# AusNet Transmission Group Pty Ltd

## Transmission Revenue Review 2017-2022

## Appendix 5D: Proposed operating and maintenance expenditure step changes (2017 – 2022)

**Submitted: 30 October 2015**

# ISSUE/AMENDMENT STATUS

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## Disclaimer



## Contact

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# 1 Introduction

This paper provides information about the proposed step changes in operating expenditure presented in the Revenue Proposal for 2017-18 to 2021-22. This paper should be read in conjunction with Chapter 5 of the Revenue Proposal.

The forecast step changes represent operating expenditure above that incurred in the 2014-15 base year that will be required to achieve the operating objectives during the forthcoming regulatory control period.

The table below summarises AusNet Services' forecast total step change opex of $13.5 million (real 2016-17). These step changes have been forecast consistent with the principles and requirements of relevant NER provisions and the AER's Expenditure Forecasting Assessment Guideline.

**Table 1: Summary of forecast step change opex ($m, real 2016-17)**

| Step change | 2017-18 | 2018-19 | 2019-20 | 2020-21 | 2021-22 | Total |
|---|---|---|---|---|---|---|
| Establishment of IT security team | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | **3.3** |
| New emergency response arrangements | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | **1.0** |
| SAIP roll out | 0.3 | 0.3 | 0.1 | 0.1 | 0.1 | **0.9** |
| West Melbourne Terminal Station (WMTS) mobile switchboard* | 0.7 | 0.3 | 0.3 | 0.7 | 0.1 | **2.0** |
| Synchronous condenser decommissioning* | 4.3 | 0.0 | 0.0 | 0.0 | 0.0 | **4.3** |
| Morwell Power Station decommissioning* | 1.9 | 0.0 | 0.0 | 0.0 | 0.0 | **1.9** |
| **Total** | **8.2** | **1.5** | **1.2** | **1.6** | **1.0** | **13.5** |

Source: AusNet Services

* Non-recurrent step change

# 2 Rule and Guideline Requirements

Under NER 6A.6.6, TNSPs are required to submit the total forecast operating expenditure that is required to achieve each of the following (the operating expenditure objectives):

1) Meet or manage the expected demand for prescribed transmission services over that period;

2) Comply with all applicable regulatory obligations or requirements associated with the provision of prescribed transmission services;

3) Maintain the quality, reliability and security of supply of prescribed transmission services; and

4) Maintain the reliability, safety and security of the transmission system through the supply of prescribed transmission services.

In addition, the AER's Explanatory Statement to the Expenditure Forecasting Assessment Guideline (the Guideline) sets out the AER's approach to assessing step changes. The AER's approach is summarised as follows:

> *"We are required to determine capex and opex forecasts that reasonably reflect the efficient costs a prudent operator would require to achieve the expenditure objectives. The expenditure objectives include compliance with regulatory obligations or requirements. Regulatory obligations or requirements may change over time, so a NSP may face a step up or down in the expenditure it requires to comply with its obligations.*
>
> *Another important consideration is the impact of the forecast capital program on opex (and vice versa), since there is a degree of substitutability between capex and opex. A NSP may choose to bring forward the replacement of certain assets (compared to its previous practice)*

*and avoid maintenance expenditure, for example. Such an approach may be prudent and efficient.*

*Our likely approach is to separately identify and assess the prudence and efficiency of any forecast cost increases associated with new regulatory obligations and capex/opex trade-offs. We may use several techniques to do this, including examining the economic justification for the investment or expenditure decisions and technical expert review of the inputs into this analysis."*[1]

The AER's assessment approach therefore provides opex additional to base costs where this is necessary to comply with new or changed regulatory obligations or implement a capex/opex trade-off. Consistent with the AER's approach, AusNet Services has forecast step change opex for:

- New or changed regulatory obligations, including:
  - Establishment of an IT security team;
  - New emergency response arrangements;
- Capex/opex trade-offs, including:
  - Smart Aerial Image Processing (SAIP) roll out; and
  - WMTS mobile switchboard.

The AER has also recognised that:

*"Any other costs base opex and the rate of change do not compensate [sic] can be added as a step change. When assessing step changes particular consideration must be given to whether the costs are already compensated for elsewhere in the opex forecast."*[2]

AusNet Services also intends to remove from service a number of transmission assets during the forthcoming regulatory control period. Because carrying out substantial decommissioning works is not reflected in AusNet Services base costs, one-off, non-recurrent step change opex has been forecast to fund the decommissioning of:

- Synchronous condensers (SCOs) at the Fishermans Bend (FBTS), Brooklyn (BLTS) and Templestowe Terminal Stations (TSTS), which have either been retired or AusNet Services is proposing to retire, subject to advice from AEMO; and
- Transmission assets at Morwell Power Station (MPS) that will be decommissioned due to the closure of MPS.

In identifying step changes for the forthcoming regulatory control period, AusNet Services has taken the opex criteria into account. In particular, AusNet Services has ensured that any proposed step changes reasonably reflect the efficient costs of achieving the opex objectives. The price impact of these step changes has also been carefully considered, given the impact of opex growth on transmission charges borne by customers.

The following table summarises how AusNet Services' proposed step changes satisfy the requirements of the NER and the Guidelines.

**Table 2: Justification for opex step changes**

| Driver | Step change | Relevant NER clause | Justification |
|---|---|---|---|
| **New or changed regulatory obligations** | Establishment of IT security team | NER 6A.6.6(a)(2) sets out the following operating expenditure objective: 'Comply with all applicable regulatory obligations or requirements associated with the provision of prescribed transmission services'.<br><br>NER 6A.6.6(a)(3)(iv) also requires a TNSP to 'maintain the reliability and security of | This step change relates to expenditure that AusNet Services must incur to align its IT security program with ASIC's view of global industry best practice.<br><br>Given the potential impact of a successful cyber-security attack on the reliability and security of the Victorian transmission network, AusNet Services considers the forecast expenditure is also integral to the achievement of NER |

[1] AER (2013) *EFA Guideline Explanatory Statement*, November 2013, p.51

[2] Ibid., p.61

| Driver | Step change | Relevant NER clause | Justification |
|---|---|---|---|
| | | the transmission system through the supply of prescribed transmission services'.<br><br>Further, NER 6A.6.6(c)(2) requires the AER to accept the total opex forecast if it is satisfied that it reasonably reflects, among other things, 'the costs that a prudent operator would require to achieve the operating expenditure objectives'. | 6A.6.6(a)(3)(iv) and reflects expenditure that a prudent operator would incur. |
| | New emergency response arrangements | NER 6A.6.6(a)(2) sets out the following operating expenditure objective: 'Comply with all applicable regulatory obligations or requirements associated with the provision of prescribed transmission services'. | This step change relates to expenditure that AusNet Services must incur to comply with changed regulatory requirements over and above those reflected in base year opex or any other element of the opex forecast. |
| **Capex/opex trade-offs** | Smart Aerial Imaging Processing Technology roll out | NER 6A.6.6(a)(3)(iv) requires a TNSP to 'maintain the reliability and security of the transmission system through the supply of prescribed transmission services'.<br><br>NER 6A6.6(a)(4) also requires a TNSP to 'maintain the safety of the transmission system through the supply of prescribed transmission services'.<br><br>Further, NER 6A.6.6(e)(6) requires the AER to consider "the substitution possibilities between operating and capital expenditure" when assessing the total opex forecast against the opex criteria and objectives.<br><br>Finally, the National Electricity Objective (NEO) is 'to promote efficient investment in, and efficient operation and use of, electricity services for the long term interests of consumers of electricity with respect to –<br>1. price, quality, safety, reliability, and security of supply of electricity; and<br>2. the reliability, safety and security of the | The proposed step change is required to maintain asset condition and current levels of reliability, safety and security of the transmission system.<br><br>The proposed step change is also justified under the NEO as it will allow future capex to be avoided that, if spent, would inefficiently increase the price pressure faced by electricity consumers over the long term. |
| | WMTS mobile switchboard | | The proposed step change is required to maintain asset condition and current levels of reliability, safety and security of the transmission system.<br><br>In particular, given the safety risks associated with the condition of the WMTS 22kV switchboard, the proposed expenditure is critical to ensuring the safety of the transmission system. |

| Driver | Step change | Relevant NER clause | Justification |
|---|---|---|---|
| | | national electricity system.' | |
| Asset decommissioning | Synchronous condenser decommissioning | NER 6A.6.6(c)(6) requires the AER to consider whether total opex forecast reasonably reflects 'the efficient costs of achieving the operating expenditure objectives" and "the costs that a prudent operator would require to achieve the operating expenditure objectives'. | These step changes relate to opex that a prudent TNSP would require over the forthcoming period that is not reflected in base opex or any other element of the opex forecast. This expenditure should therefore be approved to determine a forecast of total opex that reasonably reflects the opex objectives.<br><br>These step changes are also one-off costs driven by third party decisions, over which AusNet Services has no control. |
| | Morwell Power Station decommissioning | | |

Source: AusNet Services

# 3 New or changed regulatory obligations

The AER has recognised that where new or changed regulatory obligations result in additional opex requirements that are not reflected in base opex, or in historical productivity change where this is used to forecast productivity, step changes may be required. However, the AER has acknowledged that it is difficult to determine the impact of past regulatory change on historical expenditure. This information would be required to assess the extent to which future opex increases caused by regulatory change are compensated by the productivity forecast (where this is based on historical productivity). Accordingly, the AER has stated:

> *"Where a service provider can demonstrate that its proposed forecast includes efficient costs due to a changed regulatory obligation we will consider whether the additional costs are accounted for in the productivity growth on a case by case basis."*[3]

AusNet Services has identified a number of step changes in response to regulatory change that it considers are not reflected in historical productivity growth. This is because the proposed step changes are driven by changes in regulatory obligations or requirements in excess of the historic trend in cost increases caused by such changes.

## 3.1 Establishment of IT security team

### 3.1.1 Description

The risk of cyber-security attacks has been steadily growing in recent years on a global scale. The consequences of these threats are especially severe for critical infrastructure providers, such as electricity distribution and transmission networks. AusNet Services transmission network has been identified as national critical infrastructure by the Australian Attorney General's department.

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A recent PricewaterhouseCooper survey on cyber risks that involved more than 9,700 security, IT, and business executives found that:

[3] AER (2015) *TransGrid transmission determination 2015–18, Final decision: Attachment 7 – Operating expenditure*, April 2015, p. 47.

> *"The total number of security incidents detected by respondents climbed to 42.8 million this year, an increase of 48% over 2013. That's the equivalent of 117,339 incoming attacks per day, every day. Taking a longer view, our survey data shows that the compound annual growth rate (CAGR) of detected security incidents has increased 66% year-over-year since 2009."*

In March 2015, the Australian Securities and Investments Commission (ASIC) published its Cyber resilience: Health Check report, recommending a cyber-security framework for ASX-listed organisations. This framework is the U.S. National Institute of Standards and Technology Cyber Security Framework for Critical Infrastructure (NIST-CSFCI). Accordingly, AusNet Services is proposing expenditure to establish a dedicated security monitoring and response team to align its IT security program with NIST-CSFCI.

ASIC notes that the "NIST Cybersecurity Framework is being adopted by critical infrastructure providers in the United States, including those operating in financial services and markets." Accordingly, adopting NIST would align AusNet Services' IT security program with global industry best practice.

Given the potential consequences of a successful cyber-security attack on its network and the expectations of ASIC, AusNet Services considers that its proposed expenditure to adopt NICF-CSFCI reflects expenditure that a prudent and efficient network operator would incur. Specifically, AusNet Services has interpreted ASIC's expectations on IT security for ASX-listed entities as a change in its operating environment that is equivalent to a new compliance obligation. The proposed expenditure is, therefore, consistent with the AER's step change assessment criteria.

In light of ASIC's explicit recommendation, AusNet Services could suffer considerable reputational damage were a successful cyber-attack to take place on its network that could have been prevented by the implementation of NIST-CSFCI. Accordingly, while the risk associated with a 'do nothing' option has not been quantified, it is considered substantive enough to warrant the expenditure associated with this step change.

### 3.1.2 Costs

The following table sets out AusNet Services' proposed expenditure for the establishment of an IT security team. These costs are based on quotes obtained from security contractors and vendors. The proposed costs reflect monitoring efforts that are specifically targeted at protecting transmission SCADA systems, field devices and communications networks and hence should be recovered solely through AusNet Services' transmission network revenues.

**Table 3: Forecast opex for establishment of IT security team ($m, real 2016-17)**

| Establishment of IT security team | 2017-18 | 2018-19 | 2019-20 | 2020-21 | 2021-22 | Total |
|---|---|---|---|---|---|---|
| 24/7 operations team | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | **2.4** |
| Operating systems & network device patching analyst | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | **0.5** |
| Software maintenance cost | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | **0.4** |
| **Total** | **0.7** | **0.7** | **0.7** | **0.7** | **0.7** | **3.3** |

Source: AusNet Services

## 3.2 New emergency response arrangements

### 3.2.1 Description

AusNet Services is proposing expenditure to comply with the greater emergency management and response capacity required of it as a result of the recently established Emergency Management Victoria (EMV) and The Office of The Inspector General of Emergency Management. These organisations were established through an amendment to the Emergency Management Act 2013.

As a result of these changes, which came into effect 1 July 2015, EMV will have capacity to activate the State Control Centre (SCC) in response to emergencies – a location at which AusNet Services will be expected to provide a proportionately increased level of assistance and liaison.

This uplift in activity will be most immediately apparent over the 2015-16 bushfire season when the potential for AusNet Services being required to deploy Emergency Management Liaison Officers (EMLOs) to the State Control Centre (SCC) is greatest. It is then planned that the degree of availability will expand from a 'fire season roster' to a 24/7 year round roster to respond to floods, storms and all other forms of disruptive emergencies. All of these requirements are in addition to, not instead of the previous counter terrorism responsibilities.

AusNet Services has forecast that to comply with the new emergency response arrangements outlined above, additional opex will be required from 2015-16 for:

- Training purposes to ensure a sufficient number of EMLOs are available for deployment during emergencies;
- Staff costs associated with on-call allowances and overtime to be paid during predicted deployments;
- Audit fees to undertake an annual (newly legislated) Risk Management Plan Audit; and
- Carrying out an annual emergency exercise that has been uplifted from a terrorism event to a more onerous “all hazards” type event.

Because of the risks associated with a “do nothing” option (e.g. penalties for non-compliance with the legislated obligations), doing nothing is not considered a prudent option.

### 3.2.2 Costs

The following table sets out AusNet Services’ forecast expenditure for this step change. The forecast reflects internal estimates of the additional labour and financial resources required to address the changed obligations outlined above.

**Table 4: Forecast opex for compliance with new emergency response arrangements ($m, real 2016-17)**

| New emergency response arrangements | 2017-18 | 2018-19 | 2019-20 | 2020-21 | 2021-22 | Total |
|---|---|---|---|---|---|---|
| Training and staff induction | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | **0.19** |
| Attendance at State Control Centre | 0.11 | 0.11 | 0.11 | 0.11 | 0.11 | **0.54** |
| Audit of Risk Management Plan | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | **0.06** |
| Emergency exercise | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | **0.22** |
| **Total** | **0.20** | **0.20** | **0.20** | **0.20** | **0.20** | **1.01** |

Source: AusNet Services

# 4 Capex/opex trade-offs

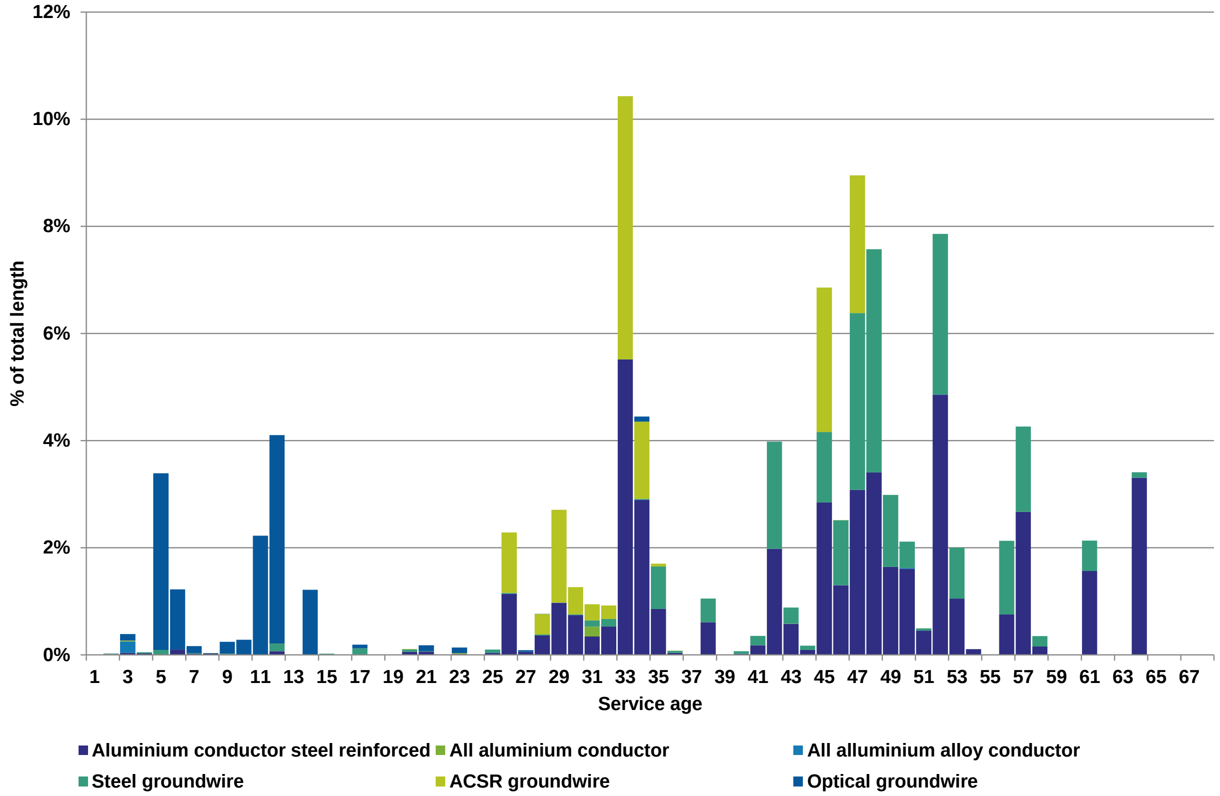
The deferral of a major terminal station rebuild in the current period and the proposed deployment enhanced condition monitoring technologies will require an increase in opex during the forthcoming period in order to meet the opex objectives. Under the NEO and the AER’s step change assessment criteria, these opex increases are justified where they result in a capex/opex trade-off.

## 4.1 Smart Aerial Image Processing (SAIP) roll out

### 4.1.1 Description

AusNet Services manages an ageing transmission network, with its older assets having an increasing probability of failure due to deteriorating condition. A significant proportion of the groundwire population is now reaching the end of its original design life, and much of the conductor population will reach the end of its design life in the next 10-20 years. The average service age of AusNet Services’ transmission line conductor and groundwire population is 45 and 35 years, respectively. The figure below shows the age profile of these assets.

**Figure 1: Conductor and groundwire age profile by type**




Source: AusNet Services

Around approximately 24% of the conductor and groundwire population has been in service for more than 50 years. This will increase to 58% by 2022. AusNet Services' Asset Management Strategy AMS 10-79 (provided as a supporting document) provides further details on the age profile and condition of conductor and groundwire assets.

Existing condition monitoring techniques, which rely on the visual inspection and judgement of asset inspectors, cannot identify hidden defects and may not identify large populations of deteriorating conductor. In some cases, the time between detecting the onset of steel core corrosion and failure of the asset can be as short as three to five years.

SAIP is an enhanced condition assessment technique that uses helicopter-mounted high resolution video cameras to capture a continuous stream of digital images of overhead conductors, which are processed and analysed to detect and map defects.

Deployment of SAIP would allow AusNet Services to better predict the extent and optimal timing of future conductor replacements, and avoid initiating replacement works before they are necessary. Given the potential safety risk of delaying replacement too long, there is considerable scope for more targeted and prioritised conductor replacement, provided the requisite condition data is available. SAIP represents a low-cost, flexible method of acquiring this data. Having an awareness of this technology and acknowledging its relatively low costs, AusNet Services' potential exposure to liability increases if this technology is not deployed.

Since 2009, AusNet Services has successfully completed a number of SAIP trials on different parts of its transmission network. This includes covering approximately 500 and 1,000 kilometres of the network in 2014-15 and 2015-16, respectively, to confirm the effectiveness of SAIP with respect to identifying signs of deterioration, minor faults and defects and providing an improved mechanism for assessing condition and predicting remaining life of the asset.

To fully realise the potential benefits of SAIP, AusNet Services is proposing to conduct a full assessment of its entire network over three years to establish a condition baseline, followed by a second, targeted cycle for change monitoring. Asset Management Strategy AMS 10-13 (provided as a supporting document) discusses AusNet Services' condition monitoring strategies for assets forming the Victorian electricity transmission network for the period until 2022, including the increased roll out of SAIP technology.

An inspection technique recommendation paper has also been developed to demonstrate the benefits of SAIP, and compare the costs and benefits of alternative inspection techniques, including the 'do nothing' option of continuing to utilise the existing inspection and condition monitoring techniques. This paper (provided at Attachment 1) demonstrates AusNet Services' commitment to increasingly utilise SAIP in the current and future regulatory periods to facilitate a more targeted lines replacement program and in doing so, efficiently defer future capex.

As discussed in Attachment 1, AusNet Services has determined that deferring the replacement of 30km of 500 kV conductor (with an estimated project cost of $30 million) by two years in five years' time (e.g. in 2020) would economically justify the proposed opex. This represents less than 1% of the length of AusNet Services' 500 kV transmission network of around 3,900km. Given the large volume of conductor and groundwire replacement expected in future periods due to the ageing profile of these assets, this is considered a conservative estimate of the potential capex deferral benefits SAIP would facilitate.

AusNet Services proposed to embed advanced condition monitoring techniques (including SAIP) into its routine practices in the previous TRR. Despite the AER's technical consultants considering that the technique had merit, the AER rejected the proposed step change for the following reasons:

- It considered that base year expenditure on overhead lines condition assessments was sufficient; and
- It considered that, at a granular level, AusNet Services' estimates of benefits and costs were not reliable enough to demonstrate the case for a step change.

The first point was not supported by any compelling quantitative analysis on why the base year expenditure was sufficient. In the current regulatory period, AusNet Services has only invested minimal operating expenditure on SAIP, as it has not received a step change in opex for it. As actual/expected opex for the current period are expected to largely equal the regulatory opex allowance, it is clear that 2011-12 base year expenditure was not sufficient to enable AusNet Services to embed SAIP during the current period. If AusNet Services had overspent its allowance in order to embed SAIP, it would have been penalised under the EBSS, substantially weakening the incentive to do so.

The second issue identified by the AER was premised on a misinterpretation of expenditure data provided by AusNet Services. This data stated that actual expenditure on asset works lines condition assessments in 2010-11 was minus $3,261 – however, the AER misinterpreted this to be minus $3.26m and expressed concerns that this undermined the transparency of expenditure at a granular level. This perceived lack of accuracy in AusNet Services' disaggregated expenditure data contributed to the AER's decision to reject the proposed step change.

For these reasons, and given the substantial future benefits that embedding SAIP in routine practices could have for future consumers, a step change for SAIP has been proposed again.

### 4.1.2 Costs

The following steps were taken to develop a forecast of the opex required to deploy SAIP:

- Estimate the cost of assessing the full transmission network, drawing on experience gained from the multiple SAIP trials successfully carried out;
- Convert this cost estimate to a per kilometre cost based on the 6,500km length of the transmission network;
- Multiply the per kilometre cost by a forecast of the kilometres required to achieve full network coverage in three years and 50% coverage across the subsequent years;
- Remove the amount of SAIP opex incurred in the proposed base year of 2014-15 to ensure the step change reflects only incremental activity and costs to that reflected in base opex; and
- Remove forecast inspection cost savings that are expected to result from SAIP.

Note that the forecast expenditure reported in the reset RIN and in the 'total' row of the table below is additional to the $125k of opex incurred in the 2014-15 base year.

**Table 5: Forecast SAIP roll out opex ($m, real 2016-17)**

| SAIP roll out | 2017-18 | 2018-19 | 2019-20 | 2020-21 | 2021-22 | Total |
|---|---|---|---|---|---|---|
| Roll out | 0.5 | 0.5 | 0.3 | 0.3 | 0.3 | **1.8** |
| Less: costs in base year | -0.1 | -0.1 | -0.1 | -0.1 | -0.1 | **-0.7** |
| Less: saving on inspection costs | -0.1 | -0.1 | -0.1 | -0.1 | -0.1 | **-0.3** |
| **Total** | **0.3** | **0.3** | **0.1** | **0.1** | **0.1** | **0.9** |

*Source: AusNet Services*

## 4.2 WMTS mobile switchboard

### 4.2.1 Description

AusNet Services has determined that it is currently economic to replace its WMTS 22kV switchroom based on the risks presented by an asset failure. These risks include:

- **Network reliability, quality and security of supply risk.** The failure of the switchboard will likely result in unplanned extended outages, placing the 22kV circuits on a single contingency and necessitating feeder redirection works to maintain supply;
- **Safety and environmental risk.** Insulation failure of oil and pitch filled switchboards presents a large safety risk to employees in the vicinity. Failures can result in explosions and fires - the large volume of oil within the circuit breaker (CB) tank may spill oil and spread oil fires;
- **Financial risk.** These include increased costs associated with emergency replacements following major failures, costs associated with collateral damage to the adjacent plant caused by failure of the switchboard and costs associated with injuries/fatalities arisen to staff and contractors working on site as a result of fires and projectiles.

The cost of replacing the switchroom, which would provide a long-term solution to address the risks outlined above, is estimated at $17.2 million. However, joint planning by AusNet Services and CitiPower concluded the most prudent and efficient outcome for the 22kV assets is for AusNet Services to retire its 22kV WMTS switchroom, and for CitiPower to similarly retire a number of ageing 22kV zone substations by integrating the customers served by WMTS 22kV onto its 66kV zone substation network.

AusNet Services understands that CitiPower plans to retire the 22kV supply from WMTS in stages, with the last circuit breakers to be retired by end-2020. All 22kV assets, including the 22kV switchboards, 22kV building, 220/22kV transformers and 22kV fault limiting reactors, can be retired from WMTS once the load transfers have been completed.

AusNet Services supports this proposal as its 22kV transmission assets at WMTS currently present a high risk of failure due to their age and condition. Under the original planned timing of the WMTS rebuild, these assets would have either been replaced or retired by the commencement of the 2017-22 period. The deferral of the WMTS rebuild has therefore necessitated an increase in opex to address the risks arising from the continued use of the existing 22kV assets.

In light of the planned retirement of the 22kV WMTS assets, it is not prudent for AusNet Services to replace these assets. As such, AusNet Services has determined that leasing a mobile switchboard is the safest and most cost-effective solution to ensure the safe operation and maintenance of the switchroom assets until the works are complete to enable them to be taken out of service.

The proposed lease of a mobile switchboard would provide continual 22kV supply while the switchboard is progressively taken out of service, inspected, tested and returned to a serviceable condition. The mobile switchboard would be designed to meet the minimum installation, switching and protection requirements for short term supply continuity.

The costs of leasing and connecting the switchboard are classified as opex because they do not relate to the replacement of assets, the extension of the life of existing assets nor the enhancement of the capability of the existing assets. Instead, the costs are intended to ensure that WMTS assets remain in serviceable condition until they are retired.

This approach, which requires expenditure of $2 million over five years, does not replace the switchboard, but is required to manage the risks of failure in the short-term while awaiting the completion of the decommissioning program, and is a significantly more prudent and efficient solution than the full replacement of the switchroom. The proposed step change is also consistent with the AER's step change assessment criteria, which recognise that it may be efficient for a TNSP to increase its opex if doing so avoids capex.

AusNet Services is therefore proposing a step change for the leasing and cabling costs of a mobile switchboard, based on quotes obtained from the market and internal estimates. Due to the critical nature of this project, some project development costs have been incurred in 2015-16 to ensure the timely establishment of a lease.

### 4.2.2 Options analysis

Four options have been considered in response to the risks presented by the WMTS 22kV switchboard. These options are discussed below.

### *1. Do nothing*

The ‘do nothing’ option is to continue to defer maintenance on the 22kV switchboard and take the risk that the switchboard will not fail. If the switchboard does fail, there is no credible contingency option, creating material supply risks. Major emergency cabling works would be required which would have an impact on the delivery of the WMTS rebuild project.

This option is not recommended.

### *2. Lease mobile switchboard and maintain the existing switchboard*

Option 2 takes advantage of initial plans to transfer the two BS feeders to BTS. The high-level details of this option are to:

- Retire the two BS feeders;
- Lease a mobile 22kV switchboard (initial proposal is for two incomers and three feeders);
- Cut in an redirect feeders to supply the remaining seven feeders from bus three and the mobile switchboard;
- Refurbish bus 1 to create a contingency for the failure of bus 3; and
- Retain this arrangement until the 22kV equipment is decommissioned.

This option:

- Requires expenditure of $2 million (shown below in Table 6) to avoid capex of $17.2 million on long-life assets that would operate for a short period of time before being retired; and
- Will provide a safe work place and reliable 22kV supply with an executable contingency plan.

This is the preferred option.

### *3. Replace switchboard with new switchboard*

This option involves replacing the switchboard with a new, permanent switchboard. The high level capital investment is estimated to be $17.2 million, which would include both the switchboard and the building to house it and the associated change over costs of rerouting, laying and jointing 22 kV cables, replacing fault limiting reactors and other outdoor equipment.

This option reduces the risks presented by the current state of the assets, and would ensure reliable supply for the next 30-40 years. However, due to the plans to retire 22kV assets at WMTS, this installation would become redundant after five years.

This option is therefore not considered a prudent solution and is not recommended.

### 4. Overhaul the switchboard in situ

This option would involve taking extended outages progressively on bus 1, 2 and 3 in order to refurbish the circuit breakers, voltage transformers and bus works connected to the switchboard. This option would improve the condition and extend the life of the switchboard. Given the WMTS 22kV retirement plans in place, substantive expenditure to refurbish assets is not considered prudent.

Furthermore, during the extended bus 2 outage required to implement this option, there is no readily available bus tie and therefore no credible contingency if the in-service bus was to fail. Accordingly, this option is would leave Citipower on a single contingency, whereas option 2 retains n-1 supply over the same period.

In light of these risks, and the aforementioned 22kV asset retirement plans, option 4 is not recommended.

### 4.2.3 Costs

The following table sets out AusNet Services’ forecast WMTS mobile switchboard costs for the forthcoming period. These costs are based on quotations obtained from providers of mobile switchboards and internal estimates of the cabling and overhaul costs.

**Table 6: Forecast opex for WMTS mobile switchboard ($m, real 2016-17)**

| WMTS mobile switchboard | 2017-18 | 2018-19 | 2019-20 | 2020-21 | 2021-22 | Total |
|---|---|---|---|---|---|---|
| Switchboard lease and transport costs | 0.26 | 0.25 | 0.25 | 0.25 | 0.00 | **1.00** |

| WMTS mobile switchboard | 2017-18 | 2018-19 | 2019-20 | 2020-21 | 2021-22 | Total |
|---|---|---|---|---|---|---|
| Overhaul | 0.00 | 0.05 | 0.00 | 0.00 | 0.05 | **0.10** |
| Cabling | 0.45 | 0.00 | 0.02 | 0.45 | 0.00 | **0.92** |
| **Total** | **0.71** | **0.30** | **0.27** | **0.70** | **0.05** | **2.02** |

*Source: AusNet Services*

# 5 Asset decommissioning

AusNet Services is proposing to decommission and make safe a number of major assets over the forthcoming period, and is proposing opex to reflect the costs of decommissioning these assets. This approach aligns with the AER's position on forecasting opex:

> *"Any other costs base opex and the rate of change do not compensate [sic] can be added as a step change. When assessing step changes particular consideration must be given to whether the costs are already compensated for elsewhere in the opex forecast."*[4]

Because AusNet Services does not routinely decommission assets, its base year opex does not include the costs of decommissioning major assets such as synchronous condensers. The retirement and decommissioning of assets because their services are no longer required is driven by decisions taken by parties other than AusNet Services. Further, these costs are not captured in the elements of the rate of change discussed in section 5.7 of the Revenue Proposal. For these reasons, and due to the quantum of these costs, AusNet Services considers that its asset decommissioning step changes are required to form a total opex forecast that reasonably reflects the efficient costs of achieving the opex objectives.

## 5.1 Synchronous condensers

### 5.1.1 Description

Synchronous condensers provide benefits by regulating the voltage of the network. There are three synchronous condensers on AusNet Services' transmission network. These were installed in the 1960's and 1970's and are located at Fisherman's Bend, Templestowe and Brooklyn Terminal Stations. These assets have reached the end of their economic lives and for this reason it is proposed to decommission these synchronous condensers in 2017-18.

As AusNet Services is only responsible for the replacement of the Victorian transmission network, AusNet Services has worked with AEMO (the network augmentation planner) to assess whether the services provided by the synchronous condensers are still required. As these assets are at end of life, the benefit of continuing these services must exceed the estimated cost of replacement for a continued service to be beneficial. Continuing to refurbish the synchronous condensers is not considered to be a viable option given the high capital expenditure that would need to be incurred to extend the life of the synchronous condensers by approximately five to ten years.

AEMO has confirmed that the Fisherman's Bend synchronous condenser was unlikely to be providing a net benefit and, as such, agreed to AusNet Services taking it out of service in July 2015. Additional opex is now required to decommission this asset and remove it from the site.

At the time of submission, the synchronous condensers at Templestowe and Brooklyn Terminal Stations remain in service. The cost of replacing both of these assets is forecast to be approximately $61m in total. AusNet Services and AEMO are continuing to work together to assess whether, given the high replacement costs, it is economic to replace these synchronous condensers, either on a like-for-like basis or with assets providing a reduced level of service. This analysis is expected to be completed in May 2016.

As there is not yet a firm case to justify the high cost of replacement, AusNet Services has proposed to decommission the remaining two synchronous condensers. Therefore the costs of decommissioning all three synchronous condensers are forecast in this submission. In the meantime, AusNet Services will progress decision-making on these assets with AEMO and will update the AER on any developments. This is also discussed in section 4.8.11 of the Revenue Proposal and in Appendix 4G – Contingent Projects.

[4] AER (2013) *EFA Guideline Explanatory Statement*, November 2013, p.61

### 5.1.2 Costs

The following table sets out AusNet Services' forecast synchronous condenser decommissioning costs.

**Table 7: Forecast synchronous condenser decommissioning opex ($m, real 2016-17)**

| Synchronous condenser decommissioning | 2017-18 | 2018-19 | 2019-20 | 2020-21 | 2021-22 | Total |
|---|---|---|---|---|---|---|
| Fishermans Bend Terminal Station | 1.4 | 0.0 | 0.0 | 0.0 | 0.0 | **1.4** |
| Brooklyn Terminal Station | 1.3 | 0.0 | 0.0 | 0.0 | 0.0 | **1.3** |
| Templestowe Terminal Station | 1.4 | 0.0 | 0.0 | 0.0 | 0.0 | **1.4** |
| **Total** | **4.3** | **0.0** | **0.0** | **0.0** | **0.0** | **4.3** |

*Source: AusNet Services*

## 5.2 Morwell Power Station assets

### 5.2.1 Description

In August 2014, Energy Brix Australia Corporations' (EBAC) Morwell Power Station (MPS) shut down due to falling electricity wholesale prices and a substantial reduction in the energy needs of its briquette manufacturing facility, which is located on-site at MPS. AusNet Services currently has a connection agreement in place with EBAC for the use of AusNet Services' transmission and distribution assets to provide connection services.

In light of the closure of MPS, an interim connection agreement is currently being negotiated with EBAC to supply its load from Morwell Terminal Station using the existing electricity distribution and transmission assets at MPS. This agreement will be in place until the establishment of the Morwell zone substation on AusNet Services' distribution network in 2018, which will be used to supply EBAC's load. This will coincide with the demolition of MPS – which EBAC has advised will take place at the end of 2017 – and the cessation of the existing connection agreement in place between AusNet Services and EBAC.

Once the Morwell zone substation is established, AusNet Services' electricity distribution and transmission assets located at MPS will no longer be required. To ensure the redundant assets do not pose a safety threat, AusNet Services is required to decommission and make safe these assets. This involves identifying all live equipment in the yard and electrically isolating and disconnecting the equipment from the network in such a way that it cannot be made live by normal switching means, as well as draining and disposing of oil from transformers.

Because there is no agreement in place for AusNet Services' decommissioned assets to be located on EBAC's land, AusNet Services is proposing a step change for the costs of decommissioning its transmission assets, removing these assets from EBAC's land and restoring the site. This approach is considered the most prudent option of mitigating the risk of the 'do nothing' option, which include exposing AusNet Services to liability if its assets are not made safe and removed from EBAC's land.

### 5.2.2 Costs

The following table sets out AusNet Services' forecast opex for the decommissioning and removal of its MPS transmission assets and the associated site restoration works.

**Table 8: Forecast opex for MPS asset decommissioning and removal and site restoration ($m, real 2016-17)**

| Morwell Power Station decommissioning | 2017-18 | 2018-19 | 2019-20 | 2020-21 | 2021-22 | Total |
|---|---|---|---|---|---|---|
| Decommissioning of assets | 0.5 | 0.0 | 0.0 | 0.0 | 0.0 | **0.5** |
| Removal of assets | 0.9 | 0.0 | 0.0 | 0.0 | 0.0 | **0.9** |
| Site restoration | 0.5 | 0.0 | 0.0 | 0.0 | 0.0 | **0.5** |
| **Total** | **1.9** | **0.0** | **0.0** | **0.0** | **0.0** | **1.9** |

*Source: AusNet Services*

# Attachment 1

The following attachment is provided in support of the step changes proposed in this document:

- Transmission Conductor Inspection Technique Recommendation Paper.

# Transmission Conductor

## Inspection Technique Recommendation

| | |
|---|---|
| **Document number** | NA |
| **Issue number** | 1 |
| **Status** | Final |
| **Approver** | Karen Miller |
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# ISSUE/AMENDMENT STATUS

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| 1 | 05/06/2015 | Document submitted to AMC | Peter Kilevics | K Miller |
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# Table of Contents

# 1 Executive Summary

It is recommended that Smart Aerial Imaging and Processing (SAIP) is adopted as a business as usual technique for assessing the condition of transmission conductor and groundwire to ensure future maintenance and investment is optimised.

Where conductor condition is not well known, a conservative approach is likely to be taken to replacement which involves replacing conductor early to avoid the consequences of failure. Where conductor condition is well known, replacement programs can be targeted to relevant sections of conductor and the timing of replacement can be optimised. Any deferral of major works based on improved Condition Assessments offers significant cost savings.

A significant proportion of the groundwire population is now reaching its original design life and much of the conductor population is reaching its design life in the next 10-20 years. With ACSR being the most common material on the network (99.5% of conductors and 56% of groundwire) and the limitations of the current inspection techniques to assess the entire length of the spans, it is considered that increased inspection requirements will be needed to develop more accurate knowledge of condition to inform future investment and maintain high reliability and safety.

It is expected that there will be a future requirement for some conductor replacement works but the extent and timing is not accurately known. As conductor replacement costs are high and given the age and extent of our network, improved assessment techniques offer a higher degree of confidence in predicting the extent and optimal timing of future replacements. Good assessment techniques also will strengthen our case for replacement program funding in future regulatory submissions.

Project G916, completed in 2014/15, demonstrated that SAIP technology was an efficient and effective technique for identifying signs of deterioration, minor faults and defects and could provide an improved mechanism for assessing condition and predicting remaining life of the asset.

Project G916 was established following the Portland Conductor failure in 2008 which highlighted the limitations of the existing conductor monitoring practices for identifying conductor condition. The project has delivered an image capture system which uses helicopter-mounted high resolution video cameras to capture a continuous stream of digital images of overhead conductors and overhead line components and software for processing the images and identifying components and defects – known as SAIP. The project has delivered its objectives of providing a solution that enables AusNet Services to assess the condition of its conductors to manage the assets efficiently with an acceptable level of reliability and safety.

The current practice for monitoring conductor and groundwire condition is through a visual inspection during tower climbing inspections and routine patrols. These follow the traditional, industry accepted practices for monitoring conductor condition but are limited by the field of vision and access to the entire length of conductor and hence a risk of undetected deterioration as the asset moves towards its end of life.

SAIP provides a less expensive and much faster form of dedicated conductor survey than enhanced traditional visual inspections. Economic analysis demonstrated that the investment of SAIP was economic if it allowed a $30M capital scheme to be deferred by 2 years.

In conclusion, it is recommended that SAIP is adopted into business as usual with a full assessment of the network completed over a 3 year period (aligning with the regulatory inspection requirement) to set a base line and then a targeted inspection programme over the next 3 years with this cycle repeated on a 6 year cycle. The current estimated cost of SAIP is $225/km based on a 3 year cycle ($490k pa).

# 2 Purpose

The purpose of this document is to seek endorsement from the Asset Management Committee for the implementation of Smart Aerial Imaging and Processing (SAIP) as part of the routine asset inspection of transmission line conductors and groundwires now that the R&D project G916 - Development of Smart Aerial Imaging and Processing System has concluded.

# 3 Background

## 3.1 The Development of SAIP

Project G916 was established in 2009 following the Portland Conductor failure in 2008 which highlighted the limitations of existing conductor monitoring practices for identifying conductor condition.

Over the past 5 years, Project G916 has developed an image capture system which uses helicopter-mounted high resolution video cameras to capture a continuous stream of digital images of overhead conductors and overhead line components. Software has been developed that processes and analyses the images to detect defects and identify components along the line. The whole system is known as SAIP.

Photographs taken from the helicopter during the SAIP data capture process are georeferenced. This allows the location to be plotted in Google Earth, making the identification of the location an easy task and also gives a visual indication of the spread of any issues found.

The SAIP algorithm analyses the boundary pattern of the conductors and flags any abnormality for further attention. Items identified as being non-normal are tagged with a pin representing a particular condition as per Figure 1. Figure 2 shows how these are represented in Google Earth.

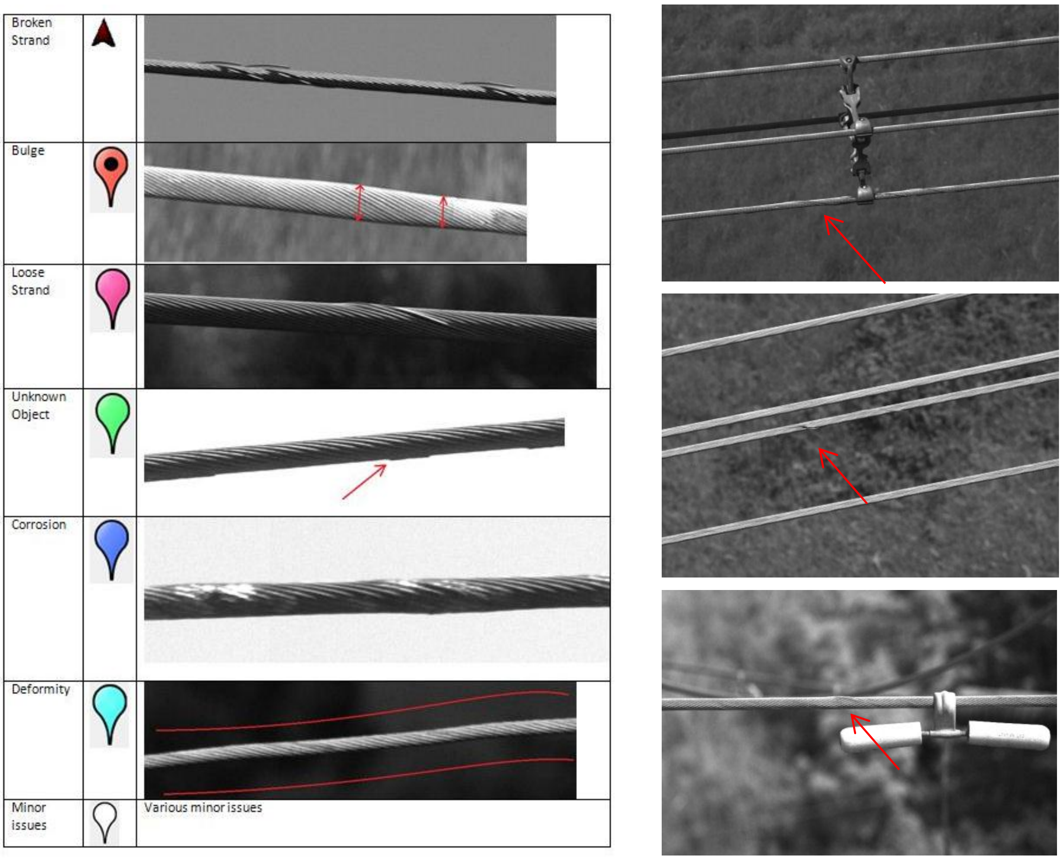


Figure 1: Legend of defects and examples of defects

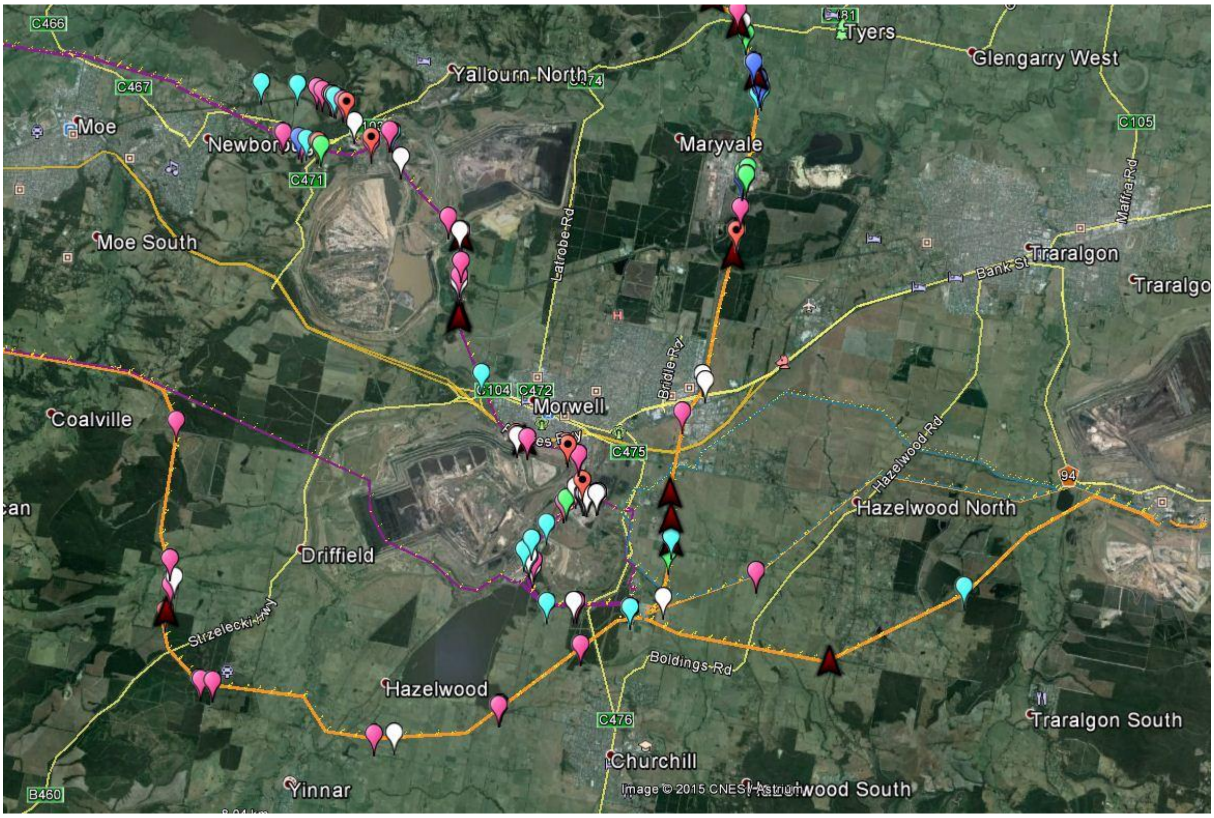


Figure 2: SAIP results near Morwell

The estimated cost of a full SAIP assessment of the entire Transmission network is $1.35M. This is based on the full network being assessed over a 3 year period at a cost of $490k per annum.

## 3.2 Current inspection and condition monitoring limitations

Transmission conductor is primarily assessed during tower climbing inspections and involves the inspector visually assessing the conductor in both directions from the top of the tower.

Climbing inspections are conducted at a maximum interval of 37 months which is aligned to the regulatory minimum requirement (*Electricity Safety (Bushfire Mitigation) Regulations 2013)* and our Condition Monitoring Asset Management Strategy (AMS 10-13).

In addition, routine patrols are conducted which are ground based inspections along the easement aimed at identifying asset defects and vegetation clearance issues. These routine patrols follow the traditional, industry accepted practices for monitoring conductor condition but are limited by the field of vision and access to the entire length of conductor and are not specifically intended for a thorough conductor inspection. Obvious issues like broken strands may be detected but detailed conductor inspection is not the prime purpose of these patrols and do not necessarily inspect all spans in a line.

Condition grading of ACSR can be difficult to perform visually as the corrosion starts and progresses at the interface between the steel core of the conductor and the inner aluminium strands before it is visible at the outer aluminium strands. This key factor requires the skilled line inspector to identify the presence of white powder or signs of bulging which are indications that the steel core has begun to degrade. See examples in Figure 3.

In some cases the time between detecting the onset of steel core corrosion and failure of the asset can be as short as three to five years. Remaining life of the conductor is very difficult to assess accurately using the existing basic inspection method. Current inspection practices may not identify large populations of deteriorating conductor.

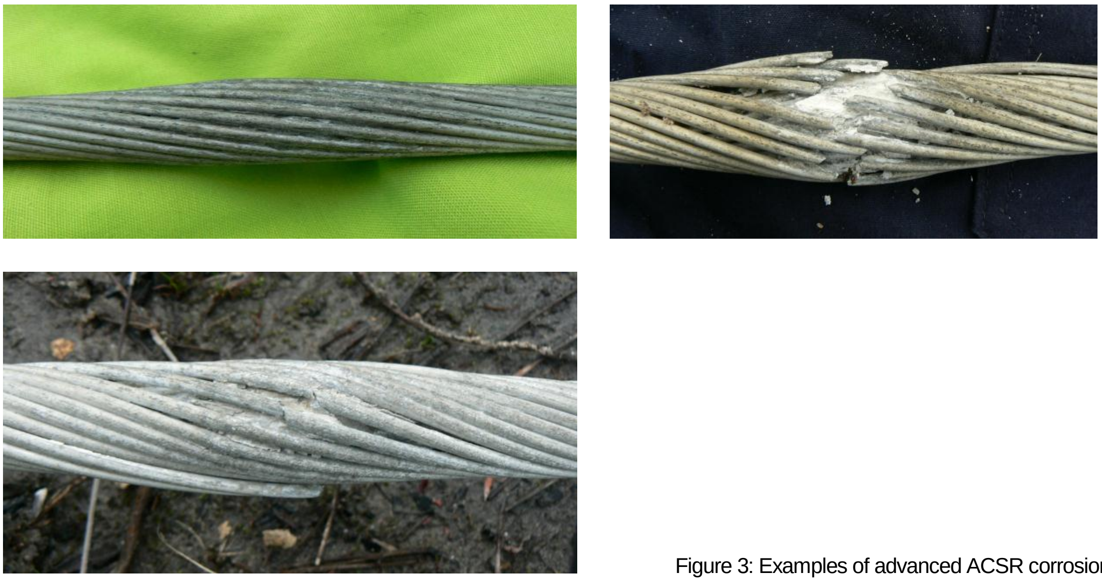

Figure 3: Examples of advanced ACSR corrosion

Assessment of conductors and groundwires is a visual based system using a numeric rating system from 1 to 6. Codes 1 to 5 are Condition Assessment levels and Code 6 represents failure for which initiates a Work Order and repair priority. ACSR conductors and groundwires are rated according to the following scale (ref LPP-09-06, 10.10):

6 – Exploded. (ie failed)
5 – Broken strands.
4 – Bird caging corrosion bulge.
3 – Just visible corrosion bulge.
2 – First white powder evident.
1 – New or oxidised.

Steel groundwires are rated according to the following scale (ref LPP-09-06, 10.14):

6 – Broken strands. (ie failed)
5 – Pitted rust.
4 – No zinc.
3 – Patchy rust.
2 – First rust.
1 – No rust.

A series of photos (ref LPP-09-06 Appendix B) is also provided as an assessment guide for all items.

In summary, the current inspection techniques allow good assessments of condition of steel conductors but are limited for the assessment of ACSR. This is due to the nature of deterioration and the limited view from the tower top or the ground and access to the entire length of the conductor

## 3.3 Conductor population and current condition

The total route length of conductor on the transmission network exceeds 6,500 km. This conductor is shielded from lightning strike by a similar length of groundwire and optical fibre groundwire (OPGW).

99.5% of conductor and 56% of groundwires are ACSR.

A significant proportion of the groundwire population is now reaching its original design life. The conductor population, particularly in harsher environments, will start to reach its design life in the next 10-20 years. Most of the conductor and ACSR groundwire is in good condition however there have been some corrosion related failures in recent years.

### 3.4 Asset replacement plans

It is estimated that over the next 7 years, 240km or 3.1% of groundwire will be replaced at a cost of $25M.

Conductor is expected to begin to reach the end of its asset design life in 10-20 years and as such no plans are in place for the replacement of conductor in the next 5 years.

# 4 The Need

A significant proportion of the groundwire population is now reaching its original design life and much of the conductor population is reaching its design life in the next 10-20 years. With ACSR being the most common material on the network (99.5% of conductors and 56% of groundwire) and the limitations of the current inspection techniques to assess the entire length of the spans, it is considered that increased inspection requirements will be needed to develop more accurate knowledge of condition to inform future investment and maintain high reliability and safety.

Currently most of the conductor is in good condition however there have been some corrosion related failures in recent years (for example, Portland ACSR). The present detection of defects and corrosion relies on visual observations during routine patrols and tower inspections which is sufficient for the detection of corroded steel groundwire but is not satisfactory for ACSR. As ACSR makes up the majority of the population, the risk of failure through not being able to detect early signs of deterioration is increased.

It is expected that there will be a future requirement for some conductor replacement works but the extent and timing is not accurately known. As conductor replacement costs are high and given the age and extent of our network, improved assessment techniques offer a higher degree of confidence in predicting the extent and optimal timing of future replacements. Good assessment techniques also will strengthen our case for replacement program funding in future regulatory submissions.

As the current inspection techniques provide limited condition data, it is likely that conductor replacement works will be initiated before they are necessary in order to maintain a low failure rate and high network reliability and safety. Delaying works too long increases the failure risk which presents significant health and safety risks to AusNet Services' workers and contractors and potentially members of the public.

# 5 Evaluation of Options

Three options have been assessed:

Option A: Do Nothing
Continue to utilise the existing inspection and condition monitoring techniques

Option B: Enhanced Visual Inspection
Have a dedicated conductor patrol that is assessing the conductor from the ground at more frequent locations to cover the entire length of the span.

Option C: Utilise SAIP

## 5.1 Qualitative Evaluation

Each of the available conductor inspection techniques has been assessed and key features are described in Table 1.

| Criteria | BAU Visual Inspection | Enhanced Visual Inspection | SAIP |
|---|---|---|---|
| Detection capability | Low | Medium-High | High |
| Cost | BAU | est $540-$800/km<br><br>based on 6km/day for 2 x 2 man crews | est $225/km<br><br>based on 110km/day (4 weeks) with 100% coverage of network in 3 years at $490k pa |
| Safety | Higher risks due to unexpected failure | Improved over BAU | Low risks due to good detection of failure points |
| Experience | Standard technique used for many years | Standard technique but additional to BAU | Two trials completed |
| Other benefits | Carried out in conjunction with tower inspection | | Detection of minor defects sooner than other options due to wider coverage<br><br>Potentially allows minor defects to be repaired before they affect line performance |
| Other limitations | Difficult to see conductor mid-span.<br>Inspection does not detect all conductor deterioration and therefore condition grading is not accurate.<br>Ground patrols are not always possible due to terrain, access restrictions and obstacles.<br>Relies on experienced inspectors and assessment is only as reliable as the inspector. | Access along whole easement may be restricted.<br><br>Slow rate of progress<br><br>Would need additional resources to achieve same timeframe as SAIP<br><br>Weather limitations | Possible flight restrictions in urban areas.<br><br>Weather limitations |

Table 1: Evaluation of Inspection Techniques

## 5.2 Economic Evaluation

Where conductor condition is not well known, a conservative approach is likely to be taken to replacement which involves replacing conductor early to avoid the consequences of failure. Where conductor condition is well known, replacement programs can be targeted to relevant sections of conductor and the timing of replacement can be optimised. Any deferral of major works based on improved Condition Assessments offers significant cost savings. The analysis below assumes that benefits arise from allowing conductor to remain in service longer without functional failures. ie there is a cost to replacing conductor before is has an elevated risk of functional failure.

Two scenarios have been considered:

1. Full SAIP to be incorporated into the inspection cycle, ie, reassessment within every 37 months
2. Full SAIP for the first 3 years to establish a baseline and then second cycle based on targeted lines (assuming 50%)

Inspection options other than BAU are more expensive and have not been further evaluated.

An NPV analysis shown in Table 2 shows that a 6 year SAIP program to cover the network twice (once for a baseline and a second pass for change monitoring) would be economic if it resulted in deferral of replacement of 30km of 500 kV conductors ($30M) in 5 years time by another 2 years.

A full 3 year program, followed by a reduced 50% program in subsequent years to target areas of concern is an alternative option at a slightly lower cost but loses some of the benefit of minor fault detection.

| | Economic Least Cost Analysis | | | | Financial Return | | |
|---|---|---|---|---|---|---|---|
| **Analysis of Investment Options ($'000s)** | **PV Capital Cost** | **PV Opex Costs** | **PV Community Costs & Benefits** | **Total PV Cost** | **NPV including Reg Return (post tax)** | **PV Cost Ratio** | **PV of Incentive / (Penalty)** |
| Business As Usual | (22,089) | - | - | **(22,089)** | 1,246 | 1.00 | - |
| SAIP -Full for 6 years (2 cycles) | (19,021) | (2,308) | - | **(21,330)** | 1,177 | 0.97 | - |
| **SAIP -Full for 3 years then 50% 3 years** | **(19,021)** | **(1,796)** | **-** | **(20,817)** | **1,177** | **0.94** | **-** |
| | - | - | - | **-** | - | - | - |
| | - | - | - | **-** | - | - | - |

*All figures are in $000's unless otherwise stated.*
*(nominal and discounted)*

Table 2: Economic evaluation of inspection options

Assumptions:

- 30 km of 500kV conductor replacement is deferred from 5 years to 7 years at a cost of $30M
- 500kV conductor replacement was chosen as an example as there are a number of 500kV lines in corrosive environments across the Latrobe Valley and near Portland.
- Costs of SAIP are based on estimate from Select Solutions following completion of the second trial
- The SAIP data would be acquired over approximately a 4 week flying period when conditions are favourable (wind, rain and daylight quality) ie about 100km/day
- Condition grades for each span of conductor are stored in the asset management system irrespective of the inspection technique adopted.

# 6 Recommendation

It is recommended that SAIP inspection of conductor is adopted as the standard inspection technique. A program of inspection involving a full coverage over a 3 year period followed by a reduced ongoing program to cover 50% in each following 3 year period is recommended. Adoption of this recommendation would result in benefits arising from deferral of capital expenditure to replace conductors and an annual increase in operational expenditure to undertake SAIP.