AMS 10-66 Power Cables

2023-27 Transmission Revenue Reset

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Disclaimer

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1 Executive Summary

This document describes major factors affecting the Victorian electricity transmission network's population of underground power cables and lists the current strategies for managing these assets.

There are two main categories of power cables within the transmission network, namely 'Interconnecting' and 'Station' cables. Interconnecting cables are utilised to connect one station to another station, for example Brunswick to Richmond, while Station cables connect items of plant within a particular station.

Within the Victorian electricity transmission network, AusNet Services owns and maintains one 220 kV and three 66 kV Interconnecting cables with the remainder of the cable population being Station cables. The one possible exception to this is the 220kV EPS-TTS line cables that are located entirely within SMTS. For this reason, these cables have been deemed Station cables.

There are approximately 393 Station cables installed within various terminal stations throughout Victoria operating at each voltage level of the transmission network depending on the plant to which the cable is connected.

Following recent station rebuilds, the power cable population age has become more wide spread with the majority of HV and EHV cables now in their infancy. The strategic factors affecting the management of power cables are

- the change from paper insulated oil filled cables to XLPE insulated cables
- the condition assessment of the electrical properties of the main insulation system
- the management of strategic spares

AusNet Services' key asset management strategies for power cables include:

1.1 Asset Strategies

The following key strategies guide the management of Transmission power cables:

1.1.1 New Assets

Continue the rigorous inspection regime of manufacturing plants to ensure the supply chain quality is maintained.

Continue to enhance Commission testing protocols, ensuring all new assets are effectively tested prior to being placed into service, thus giving a baseline or 'fingerprint' for all future condition assessment test programs.

1.1.2 Inspection

There is a regular inspection of all above ground cable assets incorporated into the station inspection program. This looks for obvious signs of deterioration of the main insulator, termination base stand-off insulators, connections and any other equipment associated with the terminations (e.g. link boxes). The inspection also covers the visual condition of the cable as it exits the ground, looking for obvious signs of mechanical damage, water ingress or the like.

1.1.3 Condition Monitoring

Continue to expand the electrical Condition Assessment testing program to all transmission network cable circuits. The tests will include HV withstand, Partial Discharge (PD) and Dielectric Dissipation Factor (DDF or Tanδ).

Oil filled cables will have scheduled oil samples taken to test for DGA and dielectric withstand.

On-line continuous monitoring techniques are beginning to be employed across critical circuits utilising fibre optic technologies. These include but are not limited to the use of Distributed Temperature Sensing (DTS) and Partial Discharge (PD) systems.

Continue to update cable asset records and fault response plans

1.1.4 Spares

All new cable circuits being installed that are identified as not already having strategic spares in the store system, shall have such spares purchased and safely stored. The Malvern Store has been selected to house all strategic spare HV and EHV cable accessories while the storage of strategic spare cable shall be on steel drums and primarily be at the Ringwood Store. All spare power cables are to be recorded in the asset management database (SAP). A full review of cable spares is planned in order to address the risks associated with cable failure. Gaps between necessary and actual will be identified and a plan established to order/stock appropriate spares.

1.1.5 Cable replacement / retirement is often driven by the parent assets

Station cables are associated with the primary plant in switchyards and decisions regarding replacement of the cable and plant can be linked as the design life of both assets is similar, particularly in a station rebuild scenario. If the primary plant is to be removed from the network, this may infer that the associated cables will also be retired. Where the primary plant is to be replaced at the end of its life, the condition of the cables is critically assessed to ensure that they will provide reliable future service or, as required, they are replaced.

1.1.6 Repairing oil filled cables

AusNet Services has a small population of oil filled cables. Although a major fault on one of these cables is currently unlikely, the consequences of such a fault could be severe.

Oil filled cables are no longer being installed on the network and with the loss of expert knowledge on repair protocols, the probability of effecting a reliable repair on such a cable is low. A strategic cable replacement program has been developed utilising modern cable types, techniques and designs to economically replace cables when appropriate. A load flow study of the individual circuits has assisted in determining suitable XLPE insulated equivalent replacement options and indicate the appropriate strategic spare levels.

Depending on the point of failure, a repair program will range from replacement of the entire cable length, to a replacement of a section of cable utilising one stop joint to the removal of the failed section of oil filled cable and being replaced with two stop joints and a short section of XLPE insulated cable.

2 Introduction

There are two main categories of power cables within the transmission network, namely ‘Interconnecting’ and ‘Station’ cables. Interconnecting cables are utilised to connect one station to another station, for example Brunswick to Richmond, while Station cables connect items of plant within a particular station.

2.1 Purpose

The purpose of this document is to set-out and explain the key asset management strategies for underground power cables in the Victorian Transmission Network.

2.2 Scope

This asset management strategy applies to all power cables managed by AusNet Services on the transmission network, including their terminations and joints and their immediate environments.

Assets covered are related to the regulated asset base, any unregulated transmission assets , owned or managed by Ausnet Services, are not included.

Strategies in this document are limited to maintaining existing cables and their capacity. Strategies for increasing installed capacity are not included. i.e. technical product specifications and project details are not covered.

2.3 Asset Management Objectives

As stated in *AMS 01-01 Asset Management System Overview*, the high-level asset management objectives are:

- Maintain network performance at the lowest sustainable cost;
- Meet customer needs now and into the future;
- Be future ready;
- Reduce safety risks; and
- Comply with legal and contractual obligations.

As stated in *AMS 10-01 Asset Management Strategy -Transmission Network*, the electricity transmission network objectives are:

- Maintain top quartile benchmarking;
- Maintain reliability;
- Minimise market impact;
- Maximise network capability;
- Leverage advances in technology and data analytics;
- Minimise explosive failure risk.

3 Asset Description

3.1 Asset Function

The function of a power cable within the transmission network is to carry the required power from one connection point to another, typically in an underground environment.

3.2 Asset Population

There is a total of 396 power cable circuits installed on the electricity transmission network. Table 1 shows the summary of the power cable population. With circuits that utilise single core cables, the actual cable length is 3 times that of the circuit length.

Table 1: Power Cable Summary

Cable Voltage	Circuits (each)	Installed Core Length (m)
Extra High Voltage (220 kV)	81	36,396
High Voltage (66 kV)	96	8,376
Medium Voltage (33 & 22 kV)	170	7,991
Medium Voltage (11 kV)	27	1.080
Medium Voltage (6.6 kV)	22	880
Total	396	54,696

[1]

There is approximately 54.7km of power cable cores installed, Figure 1 summarises the population by voltage level and insulation design. EHV power cable contribute 19.5% of the population, 25% are HV and the remaining 55.5% are MV.

[1] AHR 10-66 – Power Cable

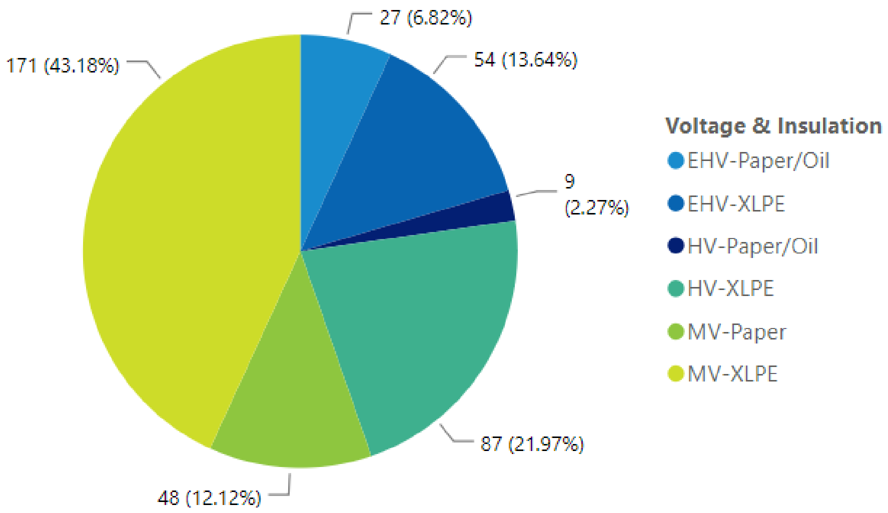

Figure 1 – Power Cable Population

Within the Victorian electricity transmission network, AusNet Services owns and maintains one 220 kV interconnecting cable and three 66 kV interconnecting cables. The 220 kV cable operates between Brunswick (BTS) – Richmond (RTS) and contains sectionalised joints and the associated metallic sheath cross-bonding systems at each joint bay. The three 66 kV interconnecting cables operate between Loy Yang Sub-station (LY) and Loy Yang Power Station (LYPSA), supply the LYPSA station service transformers and incorporate a centrally positioned sheath earthing system with sheath voltage limiters at each end of the circuit.

All four interconnecting cables are single core construction with the 220 kV BTS-RTS cable being XLPE insulated while the other three cables are paper/oil insulated.

There are approximately 390 Station cables installed within various terminal stations throughout Victoria. They are all single length cables, containing no joints, and are typically, but not solely, single core construction with a dispersion of XLPE or paper/oil insulation material.

3.3 Asset Age Profile

Following several major station rebuilds, the majority of the power cable population is now relatively young, less than 20 years of age, as shown in Figure 2. The paper/oil power cable fleet makes up the majority of the oldest population and will continue to be progressively replaced, as they reach the end of their design and/or service life.

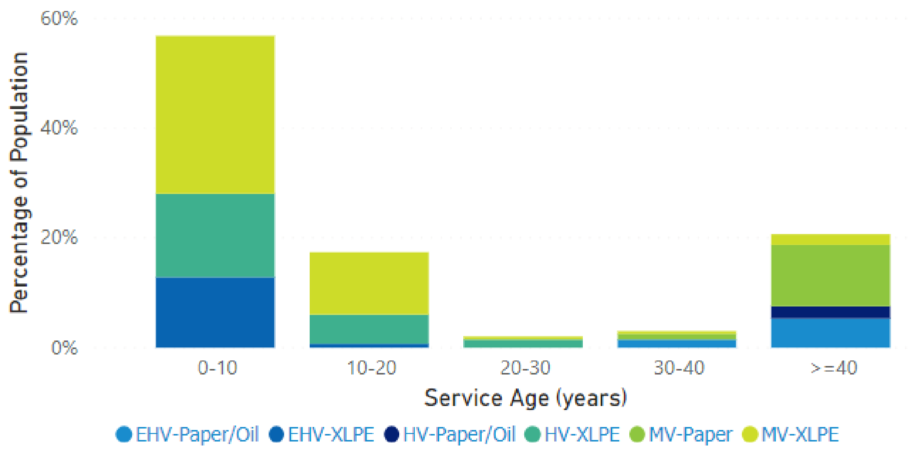

Figure 2 – Power Cable Service Age Profile

The service ages for Station cables generally correspond with the installation of the plant and equipment to which they connect. Many interplant connections have been replaced as part of asset replacement programs over the last ten years. Existing underground cables have an expected life of 60 years depending on the operating and environmental conditions.

3.4 Asset Condition

The condition of the entire population of power cables has been assessed using a consistent condition methodology that uses the known condition details of each asset and grades that asset against the common asset condition criteria.

The condition of the cable systems is determined by age and insulation material, where known, in absence of a more precise determination of condition. Figure 3 provides the qualitative assessment of the condition scoring for all transmission cables and whilst allowance has been made for electrical condition assessment test results, these have only just begun to be captured and hence have not played a significant role in determining the overall condition scores. The condition of each cable system has been scored ranging from condition C1 (very good) to condition C5 (very poor) accordingly by applying the criteria.

Figure 3 illustrates the four main stages in a cable system's lifecycle, Healthy, Deteriorated, Faulty and Failure. When the insulation is 'Healthy', the cable is performing its function. Once the health of the cable has 'Deteriorated', the cable will continue to perform except in extreme conditions. The cable system becomes 'Faulty' when it can perform its functional requirement to withstand operating voltages and currents but cannot withstand voltage surges and over-voltages. 'Failure' occurs when the cable system no longer performs its function.

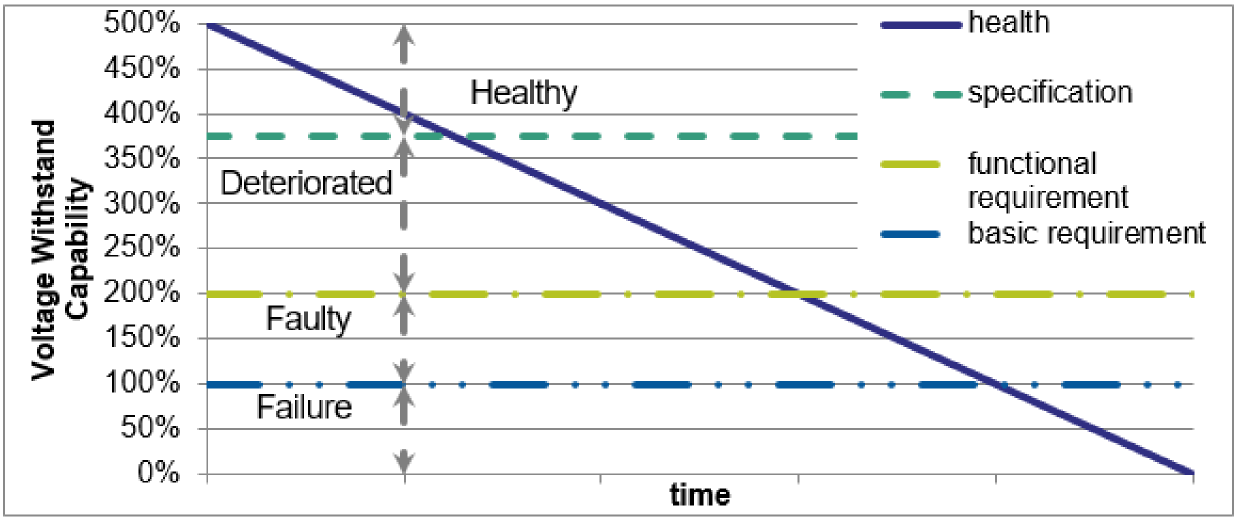

Figure 3 – Cable Voltage Withstand Capability

Table 2: Power Cable Condition Scorecard

Condition Scorecard			
Condition Score	**Condition Description**	**Summary of details of condition score**	**Remaining Life**
C1	Very good	These cables are in good operating condition with no past history of significant defects or failures. These cables are <10 years of age Condition Assessment tests have yielded results that indicate no significant defects are present within the cable circuit. High Sheath IR, Acceptable Tan δ (DDF), No detectable PD	95%
C2	Good	This category includes cables which have a better than average condition. These cables are between 10 and <20 years of age Condition Assessment tests have yielded results that indicate no significant defects are present within the cable circuit. Mid Sheath IR, Acceptable Tan δ (DDF), Limited PD in accessories	70%
C3	Average	This category includes cables in average condition. These cables are between 20 and <35 years of age There is no condition assessment data available Condition Assessment tests have yielded results that can be assigned to normal ageing of insulation systems. Mid Sheath IR, Higher but acceptable Tan δ (DDF), High but limited PD in accessories	45%
C4	Poor	This category includes cables in worse than average condition. Cables with unknown critical details and/or unknown condition assessment will typically be scored in this category until evidence is found to confirm condition. Action is required to confirm cable details and/or condition. These cables are between 35 and 55 years of age Condition Assessment tests have yielded results that indicate a fail/or near fail of a test criteria Fail Sheath IR, High/Fail Tan δ (DDF), High detectable PD in accessories	25%
C5	Very Poor	This category includes cables which are typically maintenance intensive and have a history of supply interruptions. These cables are >55 years of age and are approaching the end of technical life. The maintenance that can be performed to restore the condition is limited. The maintenance of cables in this category is typically no longer economical compared to asset replacement. Condition Assessment tests have yielded results that indicate a major defect that requires immediate action. Fail Sheath IR, Fail Tan δ (DDF) High detectable PD in accessories (>10,000pC) or detectable PD activity within a cable segment.	5%

[2]

[2] AHR 10-66 – Power Cable

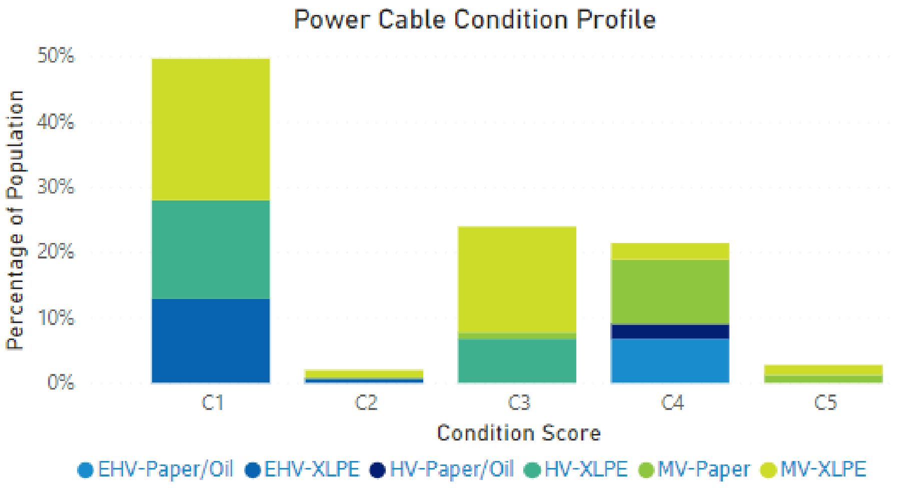

Figure 4 illustrates the overall condition of the power cable population. Following major station rebuilds and a successfully implemented commission test program for all new cables, the majority of XLPE insulated cables are in condition C1, with the only major outlier being the BTS-RTS cable entering its fourth decade of service.

The paper insulated cable population will continue to decrease as they are replaced with XLPE insulated cables.

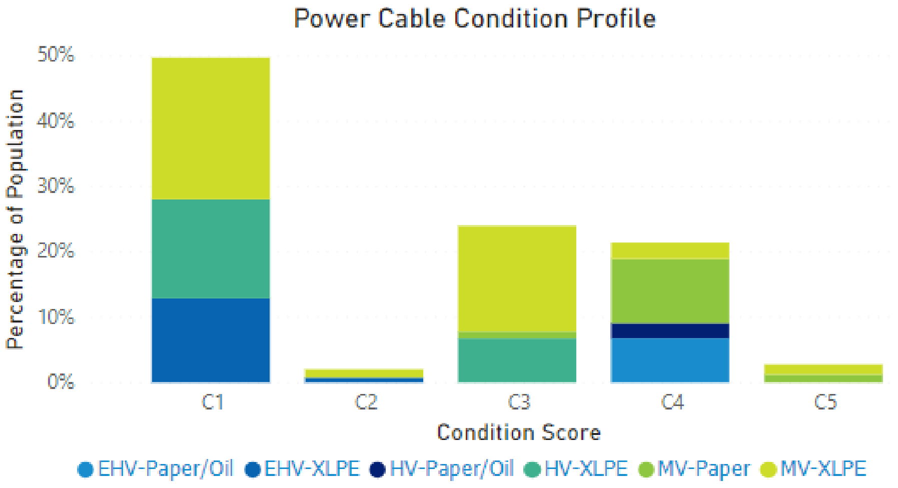

Figure 4 – Power Cable Condition Profile

3.5 Asset Criticality

Asset Criticality was determined by considering the following consequences of cable failure with the failure effects mentioned below.

I. Safety impact,
II. Community impact due to outages (unserved energy)
III. Collateral damage

Asset criticality is the severity of consequence from a major failure of a power cable at a certain location due to the above failure effects irrespective of the likelihood of the actual failure.

Safety impact is assessed on catastrophic failure risk and it fundamentally depends on the explosive failure mode of porcelain housings associated with older cable terminations. Modern terminations have polymeric insulators and whilst are oil filled and therefore will suffer fire damage should a failure occur, they will not cause exploded porcelain fragments to strike personnel or other primary assets within close proximity.

The electricity transmission cables forming the National Electricity Market have high levels of redundancy under average loading conditions. However, at peak loading periods; transmission cable failures can constrain generator connections causing a re-scheduling of generators in other states and load shedding may be required to provide network security for a subsequent un-related failure.

The failure of a transmission cable alters the redundancy of the equipment either directly connected to it or associated with it within the relevant station.

The applied interpretation of relative base criticality is shown in Table 3.

Table 3: Interpretation of Relative Base Criticality

Relative Base Criticality	Criticality Banding	Economic Impact
Very low	1	Total failure effect cost < 0.30 times Replacement Cost
Low	2	Total Effect Cost is between 0.30 – 1.0 times of replacement cost
Medium	3	Total Effect Cost is between 1.0 - 3 times of replacement cost
High	4	Total Effect Cost is between 3 -10 times of replacement cost
Very high	5	Total Effect Cost exceeds 10 times of replacement cost

As an example, an estimate of the potential market impact cost of an in-service failure of the 220kV EPS - TTS cables at SMTS and taking approximately 12 months to be returned to service is about $450 million/year. This is due to lower transfer capacity between Victoria and New South Wales which would require more expensive generation to be dispatched. Note that the line is part of the major corridor between the two states.

Tabulated, these impact results could be represented

Table 4: Market impact studies to date

Circuit	Average Market Impact costs over the TRR period AUD M per year	Estimated Replacement Cost AUD M	Relative Base Criticality
220kV EPS-TTS Line	450	50	High
220kV BTS-RTS	130	130	Medium

Further market impact studies are being undertaken and will be incorporated as they become available

3.6 Asset Performance

Power cables are generally low maintenance assets offering very limited opportunities for maintenance. There is a regular inspection of all above ground cable assets incorporated into the station inspection program. This looks for obvious signs of deterioration of the main insulator, termination base stand-off insulators, connections and any other equipment associated with the terminations (e.g. link boxes). The inspection also covers the visual condition of the cable as it exits the ground, looking for obvious signs of mechanical damage, water ingress or the like.

All new cables installed after 2012 undergo a commission testing program that ensures installation workmanship and asset performance is satisfactory to ensure cable reliability for the full expected service lifecycle.

A condition assessment regime has been established to determine the integrity of the outer protection sheath of all cable circuits, leaning on the understanding that if the outer sheath is intact then the inner core is protected from external influences and should operate as expected for its entire service life. This will be extended in the coming years to incorporate condition assessment of the main insulation systems of the cable circuit.

All 22kV rated transmission cables are located within the station boundaries and are therefore protected from third party interference.

3.6.1 Power Cable Failures

To date, there have been no cable circuit failures that have been attributed to the cable itself. Generally, the installation requirements for cables rated 66kV or higher are more stringent and have more detailed works practices than are their MV counterparts. This leads to a higher circuit reliability.

3.6.2 Termination Failures

To date, there have been no cable termination faults that have led to a catastrophic failure of the termination. There have been however two recent incidents that have been identified through physical inspection of the above ground assets, both being oil leaks. The first being from the oil feed pipes on the 220kV EPS-TTS line cables at SMTS wherein an inline pipe insulator had fractured and was leaking oil, the second being oil weeping from a termination on the TTS B5 transformer 66kV cable circuit. The first was repaired within a few days of it being identified, the second has been scheduled to occur during a planned transformer outage. The station inspection program mentioned above, is satisfactory to capture incipient failure modes with an oil leak being the first indicator along with low oil pressures and the like.

3.6.3 Joint Failures

Apart from a joint failure on the BTS-RTS cable in 2004, primarily attributed to the failure of oil monitoring equipment on the joint, to date, there have been no cable joint faults that have led to a catastrophic failure of the joint. Being underground, cable joints can be difficult to condition assess. Sheath integrity testing is a way of monitoring if the internal joint body is still protected from the external environment.

The BTS-RTS cable has proven reliable during its 30 year history, with all of the original oil filled joints having now been replaced with two new joints and a short length of cable following the above mentioned failure.

The original oil filled terminations have also been replaced with SF_6 cable terminations as a part of the station upgrade projects at both BTS and RTS.

These replacement programs should assist in helping the circuit remain reliable, however there have not been any condition assessment tests undertaken on the main insulation material due to the lack of a suitable test voltage source.

4 Other Issues

This section describes the key issues associated with the fleet of power cables. These issues have been categorised into voltage levels. More detailed information is available in the Asset Health Report, AHR 10-66 Power Cables.

As an introduction, a brief overview of the background for the planned Condition Assessment test programs is presented, the results of which may present other cable issues that are unknown at this point in time.

4.1 Power Cable Condition Assessment

Testing of cables is carried out at different stages of the cable’s life. The lower arrows in Figure 5 represent the opportunities that the asset manager has available to measure the insulation degradation of the cable system with the desire to accurately predict the end of life. The upper arrows represent when detrimental influences to a cable’s lifecycle can occur.

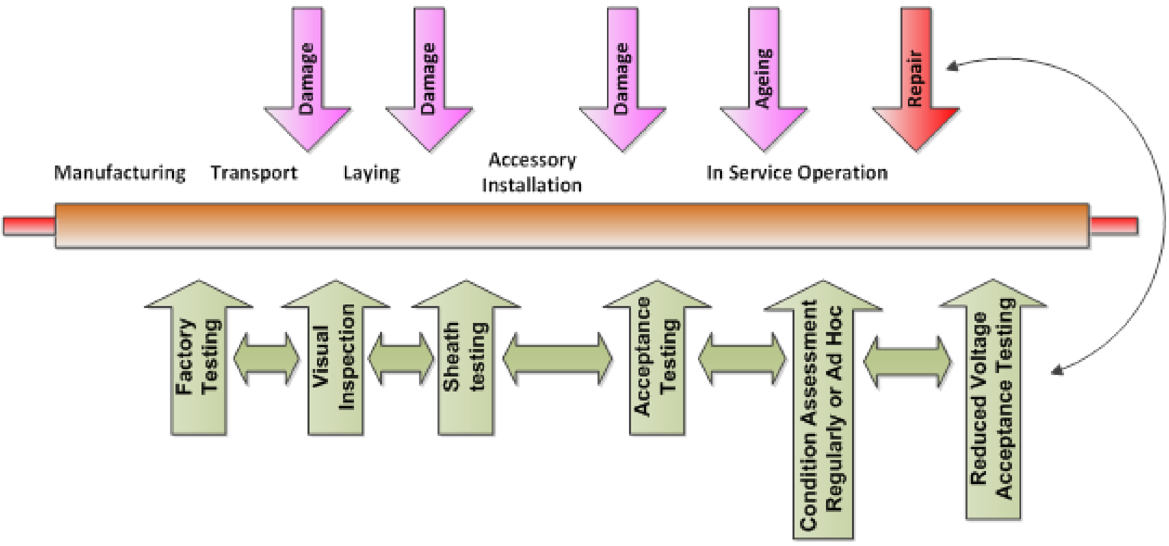

Figure 5 – Testing opportunities in a cables' lifecycle

Acceptance tests are undertaken during commissioning to ensure that the installed asset is fit for service by adequately measuring the voltage withstand and current carrying capabilities of the entire cable system. Additional tests are done to determine if any damage to the outer protection sheaths has occurred during the installation process. These tests give a 'benchmark' or 'fingerprint' of the condition for the insulation and protection layers.

The acceptance tests form an integral part of the quality assurance system surrounding the correct installation of the cable and accessories. They go toward ensuring that consistent, high quality installation practices are always followed for both the cable and the accessories

Condition Assessment tests of the cables main insulation system are only starting to be scheduled. One of the main issues surrounding the longer 220kV cable circuits within the network is the lack of a suitable test voltage source.

The electricity network is typically a balanced three phase network, allowing an immediate comparison to be made of measurements between phases.

Acceptance criteria for the individual tests is typically stipulated to be:

a) Below a maximum or above a minimum value;
b) Comparable with design values; and
c) Consistent between phases.

Cables operate in a homogeneous insulation system so there should be no significant differences between the measurements made on the various phases. All 3 phases operate at the same voltage, carry approximately the same current, are installed in the same trench, and surrounded with the same backfill.

Power cables are now commission tested after installation, yielding a higher degree of confidence to their suitability to perform satisfactorily for the full designed service life. In the coming years, these tests will be complimented by a scheduled set of condition assessment tests throughout the service life of the cable to confirm the rates of material degradation and thus enabling a more informed projection of end-of-life replacement.

There are however some on-going issues with the existing circuits that will now be discussed.

4.2 220 kV Cable Issues

The population of 220 kV rated cables is growing as insulated cable systems are becoming the preferred connection method into newly installed switchgear and power transformers. This can be seen in the recent rebuilding of the BTS, RTS and WMTS stations utilising Gas Insulated Switchgear (GIS) and cable connections for the majority of the 220kV, 66kV and 22kV circuits, where applicable.

As the BTS-RTS cable enters its fourth decade of successful operation, the following known issues exist

- it will soon be in the C5 Condition category, as it reaches the end of its designed service life
- To date, no electrical condition assessment test measurements have been undertaken on the main insulation system due to the circuit length and lack of suitable test voltage source equipment.
- Due to the route taken by this cable circuit, access to some of the link boxes for the cross-bonding system require the closure of traffic lanes along Hoddle Street, one of Melbourne's busiest. This has a direct impact to undertaking the sheath insulation resistance (IR) tests and to minimise the interruption to traffic flow, the annual sheath tests are undertaken during early hours of the morning. Recent sheath IR tests are returning lower than expected levels which will require further testing to establish the severity of insulation deterioration.
- The route also passes through sensitive environmental areas connected with Merri Creek and the Yarra River, where access to either area for major repairs will require extensive stakeholder negotiations.
- The route passes under and along the side of the CityLink South Eastern Freeway, in an area that is subject to flooding and is used (in part) for shelter by homeless people. An investigation is required into the condition of the cleating and support systems used in these areas.
- Accessing the cable joint bays and actual cable should a failure occur. As previously mentioned, many of the cable joint bays (JBs) are located on or adjacent to major roads or freeways, for example JB 6, JB 8 and JB 9 are located in the middle of Hoddle Street, and present traffic management issues and a difficult work environment for routine inspection or maintenance activities. Figure 6 illustrates the location of JB 8 and its associated link box in Hoddle Street (adjacent to the median strip).

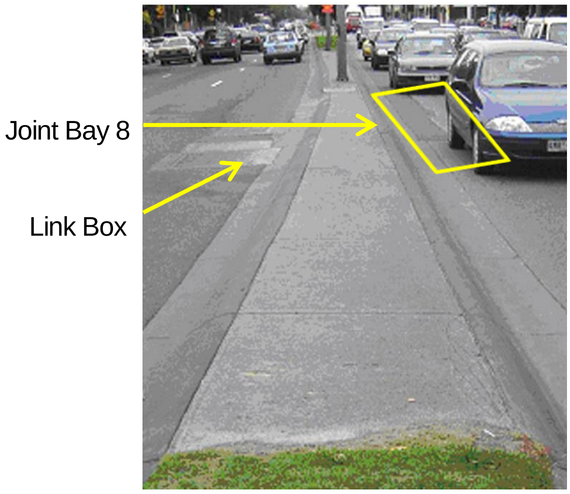

Figure 6 – Hoddle Street BTS-RTS Cable

The 220kV EPS-TTS line oil filled cables at located at SMTS have known issues due to a significant disturbance of thermal backfill sand from the joint bay and adjacent ground due to animals burrowing. This is currently being monitored however a proactive replacement strategy is being adopted, give the high criticality of these cables.

- There are two parallel cables per phase. With the manufacturer not offering a repair option it has been decided to begin a duplication of these circuits with plans to lay a new set of conduits next to the existing cables. The new circuits will be installed and fully tested prior to the existing lines being removed therefore minimising outage durations.

4.3 66 kV Cable Issues

The key issue associated with the 66 kV cable population is the sheath integrity of three cables installed between LY and LYPSA. These cables have recently been tested for sheath insulation resistance, recording lower than expected results. A detailed investigation is now required into the consequences of such low readings.

4.4 22 kV, 11 kV and 6.6 kV Cable Issues

There are minimal testing and recorded issues on the 22 kV, 11 kV and 6.6 kV fleets. An opportunity exists to improve understanding of asset condition by using a more disciplined and objective asset health information capturing system. This will involve condition assessment testing and analysis to determine and confirm rate of degradation of the asset. Test results can inform the condition of the cable and can indicate if an asset is approaching the end of its useful life, which will provide a basis for asset replacement strategies.

Due to the age, condition and the constrained ability to repair the paper insulated cable fleet, there is a concerted effort to transition from Paper/Oil to XLPE insulated cables.

5 Risk and Option Analysis

This section outlines the key risks associated with MV, HV and EHV underground cables and discusses how those risks should be addressed.

5.1 Risk Assessment Methodology

The probability of failure is directly related to the individual cable segment condition assessment score and the consequence is determined by considering following criteria:

- Cable function/role in the network,
- Number of customers supplied by the cable segment and

The relative risk level associated with a particular cable circuit is directly proportional to its rated voltage, the higher the rated voltage, the higher the consequence of a failure will have on network performance. Therefore, a focus has been made toward on-line monitoring of 220kV circuits.

All new 220kV circuits, that either have no circuit redundancy or form a part of a main transmission line, will be fitted with a fibre optic cable (FOC) to monitor the cable performance in regard to but not limited to Distributed Temperature Sensing (DTS) along the route length. If the cable circuit interconnects station to station, the use of the FOC will be expanded to include acoustic/vibration monitoring of the immediate vicinity around the cable to detect any unauthorised third-party activity that may impact public safety or cable circuit performance.

The retrofitting of FOCs to existing cables is extremely difficult, if not impossible

For lower voltage cables typically within stations, they have an inherent redundancy built in to the station design

Cables within the C5 condition category will systematically be replaced as the primary plant to which they are connected is replaced.

5.2 Capex Forecast

5.2.1 220kV EPS-TTS Cable

There are known issues with the 220kV EPS-TTS line oil filled cables at located at SMTS. There are two parallel cables per phase. With the manufacturer now not supporting any repairs it has been decided to investigate a duplication of these circuits with plans to lay a new set of conduits and cables next to the existing cables. The new circuits would be installed and fully tested prior to the existing lines being removed therefore minimising outage durations. The detailed design of these circuits will commence post a justification study for this circuit. .

The first proposed step is purchasing strategic depreciable spare cable and accessories for one phase of this circuit, along with other asset critical cable circuits ensuring that common spares are cross referenced as often as possible to reduce expenditure.

5.2.2 BTS-RTS 220kV Cable

For the BTS-RTS circuit, instruments to monitor the on-line Partial Discharge (PD) activity within the cable circuit, are planned to be installed at each end of the circuit. While being difficult to calibrate to monitor exact discharge magnitudes, it will be possible to immediately detect the location of an electrical breakdown of the main insulation system, should it occur, saving several days of fault investigation works on one of Melbourne busiest roads.

6 Asset Strategies

The following key strategies guide the management of Transmission power cables:

6.1 New Assets

Continue the rigorous inspection regime of manufacturing plants to ensure the supply chain quality is maintained.

Continue to enhance Commission testing protocols, ensuring all new assets are effectively tested prior to being placed into service, thus giving a baseline or 'fingerprint' for all future condition assessment test programs.

6.2 Inspection

There is a regular inspection of all above ground cable assets incorporated into the station inspection program. This looks for obvious signs of deterioration of the main insulator, termination base stand-off insulators, connections and any other equipment associated with the terminations (e.g. link boxes). The inspection also covers the visual condition of the cable as it exits the ground, looking for obvious signs of mechanical damage, water ingress or the like.

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Continue to expand the electrical Condition Assessment testing program to all transmission network cable circuits. The tests will include HV withstand, Partial Discharge (PD) and Dielectric Dissipation Factor (DDF or Tanδ).

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Continue to update cable asset records and fault response plans

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All new cable circuits being installed that are identified as not already having strategic spares in the store system, shall have such spares purchased and safely stored. The Malvern Store has been selected to house all strategic spare HV and EHV cable accessories while the storage of strategic spare cable shall be on steel drums and primarily be at the Ringwood Store. All spare power cables are to be recorded in the asset management database (SAP). A full review of cable spares is planned in order to address the risks associated with cable failure. Gaps between necessary and actual will be identified and a plan established to order/stock appropriate spares.

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6.6 Repairing oil filled cables

AusNet Services has a small population of oil filled cables. Although a major fault on one of these cables is currently unlikely, the consequences of such a fault could be severe.

Oil filled cables are no longer being installed on the network and with the loss of expert knowledge on repair protocols, the probability of effecting a reliable repair on such a cable is low. A strategic cable replacement program has been developed utilising modern cable types, techniques and designs to economically replace cables when appropriate. A load flow study of the individual circuits has assisted in determining suitable XLPE insulated equivalent replacement options and indicate the appropriate strategic spare levels.

Depending on the point of failure, a repair program will range from replacement of the entire cable length, to a replacement of a section of cable utilising one stop joint to the removal of the failed section of oil filled cable and being replaced with two stop joints and a short section of XLPE insulated cable.