed Accelerated Depreciation Allowance – Current Period ($m, nominal)

	2016	2017	2018	2019	2020	Total
Accelerated Depreciation	-	-	-	$0.16	$0.16	$0.32

Source: AusNet Services

In addition, AusNet Services proposes to accelerate a further $2.68 million ($Nominal) in the next regulatory control period (2021-25) relating to assets replaced at Kalkallo (**KLO**), Benalla (**BN**), Lang Lang (**LLG**) and Sale (**SLE**).

The remaining value of these assets as at January 2021 has been calculated using the approach outlined above, i.e., by establishing the 2015 estimated opening values and rolling forward to January 2021 using a nominal RAB roll forward approach.

As shown in Table 17 below, the remaining RAB value shall be accelerated over the first two years of the period (2021-22) in line with construction dates at these four sites. AusNet Services will include this forecast of accelerated depreciation within its forthcoming 2021-25 Electricity Distribution Revenue Proposal.[34]

Table 17 Proposed Accelerated Depreciation Allowance – 2021-25 Period ($m, nominal)

	2021	2022	2023	2024	2025	Total
Accelerated Depreciation	$1.34	$1.34	-	-	-	$2.68

[34] In accordance with AusNet Services' 2021-25 Electricity Distribution Revenue Proposal - Regulatory Depreciation chapter

12 Incremental revenue requirement

12.1 Introduction

This section presents information on the incremental revenue requirement of the contingent project described in this application. We have used the post-tax building block approach outlined in NER 6.5.4, and the AER's post-tax revenue model to calculate the incremental revenue requirement. Information that explains and substantiates the forecast incremental capital and operating expenditure has been set out in sections 8 and 9.

The building block formula applied in each year of the regulatory control period is:

MAR = return on capital + return of capital + opex + revenue adjustments + tax

= (WACC x RAB) + D + opex + revenue adjustments + tax

where:

MAR = Maximum allowed revenue

WACC = Post tax nominal weighted average cost of capital

RAB = Regulatory Asset Base

D = Economic depreciation (nominal depreciation minus indexation of the RAB)

Opex = Operating and maintenance expenditure

Revenue adjustments = efficiency benefit sharing scheme carry-overs, forecast DMIA, 2010 S-factor scheme close out and shared asset adjustments

Tax = Cost of corporate income tax of the regulated business

The sections below set out further information on each building block component of the incremental revenue requirement. Details regarding the total incremental revenue allowance and the amended revenue determination to enable recovery of the contingent project costs are provided at the conclusion of this section.

12.2 Regulated asset base and depreciation

The forecast RAB in relation to the contingent project is set out in the table below. These values incorporate the capital expenditure plans set out in section 1, and the forecast depreciation over the period.

Table 18 Contingent Project Regulatory Asset Base ($m, nominal)

	2016	2017	2018	2019	2020
Contingent project Opening RAB	-	0.5	0.5	0.5	11.2
Contingent project capital expenditure[35]	0.5	-	-	10.6	36.7
CPI indexation on opening RAB	-	0.0	0.0	0.0	0.3
Contingent project depreciation	-	-0.0	-0.0	0.1	-0.4
Contingent project Closing RAB	**0.5**	**0.5**	**0.5**	**11.2**	**47.9**

Source: AusNet Services PTRM.

The regulatory depreciation in relation to this contingent project has been calculated using the straight-line depreciation method and the standard asset lives approved by the AER in its final decision for the 2016-20 regulatory period. Full details of this calculation are provided in the updated PTRM which is submitted as part of this contingent project application.

For completeness, the table below shows the derivation of the regulatory asset base (**RAB**) for the 2016-20 period, sourced from the AER's Final Determination PTRM model and updated for the 2019 cost of debt in accordance with the Final Determination WACC requirements and Tranches 1 and 2 of this REFCL Program.

Table 19 AER's Final Decision Regulatory Asset Base 2016-20 ($m, nominal)

	2016	2017	2018	2019	2020
Opening RAB	3,442.1	3,685.3	4,025.4	4,338.0	4,674.7
Capital expenditure	346.3	427.7	405.6	433.3	390.8
CPI indexation on opening RAB	80.9	86.6	94.6	101.9	109.8
Straight-line depreciation	-183.9	-174.2	-187.5	-198.6	-215.3
Closing RAB	**3,685.3**	**4,025.4**	**4,338.0**	**4,674.7**	**4,960.0**

Source: AusNet Services PTRM.

Table 20 below shows the amended RAB for the 2016-20 period, which reflects the summation of the values set out in Table 18 and Table 19.

[35] Note: the capital expenditure reported in 2016 reflects the change in equity raising costs over the regulatory period.

Table 20 AusNet Services' Amended Regulatory Asset Base ($m, nominal)

	2016	2017	2018	2019	2020
Amended Opening RAB	3,442.1	3,685.8	4,025.8	4,338.5	4,685.9
Amended Capital expenditure	346.7	427.7	405.6	444.0	427.5
CPI indexation on opening RAB	80.9	86.6	94.6	101.9	110.1
Amended Straight-line depreciation	-183.9	-174.2	-187.5	-198.5	-215.7
Amended Closing RAB	**3,685.8**	**4,025.8**	**4,338.5**	**4,685.9**	**5,007.9**

Source: AusNet Services PTRM.

12.3 Return on capital

The return on capital in relation to the contingent project has been calculated by applying the AER's estimated post-tax nominal vanilla WACC to the regulatory asset base, in accordance with the AER's 2016-2020 EDPR Final Decision. This calculation is shown in the table below.

Table 21 Return on capital for contingent project, 2016-20 ($m, nominal)

	2016	2017	2018	2019	2020
Contingent project RAB for revenue calculation purposes	-	0.5	0.5	0.5	11.2
WACC (percent per annum)[36]	6.31%	6.27%	6.24%	6.18%	6.18%
Contingent project return on capital	**-**	**0.0**	**0.0**	**0.0**	**0.7**

Source: AusNet Services PTRM.

For completeness, Table 22 below shows the return on capital for the 2016-20 period, as set out in the AER's Final Determination, updated to include its decision on Tranches 1 and 2 of the REFCL contingent project application and updates to the annual WACC allowance.

Table 22 AER's Final Decision Return on capital, 2016-20 ($m, nominal)

	2016	2017	2018	2019	2020
RAB for revenue calculation purposes	3,442.1	3,685.3	4,025.4	4,338.0	4,674.7
WACC (percent per annum)[37]	6.31%	6.27%	6.24%	6.18%	6.18%
Return on capital	**217.3**	**230.9**	**251.2**	**268.2**	**289.0**

Source: AusNet Services PTRM.

Table 23 below shows the amended return on capital for the 2016-20 period, which reflects the summation of the values set out in Table 21 and Table 22.

36 Updated annually for return on debt.

37 Updated annually for return on debt.

Table 23 AusNet Services' Amended return on capital, 2016-20 ($m, nominal)

	2016	2017	2018	2019	2020
Amended RAB for revenue calculation purposes	3,442.1	3,685.8	4,025.8	4,338.5	4,685.9
WACC (percent per annum)[38]	6.31%	6.27%	6.24%	6.18%	6.18%
Amended return on capital	**217.3**	**230.9**	**251.2**	**268.2**	**289.7**

Source: AusNet Services PTRM.

12.4 Tax allowance

The calculation of estimated corporate income tax attributable to the contingent project has been undertaken in accordance with the provisions set out in clause 6.5.3 of the NER. The estimated tax allowance is shown in the table below.

Table 24 Estimated cost of corporate tax for contingent project, 2016-20 ($m, nominal)

	2016	2017	2018	2019	2020
Tax payable	-	-0.0	-0.0	-0.1	-0.0
Less value of imputation credits	-	0.0	0.0	0.0	0.0
Net corporate income tax allowance	**-**	**-0.0**	**-0.0**	**-0.0**	**-0.0**

Source: AusNet Services PTRM.

For completeness, the table below shows the corporate tax allowance for the 2016-20 period, as set out in the AER's Final Determination updated to include its decision on Tranches 1 and 2 of the REFCL contingent project applications.

Table 25 AER's Final Decision on corporate tax allowance, 2016-20 ($m, nominal)

	2016	2017	2018	2019	2020
Tax payable	55.1	44.8	45.9	48.3	47.2
Less value of imputation credits	-22.0	-17.9	-18.4	-19.3	-18.9
Net corporate income tax allowance	**33.0**	**26.9**	**27.6**	**29.0**	**28.3**

Source: AusNet Services PTRM.

Table 26 below shows the amended tax allowance for the 2016-20 period, which reflects the summation of the values set out in Table 24 and Table 25.

[38] Updated annually for return on debt.

Table 26 AusNet Services' Amended corporate tax allowance, 2016-20 ($m, nominal)

	2016	2017	2018	2019	2020
Tax payable	55.1	44.8	45.9	48.2	47.2
Less value of imputation credits	-22.0	-17.9	-18.4	-19.3	-18.9
Amended net corporate income tax allowance	**33.0**	**26.9**	**27.5**	**28.9**	**28.3**

Source: AusNet Services PTRM.

12.5 Incremental operating expenditure

AusNet Services' operating expenditure forecasts for this contingent project are described in section 1 of this proposal.

The table below shows the operating expenditure allowance for the 2016-20 period set out in the AER's Final Determination updated to include its decision on Tranche 1 of the REFCL CPA. Also shown is the amended operating expenditure allowance for the 2016 period, which is the sum of the AER's Final Determination allowance and the incremental operating expenditure for the contingent project.

Table 27 Amended operating expenditure allowance, 2016-20 ($m, nominal)

	2016	2017	2018	2019	2020
Contingent project operating expenditure	-	-	-	-	0.04
Opex allowance, AER Final Determination (updated)	230.4	240.2	251.8	262.7	275.1
Revised operating expenditure allowance	**230.4**	**240.2**	**251.8**	**262.7**	**275.14**

Source: AusNet Services

12.6 Incremental revenue allowance

The table below shows the building block elements that comprise the incremental revenue requirement for the contingent project over the 2016-20 period.

Table 28 Contingent project revenue requirement, 2016-20 ($m, nominal)

	2016	2017	2018	2019	2020	Total
Return on capital	-	0.0	0.0	0.0	0.7	0.8
Regulatory depreciation	-	-0.0	-0.0	-0.1	0.1	0.0
Operating expenditure	-	0.0	0.0	0.0	0.0	0.0
Revenue adjustments	-	-	-	-	-	-
Net tax allowance	-	-0.0	-0.0	-0.0	-0.0	-0.1
Annual revenue requirement (unsmoothed)	-	0.0	0.0	-0.1	0.8	0.8
Annual revenue requirement (smoothed)	**-**	**-**	**-**	**-**	**0.8**	**0.8**

Source: AusNet Services

12.7 Revised revenue determination

Table 29 below shows the revenue allowance and X factors for the 2016-20 period sourced from the AER's Final Determination and updated to include its decision on Tranche 1 and 2 of the REFCL contingent project application. Accordingly, the 2020 X Factor has been updated to determine the smoothed revenue requirement shown in Table 30.

Table 29 AER Final Determination revenue requirement, 2016-20 ($m, nominal)

	2016	2017	2018	2019	2020	Total
Return on capital	217.3	230.9	251.2	268.2	289.0	1,256.6
Regulatory depreciation	103.0	87.6	92.9	96.7	105.5	485.7
Operating expenditure	230.4	240.2	251.8	262.7	275.1	1,260.1
Revenue adjustments	5.3	-6.4	-3.6	16.2	0.1	11.6
Net tax allowance	33.0	26.9	27.6	29.0	28.3	144.8
Annual revenue requirement (unsmoothed)	**589.0**	**579.3**	**619.8**	**672.7**	**698.0**	**3,158.7**
Annual expected revenue (smoothed)	**586.0**	**597.9**	**623.0**	**656.9**	**692.6**	**3,156.4**
X factor[39]	8.27%	0.30%	-1.84%	-3.01%	-3.01%	

[39] The X factors from 2018 to 2020 will be revised to reflect the annual return on debt update. Under the CPI–X framework, the X factor measures the real rate of change in annual expected revenue from one year to the next.

The table below shows our amended revenue requirement, which includes the contingent project Tranche 3 revenue requirement.

Table 30 Amended revenue requirement, 2016-20 ($m, nominal)

	2016	2017	2018	2019	2020	Total
Return on capital	217.3	230.9	251.2	268.2	289.7	1,257.4
Regulatory depreciation	103.0	87.6	92.9	96.6	105.6	485.7
Operating expenditure	230.4	240.2	251.8	262.7	275.1	1,260.1
Revenue adjustments	5.3	-6.4	-3.6	16.2	0.1	11.6
Net tax allowance	33.0	26.9	27.5	28.9	28.3	144.7
Annual revenue requirement (unsmoothed)	**589.0**	**579.3**	**619.8**	**672.6**	**698.8**	**3,159.4**
Annual expected revenue (smoothed)	**586.0**	**597.9**	**623.0**	**656.9**	**693.3**	**3,157.1**
X factor[40]	8.27%	0.30%	-1.84%	-3.01%	-3.13%	

[40] The X factors from 2018 to 2020 will be revised to reflect the annual return on debt update. Under the CPI–X framework, the X factor measures the real rate of change in annual expected revenue from one year to the next.

13 List of supporting documents

The following documents are provided as attachments to this document.

Table 31 Attachment List

Attachment	Title
Attachment 1	REF 70-23 REFCL Program - MSD Functional Scope v1.0
Attachment 2	REF 70-24 REFCL Program - LLG Functional Scope v1.0
Attachment 3	REF 70-25 REFCL Program - SLE Functional Scope v1.0
Attachment 4	REF 70-26 REFCL Program - BN Functional Scope v1.0
Attachment 5	REF 70-27 REFCL Program - KLO Functional Scope v1.0
Attachment 6	REFCL Program - Equipment Building Block Functional Description Issue 3
Attachment 7	REFCL Program Network Balancing Strategy Issue 2
Attachment 8	REF 20-10 REFCL Program Primary Assets Hardening Strategy Issue 1
Attachment 9	REF 20-07 REFCL Program Line Hardening Strategy v0.4 - PUBLIC
Attachment 10	REF 20-08 Compatible Equipment Automatic Circuit Recloser Strategy Issue 2
Attachment 11	REF 20-09 REFCL Program Voltage Regulator Strategy Issue 2
Attachment 12	REF 20-13 REFCL Program Distribution Feeder Automation Strategy Issue 1
Attachment 13	Operating Modes Policy - REF 30-16 - PUBLIC
Attachment 14	REF 30-04 REFCL Program - Arc Suppression Coil Sizing Policy Issue 3
Attachment 15	REF 30-10 REFCL Program HV Customer Policy Issue 3 - PUBLIC
Attachment 16	REF 70-22 REFCL Program - Cost Estimating and Program Delivery v3.0 - PUBLIC
Attachment 17	BFM 10-01 BFM Plan Distribution v25 - PUBLIC
Attachment 18	REF 70-28 REFCL Program T3 HV Customer Engagement Overview v1.0 - PUBLIC
Attachment 19	REF 70-29 REFCL Program T3 HV Customers v1.0 - CONFIDENTIAL
Attachment 20	Capex Unit Rate Analysis - PUBLIC
Attachment 21	KLO overview presentation - CONFIDENTIAL

Table 32 Model List

Attachment	Title
Attachment 22	AST Contingent Project 3 Total Cost Model - CONFIDENTIAL
Attachment 23	AER - AST 2019 debt update PTRM - REFCL T3_CONFIDENTIAL
Attachment 24	AST Distribution Amended Depreciation model - Public
Attachment 25	T3 HV customer model - CONFIDENTIAL
Attachment 26	Cables - Condition and Criticality in Sections - CONFIDENTIAL
Attachment 27	DFA reliability model - CONFIDENTIAL
Attachment 28	Capacitance Forecast model - CONFIDENTIAL

14 Compliance Checklist

This document and the accompanying supporting documents provide the following information in accordance with the National Electricity Rules[41]:

Table 33 Compliance Checklist

Rule provision	Requirement	Relevant section
Part C: Building block determinations for standard control services		
6.6A	Contingent Projects	
6.6A.2(a)	Subject to paragraph (b), a Distribution Network Service Provider may, during a regulatory control period, apply to the AER to amend a distribution determination that applies to that Distribution Network Service Provider where a trigger event for a contingent project in relation to that distribution determination has occurred.	Noted
6.6A.2(b)	An application referred to in paragraph (a):	Noted
6.6A.2(b)(1)	must not be made within 90 business days prior to the end of a regulatory year;	Noted
6.6A.2(b)(2)	subject to subparagraph (1), must be made as soon as practicable after the occurrence of the trigger event;	Noted
6.6A.2(b)(3)	must contain the following information:	Noted
6.6A.2(b)(3)(i)	an explanation that substantiates the occurrence of the trigger event;	Section 3.1
6.6A.2(b)(3)(ii)	a forecast of the total capital expenditure for the contingent project;	Section 8.10
6.6A.2(b)(3)(ii)	a forecast of the capital and incremental operating expenditure, for each remaining regulatory year which the Distribution Network Service Provider considers is reasonably required for the purpose of undertaking the contingent project;	Section 1
6.6A.2(b)(3)(iv)	how the forecast of the total capital expenditure for the contingent project meets the threshold as referred to in clause 6.6A.1(b)(2)(iii);	Section 3.2
6.6A.2(b)(3)(v)	the intended date for commencing the contingent project (which must be during the regulatory control period);	Section 6

41 NER, clause 6.6A.2(b).

Rule provision	Requirement	Relevant section
Part C: Building block determinations for standard control services		
6.6A	Contingent Projects	
6.6A.2(b)(3)(vi)	the anticipated date for completing the contingent project (which may be after the end of the regulatory control period);	Section 8.10
6.6A.2(b)(3)(vii)	an estimate of the incremental revenue which the Distribution Network Service Provider considers is likely to be required to be earned in each remaining regulatory year of the regulatory control period as a result of the contingent project being undertaken as described in subparagraph (iii); and	Section 12
6.6A.2(b)(4)	the estimate referred to in subparagraph (3)(vii) must be calculated:	Noted
6.6A.2(b)(4)(i)	in accordance with the requirements of the post-tax revenue model referred to in clause 6.4.1;	Section 12
6.6A.2(b)(4)(ii)	in accordance with the requirements of the roll forward model referred to in clause 6.5.1(b);	Section 12
6.6A.2(b)(4)(iii)	using the allowed rate of return for that Distribution Network Service Provider for the regulatory control period as determined in accordance with clause 6.5.2;	Section 12
6.6A.2(b)(4)(iv)	in accordance with the requirements for depreciation referred to in clause 6.5.5; and	Section 12
6.6A.2(b)(4)(v)	on the basis of the capital expenditure and incremental operating expenditure referred to in subparagraph (3)(iii).	Section 12
6.6A.2(i)	A Distribution Network Service Provider must provide the AER with such additional information as the AER requires for the purpose of making a decision on an application made by that Distribution Network Service Provider under paragraph (a) within the time specified by the AER in a notice provided to the Distribution Network Service Provider by the AER for that purpose.	Noted

Source: AusNet Services