Asset Management Plan
Pole Top Structures
2020-25

January 2019

Part of the Energy Queensland Group

Executive Summary

This Asset Management Plan (AMP) focuses on the management of pole top structures.

Pole top structures support the overhead network which delivers electricity to customers across Queensland. Energy Queensland Limited (EQL) manages over 2,100,000 pole top structures, comprised of around 1,500,000 in the Northern and Southern Regions (Ergon Energy) and 630,000 in the South East Region (Energex).

EQL undertakes lifecycle management of pole top structures through performance and condition monitoring processes that include periodic routine inspections, maintenance, and refurbishment to achieve optimum performance, and where possible extend asset service life. These key functions ensure that EQL is consistent with sound asset and risk management principles to operate safely as an efficient and effective organisation, deliver customer expectations, meet regulatory requirements, and manage long term strategic risks in relation to price, asset value, and shareholder returns.

Pole top structures are made up of crossarms, insulators, and other accessories. Crossarms may be constructed from wood, laminated softwood, steel, concrete, or composite fibres. Other pole top structure designs do not require crossarms at all (e.g. Single Wire Earth Return). The majority of the crossarm population is constructed from wood. Wood crossarms are susceptible a wide variety of environmental damage including termite attack, rot and decay, flammability, and splitting due to weathering, all of which can increase the likelihood of catastrophic failure. The current strategy is to transition away from wood crossarms in favour of alternatives such as composite crossarms or constructions with no crossarm for standard designs. Due to known issues with laminated crossarms, the feasibility of specific condition-based assessment is to be investigated.

EQL measures crossarm reliability using a three-year moving average, with an internal target of 0.02% set across the asset population. Overall population performance is evaluated as part of the general organisation obligations for reliability and annual Dangerous Electrical Events incidents.

EQL is working to improve its data quality, cost capture, and failure and condition monitoring capability, and actively investigating and pursuing advancements in overhead inspection, using emerging technologies that will further assist in the management of this asset class.

Work is continuing with respect to the alignment of maintenance and operating practices from legacy organisations, to drive efficiency, deliver customer outcomes, and mitigate risks across all EQL operations.

Document Tracking Details

Network and Non-Network Document Hierarchy Reference Number	Regulatory Proposal Chapter Reference	Document	File Name
NET AMP – 010	7.036	Asset Management Plan - Pole Top Structures	EGX ERG 7.036 Asset Management Plan - Pole Top Structures JAN19 PUBLIC

Contents

Figures

Tables

1 Introduction

Energy Queensland Limited (EQL) was formed 1 July 2016 and holds Distribution Licences for the following regions:

- South East Region (Legacy organisation: Energex Limited); and
- Northern and Southern Regions (Legacy organisation: Ergon Energy Corporation Limited).

There are variations between EQL's operating regions in terms of asset base and management practice, as a result of geographic influences, market operation influences, and legacy organisation management practices. This Asset Management Plan (AMP) reflects the current practices and strategies for all assets managed by EQL, recognising the differences that have arisen due to legacy organisation management. These variations are expected to diminish over time with the integration of asset management practices.

1.1 Purpose

The purpose of this document is to demonstrate the responsible and sustainable management of pole top structures on the EQL network. The objectives of this plan are to:

1. Deliver customer outcomes to the required level of service.
2. Demonstrate alignment of asset management practices with EQL's Strategic Asset Management Plan and business objectives.
3. Demonstrate compliance with regulatory requirements.
4. Manage the risks associated with operating the assets over their lifespan.
5. Optimise the value EQL derives from this asset class.

This Asset Management Plan will be updated periodically to ensure it remains current and relevant to the organisation and its strategic objectives. Full revision of the plan will be completed every five years as a minimum.

This Asset Management Plan is guided by the following legislation, regulations, rules and codes:

- *National Electricity Rules (NER)*
- *QLD Electricity Act 1994*
- *QLD Electrical Safety Act 2002*
- *QLD Electrical Safety Regulation 2013 (ESR)*
- *QLD Electrical Safety Code of Practice 2010 – Works (ESCOP)*
- *QLD Work Health & Safety Act 2014*
- *QLD Work Health & Safety Regulation 2011*
- Ergon Energy Corporation Limited Distribution Authority No D01/99
- Energex Limited Distribution Authority No. D07/98

This Asset Management Plan forms part of EQL's strategic asset management documentation, as shown in Figure 1. It is part of a suite of Asset Management Plans, which collectively describe EQL's approach to the lifecycle management of the various assets which make up the network used to deliver electricity to its customers. Appendix 1 contains references to other documents relevant to the management of the asset class covered in this plan.

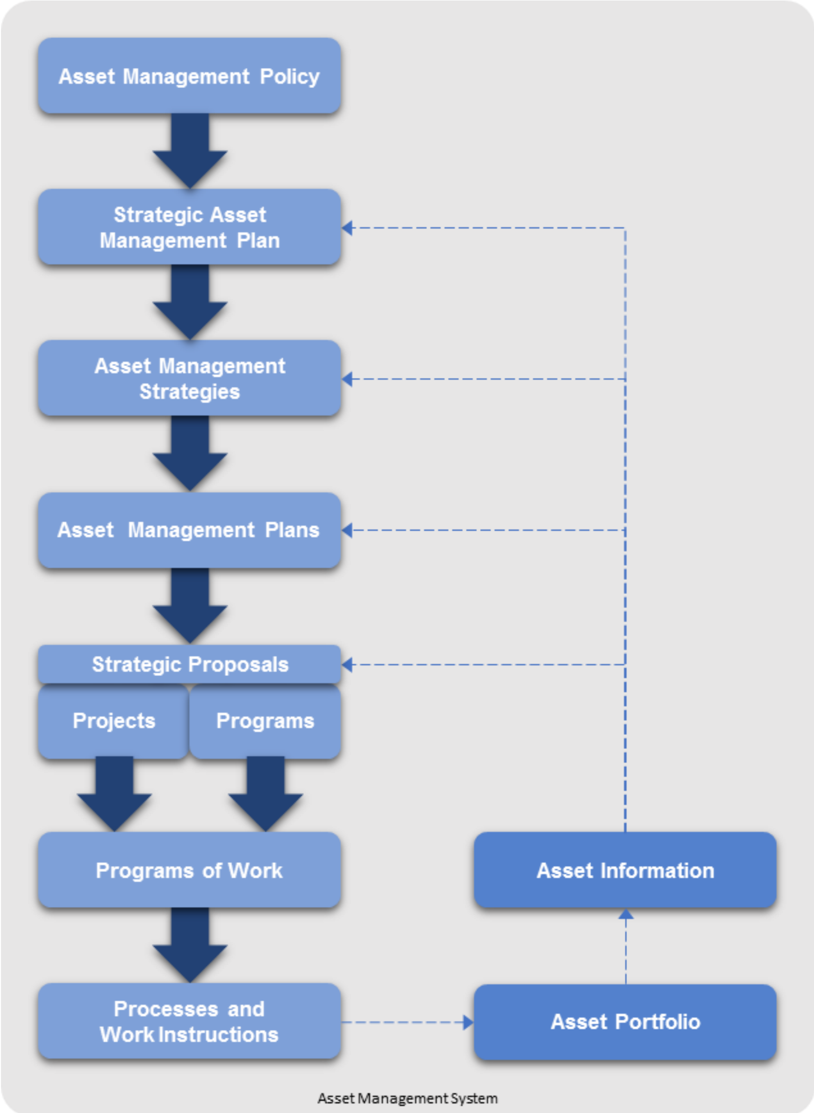


Figure 1: EQL Asset Management System

1.2 Scope

This plan covers pole top structures, at all voltage levels, predominately focusing on the following assets:

- Crossarms including wood, composite, steel, laminated and aluminium
- Insulators including porcelain, glass, and composite.

EQL aims to provide a co-ordinated and optimised approach to the lifecycle management of all assets within the asset base. The scope of this Asset Management Plan has a strong linkage to other overhead assets including poles, lattice towers, and overhead conductor. These plans should be considered together.

Many customers, typically those with high voltage connections, own and manage their own network assets including pole top structures and insulators. EQL does not provide condition and maintenance services for third party assets, except as an unregulated and independent service. This AMP relates to EQL owned assets only and excludes any consideration of such commercial services

1.3 Total Current Replacement Cost

Pole top structures are relatively low individual cost assets; however, the very high volume of these assets in the network makes them a significant component of the overall asset base. Based upon asset quantities and replacement costs, EQL pole top structures have a replacement value of approximately $3.33 billion. This valuation is the gross replacement cost of the assets, based on the cost of modern equivalents, without asset optimisation or age assigned depreciation. Figure 2 provides an indication of the relative financial value of EQL pole top structures compared to other asset classes.

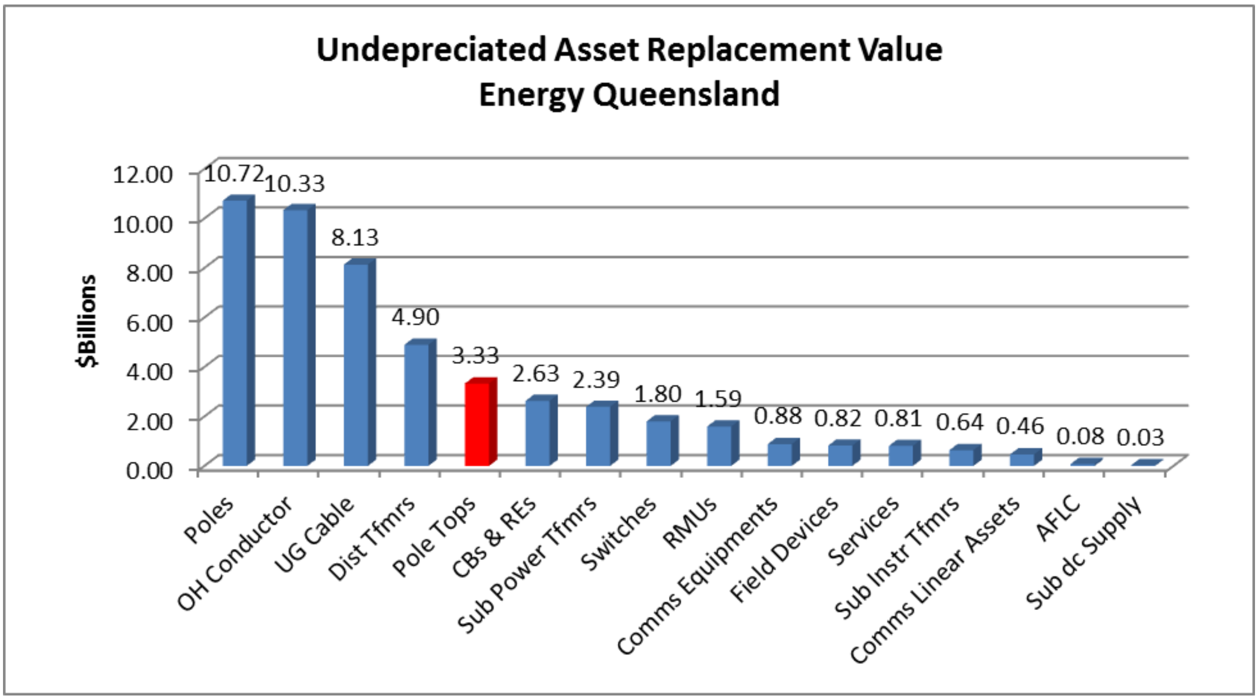


Figure 2: EQL – Total Current Asset Replacement Value

1.4 Asset Function and Strategic Alignment

Pole top structures support the overhead network which delivers electricity to customers across Queensland. Pole top structures are a distributed asset class, located in all terrains and environments, and are located in frequented urban areas as well as remote rural areas.

Table 1 details how pole top structures contribute to the corporate strategic asset management objectives.

Relevant Asset Management Objectives	Relationship of Asset to Asset Management Objectives
Ensure network safety for staff, contractors, and the community	Diligent and consistent operations and maintenance of pole top structures supports asset performance and therefore safety for all stakeholders. Asset failure of pole top structures may result in safety hazards.
Meet customer and stakeholder expectations	Continued pole top serviceability supports network reliability and promotes delivery of a standard quality electrical service.
Manage risk, performance standards and asset investment to deliver balanced commercial outcomes	Failure of pole top structures can result in increased public safety risk and disruption of the electricity network. Asset longevity assists in minimising capital and operational expenditure.

Relevant Asset Management Objectives	Relationship of Asset to Asset Management Objectives
Develop Asset Management capability and align practices to the global ISO55000 standard	This AMP is consistent with ISO55000 objectives and drives asset management capability by promoting a continuous improvement environment
Modernise the network and facilitate access to innovative energy technologies	This AMP promotes replacement of assets at end of economic life as necessary to suit modern standards and requirements. Innovation in the lifecycle management of pole top structures has a significant potential to deliver ongoing efficiencies through the use of technology because of the high volume and geographic spread of these assets. Inspection technologies are a particular focus of opportunity.

Table 1: Asset Function and Strategic Alignment

1.5 Owners and Stakeholders

The key roles and responsibilities for the management of this asset class are outlined in Table 2.

Role	Responsible Party
Asset Owner	Chief Financial Officer
Asset Operations Delivery	EGM Distribution
Asset Manager	EGM Asset Safety & Performance

Table 2: Stakeholders

2 Asset Class Information

The following sections provide a summary of the key functions and attributes of the assets covered in this AMP.

2.1 Asset Description

Pole top structures refer to the structures, insulators, and hardware at the top of a pole that supports and position conductors and other pole top equipment such as air break switches.

Cross-arms are predominately used as part of the pole top. Some pole top designs utilise insulators and steel brackets directly attached to the pole instead of crossarms.

Transformer platforms, surge arrestors, and raiser brackets also form part of the pole top structure. Raiser brackets are treated in a similar fashion to crossarms for the purposes of maintenance.

2.1.1 Crossarms

Crossarms are used to support electrical conductors as well as to provide physical and electrical separation between them. Where crossarms form part of the pole top, they are categorised by material which includes wood, laminated wood, composite fibre, steel, and aluminium. Wood crossarms are predominately made out of hardwood timber. Lightweight laminated softwood plantation timber crossarms have also been used. Due to delamination issues which compromise the safety of the asset, all regions ceased installing these laminated crossarms between 2000 and 2005.

Composite crossarms use thermosetting resin binders including epoxies, vinyl esters, polyurethane, or phenolic compounds, combined with glass fibre reinforcement applied by a pultruded or filament winding process. This product has significant promise with regard to longevity and electrical performance and is lightweight. Second generation composite crossarms are also coated with a membrane of thermoplastic polymer alloy, which has excellent electrical insulation and tracking resistance properties. Composite crossarms have a tendency to deform or bend rather than break when lines are impacted by either vegetation of a third party. This results in a generally improved safety result, as conductors remain suspended at height as opposed to falling to ground.

Steel crossarms were anticipated to provide longer life and avoid the risks resulting from catastrophic failure of wood crossarms. These arms were typically used where high strength and reliability was required such as over railway crossing. While effective in terms of strength, steel crossarms are significantly heavier than other crossarms and so present other risks in terms of manual handling. The South East Region briefly trialled aluminium crossarms as a lightweight alternative to steel, however, the unit cost of aluminium crossarms was found to be uneconomical.

Not all pole top construction types use crossarms. Some use brackets, while others use bolts or insulators directly attached to the pole. Examples include low voltage aerial bundled cable (LV ABC), single wire earth return (SWER), and trident constructions.

2.1.2 Insulators

Insulators are used to attach and support overhead conductors to their supporting structures. The accessories used to secure the conductor to the insulator are covered under the Overhead Conductor Asset Management Plan.

The material and type of insulator used is application specific and is influenced by pollution, power frequency and switching surge voltage, lightning performance, and mechanical load. Insulators are manufactured from glass, porcelain, or composite polymer materials such as ethylene propylene diene monomer (EPDM) or silicon rubber.

Pin type insulators are typically constructed of porcelain and are mounted vertically to the crossarm via a threaded stud. The conductor passes through a groove in the head of the insulator and is fixed in place with a suitable tie accessory.

Line post insulators are of similar construction to pin type; however, they can be mounted vertically or horizontally, either to the crossarm or directly to the pole using a gain base. Depending on the application, the conductor may be fixed in place with ties or secured with additional hardware. Line post insulators at 66kV and above are typically constructed of composite polymer material.

At distribution voltages and higher, suspension type insulators may also be used. These insulators were historically constructed using strings of individual toughened glass or ceramic discs connected in series. Additional hardware is connected to support the conductor. The arrangement of suspension insulators at a termination dead-end is referred to as strain insulators. There is a preference to use composite materials for suspension and strain type constructions, due to their lighter weight and resistance to vandalism. Composite, long rod insulators are constructed using a central member or “core” of solid high-density, axially aligned, glass-fibre-reinforced, epoxy resin rod. The housing and sheds are moulded from suitable elastomer which is stabilised against the effects of ultraviolet and other solar radiation.

2.1.3 Surge Arrestor

A surge arrestor (also referred to as a lightning arrestor) is a protective device connecting a live conductor on an electrical system and earth. Its function is to limit the magnitude of transient overvoltage applied to the system equipment primarily due to lightning induced surges. Surge arrestors are sealed units with a long service life and are essentially maintenance free. They are a standard stock item and are replaced on failure. Where surge arrestors form part of the pole top structure, they are maintained alongside other pole top assets. Surge arrestors have not been focused on with a high level of detail throughout this document due to the nature of their use.

2.2 Asset Quantity and Physical Distribution

Pole tops are not recorded as separate assets in the legacy corporate systems, so comprehensive information on age, date of installation, material and condition is incomplete. Table 3 presents the quantity of pole top structures by type based on available data (see Sections 2.1.1 and 2.1.2 for further detail).

Pole Top Grouping	Pole Top Type	South East	Northern and Southern	EQL Total
Crossarms	Wood	337,057	941,782	1,444,790
	Laminated	8,572		
	Composite	157,379		
Pole Top Other	Steel	111,250	300,558	424,428
	Aluminium	744		
	Other	11,876		
	SWER	160	236,437	236,597
Total		627,038	**1,478,777**	**2,105,815**

Table 3: Pole Top Structures Quantity

2.2.1 Crossarms

Crossarm data has been derived for each region based on the below information. As this data is partially derived, errors and inaccuracies may be present.

Northern and Southern Regions:

In the Northern and Southern Regions, the installation year can only be determined for crossarms which have been replaced since 2003, by using the date of replacement on the relevant work order. If this data is not available, the pole top age profile data is used to infer the installation year, and to derive an age estimate for the pole top.

The number of crossarms is calculated by counting the number of individual crossarms recorded against each pole asset in the Enterprise Asset Management (EAM) system (Ellipse).

Breakdown of crossarm quantity data into material type isn't achievable at this stage. Further work is required to obtain this data. Please refer to 9.2 for more details on supporting data requirements.

SWER quantities are based on the number of poles that corporate data indicates have SWER attached. Other pole top data is inferred by using the voltages attached to each pole top that is not indicated to have crossarms attached.

South East Region:

Data on age brackets and material types have been developed based on actual data and derived age estimates, using a consistently applied methodology taking into consideration:

- Available crossarm asset data in the asset register.
- Pole type, age, and voltage level.
- Pole inspection data. (By November/December 2018 the first round of data obtained from a full 5-year inspection program will have been completed.)
- Ellipse replacement work orders since 2003.

SWER quantities are based on the number of poles that corporate data indicates have SWER attached.

2.2.2 Insulators

EQL has a large and diverse population of insulators, with very little corporate data on the type, age and condition of these assets available at present.

Condition information on insulators is not collected. Defects are identified and recorded during routine visual inspections.

Due to the limited data this AMP does not present population details of insulators. The majority of the pole top types include insulators as part of the design. An exception to this is LV ABC. Total numbers of pole tops presented in this document can, therefore, be used to give a general indication of numbers of insulators. The number of insulators required per pole top structure is generally reflected by the voltage and type of pole top structure.

2.3 Asset Age Distribution

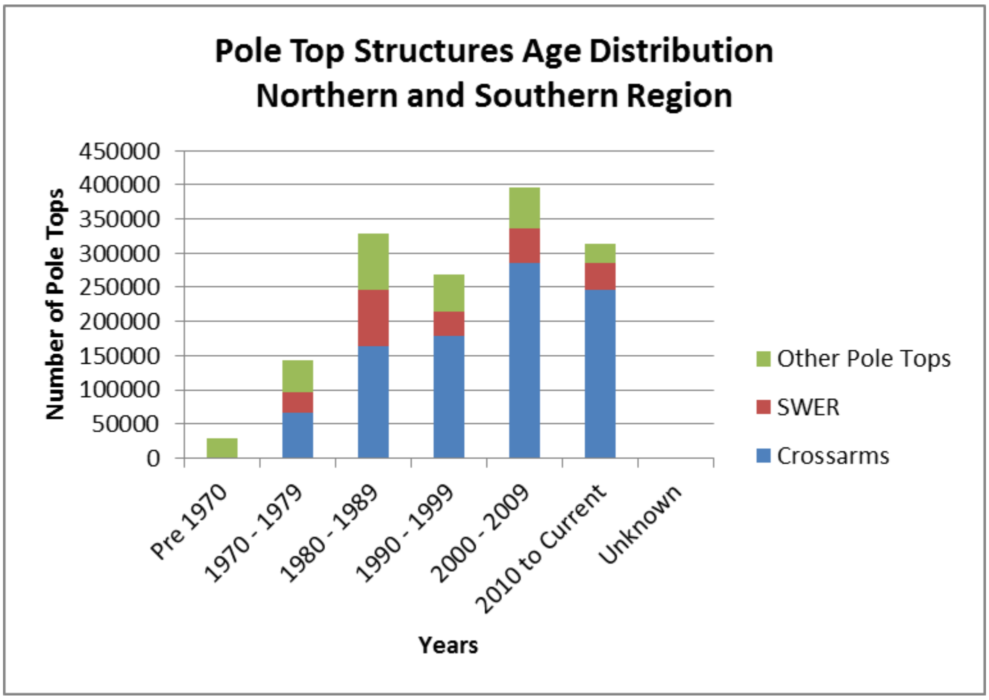


Figure 3: Northern and Southern Regions Pole Top Age Profile

Figure 3 shows the Northern and Southern regions derived age for the pole top population. The majority of the crossarm population presented are wood.

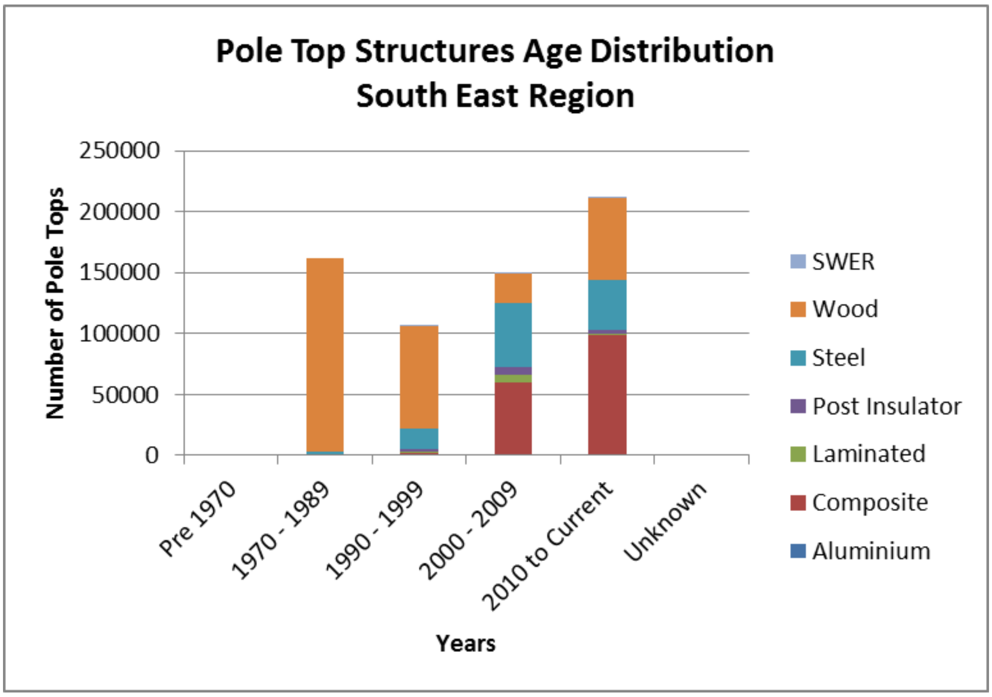


Figure 4: South East pole top structures age by type

Figure 4 shows the South East region derived age for the pole top structures population.

2.4 Population Trends

The following sections describe the general asset population trends of different assets covered in this AMP.

2.4.1 Wood Crossarms

Prior to 1990, overhead distribution (LV, 11kV and 22kV) feeders were constructed exclusively with hardwood timber crossarms. On the 33kV, 66kV, 110kV and 132kV networks, wooden crossarms were also used for pin, post, underslung, and wishbone constructions making up a large portion of the total population at these voltages.

In the early to mid-1990s, all regions introduced the practice of painting the top surface of wooden crossarms to prevent moisture collecting on the top of the crossarm and accelerating rot.

Use of wood crossarms for common construction types is no longer the preferred option due to the wide range of environmental factors that influence the useful life. Composite or steel/pole top bracket construction types are preferred. Work is currently underway in the Northern and Southern regions to move towards composite crossarms for 33kV and below. In the South East region, the vast majority of LV and 11kV wood crossarm construction types have been migrated to composite crossarms along with the majority of 33kV constructions. Wood crossarms are still being used for 33kV wishbone construction types, while the feasibility of wishbone composite replacement is being determined in the South East region. The Northern and Southern regions have already adopted composite crossarm wishbone constructions where feasible.

2.4.2 Composite Crossarms

All regions introduced the first generation of composite crossarms around 2005/2006.

In the South East, the first trials of 100 x 100mm composite crossarms were LV and 11kV intermediate constructions (pin and post). Composite crossarms were later extended to 11kV strain and termination constructions (these crossarms required a larger 125 x 125mm arm). Installation location wasn't limited by proximity to the coast, as composite fibres are less susceptible to deterioration by coastal environments than other materials. The extra strength capability of composite crossarms was utilised in design practices.

In the Northern and Southern regions, composite crossarms were installed at a range of voltages with the first being installed at 110kV to replace timber wishbone constructions. Composite crossarms for high voltage constructions were not installed within 5km of the coastline. Strength requirements of crossarms were based on equivalent wood strength, allowing for interchangeability with wood crossarms if required.

The second generation of composite crossarms, coated with a membrane of thermoplastic polymer alloy, which has excellent electrical insulation and tracking resistance properties, was introduced around 2009/2010.

In 2015, the South East region embarked on a composite crossarm trial in 33kV networks and has since begun replacing 33kV wooden crossarms with composite.

In all regions, aged LV network timber crossarms are now replaced with either composite crossarms, or removed entirely; by replacement with Aerial Bundled Cable (ABC) construction (full rollout of ABC is limited by cost associated with related pole replacements). A universal bracket is being developed to facilitate the rollout of composite crossarms across the entire HV network.

2.4.3 Steel Crossarms / Pole top brackets

In the late 1990s all regions began using steel 11kV, 22kV trident constructions to replace wood pin insulator constructions. Typically these designs utilise insulators and steel brackets directly attached to the pole instead of crossarms. The South East replaced timber crossarms with steel crossarms on 11kV and 33kV, shackle and termination constructions.

SWER (Single Wire Earth Return) pole tops also typically utilise a steel bracket and insulator attached directly to the pole.

The South East region briefly trialled aluminium crossarms as a lightweight alternative to steel, however, the unit cost of aluminium crossarms was found to be uneconomical.

2.4.4 Laminated Crossarms

The introduction of laminated softwood plantation timber crossarms occurred in the late 1990's in the South East region and in the early 2000's in the Northern and Southern regions. Due to delamination issues which lead to loss of mechanical strength, all regions ceased installing these crossarms, the South East in the early 2000's, and the Northern and Southern regions in 2005.

2.4.5 Post / Clamp Constructions

Post insulator and clamp suspension constructions do not use crossarms at all. Post insulator constructions such as vertical offset and vertical delta arrangements typically use an insulator that is directly attached to the pole. Other pole top constructions, such as LV ABC, use a clamp that is typically attached by a bolt to the pole.

2.5 Asset Life Limiting Factors

The following tables describe the key factors that influence the life of Pole Top Structures and as a result, have a significant bearing on the programs of work implemented to manage the lifecycle.

2.5.1 Crossarms

Table 4 details the life limiting factors associated with wood, composite, and steel crossarms, as well as pole top metallic hardware.

Factor	Influence	Impact
Age	Deterioration of strength over time. Wood crossarm splitting due to age.	Reduction in the remaining life
Environment	Outdoor, corrosive or coastal environments, ultra-violet radiation, high rainfall areas, and environmental factors such as lightning, resulting in degradation of the crossarm and other pole top components. Wood crossarms are susceptible to termite attack, fungal fruiting bodies, rot and decay, and splitting due to weathering. Environmental influences make composite crossarms more prone to tracking and blooming. Steel and other pole tops metallic hardware are susceptible to corrosion.	Reduction in the remaining life, defects and failures
Design	Wood crossarm design can result in burning due to leakage currents – leakage mitigation such as gang nail plates are used to reduce this issue. Laminated wood crossarms present a greater risk of premature failure due to their design. Delamination leads to rot forming between laminations. Composite crossarm tracking and blooming issues resulting from environmental influences detailed above have been mainly associated with first generation crossarms. Design of the second generation crossarms has reduced this issue. Weld cracks compromise strength in steel crossarms and other pole tops metallic hardware.	Defects and failures

Table 4: Crossarms Life Limiting Factors

2.5.2 Insulators

Table 5 details the life limiting factors associated with insulators.

Factor	Influence	Impact
Age	Deterioration of strength over time.	Reduction in the remaining life.
Environment	Outdoor, corrosive or coastal environments and environmental factors such as lightning can result in flashover, corrosion, and degradation of the physical asset and components. Composite insulators are also susceptible to damage by birds and ultra-violet radiation.	Reduction in the remaining life, defects and failures
Design	Network design and other influences can result in vibrations that can cause damage to the insulators. Porcelain insulators are susceptible to cement growth, resulting in cracking and moisture ingress and subsequently corrosion of metal components.	Defects and failures
External factors	Vandalism results in damage to the insulators	Defects and failures

Table 5: Insulators Life Limiting Factors

3 Current and Desired Levels of Service

The following sections define the level of performance required from the asset class, measures used to determine the effectiveness of delivering corporate objectives, and any known or likely future changes in requirements.

3.1 Desired Levels of Service

This asset class will be managed, consistent with corporate asset management policy, to achieve all legislated obligations and any specifically defined corporate key performance indicators and to support all associated key result areas as reported in the Statement of Corporate Intent (SCI).

Safety risks associated with this asset class will be eliminated so far as is reasonably practicable (SFAIRP), and if not able to be eliminated, will be mitigated SFAIRP. All other risks associated with this asset class will be managed to be as low as reasonably practicable (ALARP).

This asset class consists of a functionally alike population, differing in age, brand, technology, material, construction design, technical performance, purchase price, and maintenance requirements. The population will be managed consistently based upon generic performance outcomes, with an implicit aim to achieve the intended and optimised life cycle costs for the asset class and application.

All inspection and maintenance activities will be performed consistent with manufacturers' advice, good engineering operating practice, and historical performance, with the intent to achieve the longest practical asset life overall.

Life extension techniques will be applied where practical, consistent with overall legislative, risk, reliability, and financial expectations. Problematic assets such as very high maintenance or high safety risk assets in the population will be considered for early retirement.

Assets of this class will be managed by population trends, inspected regularly, and allowed to operate as close as practical to end of life before replacement. End of asset life will be determined by reference to the benchmark standards defined in the Defect Classification Manuals and or Maintenance Acceptability Criteria. Replacement work practices will be optimised to achieve bulk replacement to minimise overall replacement cost and customer impact.

3.2 Legislative Requirements

Regulatory performance outcomes for this asset include compliance with all legislative and regulatory standards, including the *Electrical Safety Act 2002 (Qld)*, the *Electrical Safety Regulation 2013* (Qld), and the Queensland Electrical Safety Codes of Practice.

The *Electrical Safety Act 2002 (Qld)* s29 imposes a specific duty of care for EQL, which is a prescribed Electrical Entity under that Act:

1) An electricity entity has a duty to ensure that its works—
    a. are electrically safe; and
    b. are operated in a way that is electrically safe.
2) Without limiting subsection (1), the duty includes the requirement that the electricity entity inspect, test and maintain the works.

3.3 Performance Requirements

EQL has a strategic objective to ensure a safe and reliable network for the community. Performance targets associated with these asset classes, therefore, aim to reduce in service failures to levels which deliver a safety risk outcome which is considered so far as is reasonably practicable (SFAIRP) and as a minimum, maintains current performance standards.

The Electrical Safety Code of Practice 2010 Risk Management discusses the need to identify and rectify obvious, concealed, developing, and transient risks on the network. The Code recommends that the most simple and effective way to do this is by regular visual inspection and observation. EQL has developed a suite of maintenance programs to identify, prioritise and remediate pole top structure defects. Defects identified via inspection programs are classified and prioritised according to the EQL Lines Defect Classification manual (LDCM). The P1 and P2 defect categories relate to priority of repair, which effectively dictates whether normal planning processes are employed (P2), or more urgent repair works are initiated (P1).

Asset failures occur where the programs in place to manage the assets do not identify and rectify an issue prior to it failing in service. Failures typically result in or expose the organisation to risk and represent the point at which asset related risk changes from being proactively managed to retrospectively mitigated.

While there are no specific Serious Electrical Incidents (SEI) or Dangerous Electrical Events (DEEs) targets, EQL is committed to reducing these indicators in compliance with our electrical safety obligations under the regulations.

The frequency and duration of outages are also tracked to ensure ongoing compliance with minimum service standards set forth under the Electricity Industry Code. Under the Service Target Performance Incentive Scheme (STPIS), EQL is provided with financial incentive to maintain and improve reliability performance.

3.4 Current Levels of Service

The EQL crossarm reliability target is set at 0.02% of the Asset Population. Figure 5 is produced on a monthly basis to track the three-year rolling average of crossarm failures. Failure rates are within the agreed business limits across all of EQL for the financial year ending 17/18.

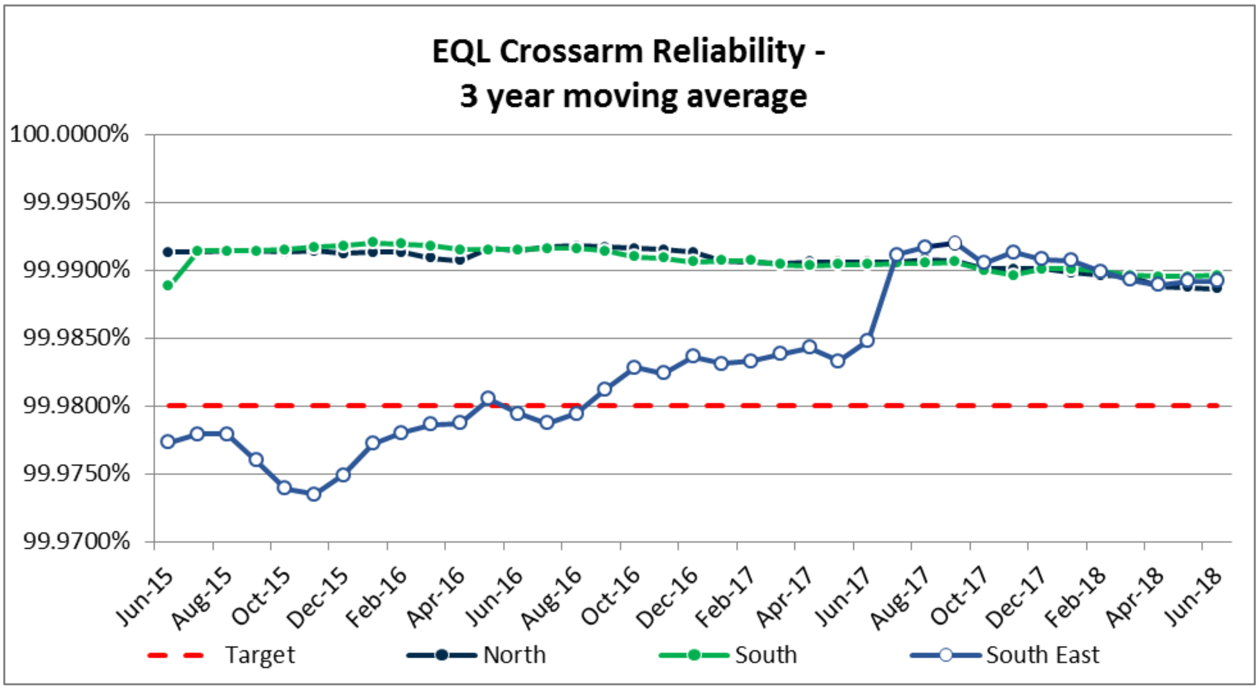


Figure 5: EQL Crossarm Reliability

Figure 6 and Figure 7 present the pole top structure failure counts in the South East region. Due to data limitations, this data was not able to be broken down further into components. The percentage of failures presented in Figure 7 is based on the current pole top structures population in all years as the historical population figures are not available.

It should be noted that a reduction in crossarm population is occurring due to rollout of LV ABC across EQL networks, and so a reduction in failure count over time is expected.

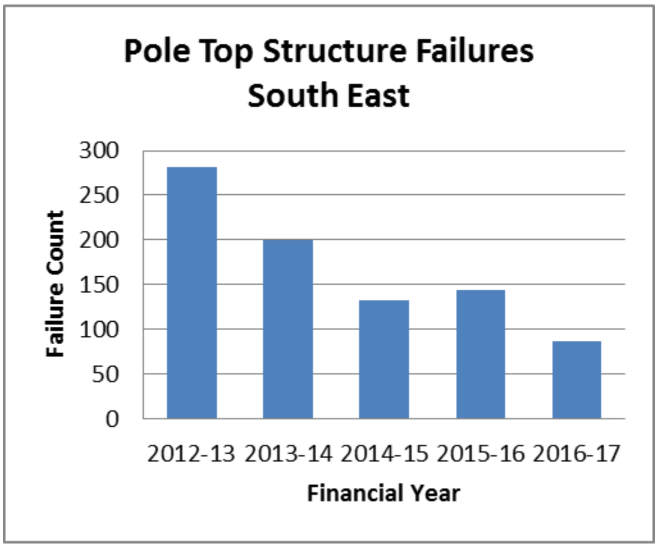


Figure 6: South East pole top structure failure count

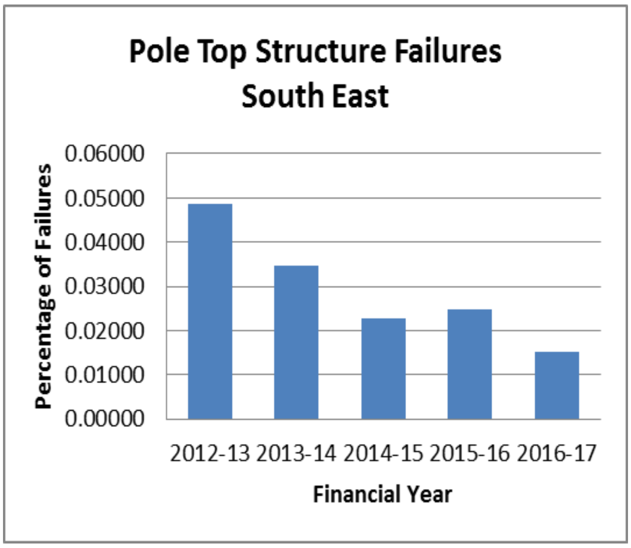


Figure 7: South East pole top structures failure percentage

Figure 8 shows the number of pole top failures in the Northern and Southern regions, broken down into component type. The Maintenance Strategy Support System (MSSS) code utilisation method changed in 2015 due to the introduction of Field Force Automation (FFA) which changed the tools used to record this information. This is the reason for the change in Figure 8 between the 12/13 to 14/15 and 15/16 to 17/18 periods. Due to the predominate population of wood crossarms it can be inferred that the majority of the Crossarm-General category would be related to wood crossarm failures. Due to limited population information on insulators, and pole top components other than crossarms, normalisation of this graph has not been provided.

The disparity between the reported failures of the EQL legacy organisations reported failures is due to differences in source data and calculation methodology. EQL is working towards alignment of methodologies to ensure a common approach moving forward.

EQL is required to report AER annually on asset failure for the given RIN asset classes as part of template 2.2.1. The AER definition of an asset failure is the failure of an asset to perform its intended function safely and in compliance with jurisdictional regulations. It excludes external impacts such as weather events, third party interference, and planned interruptions.

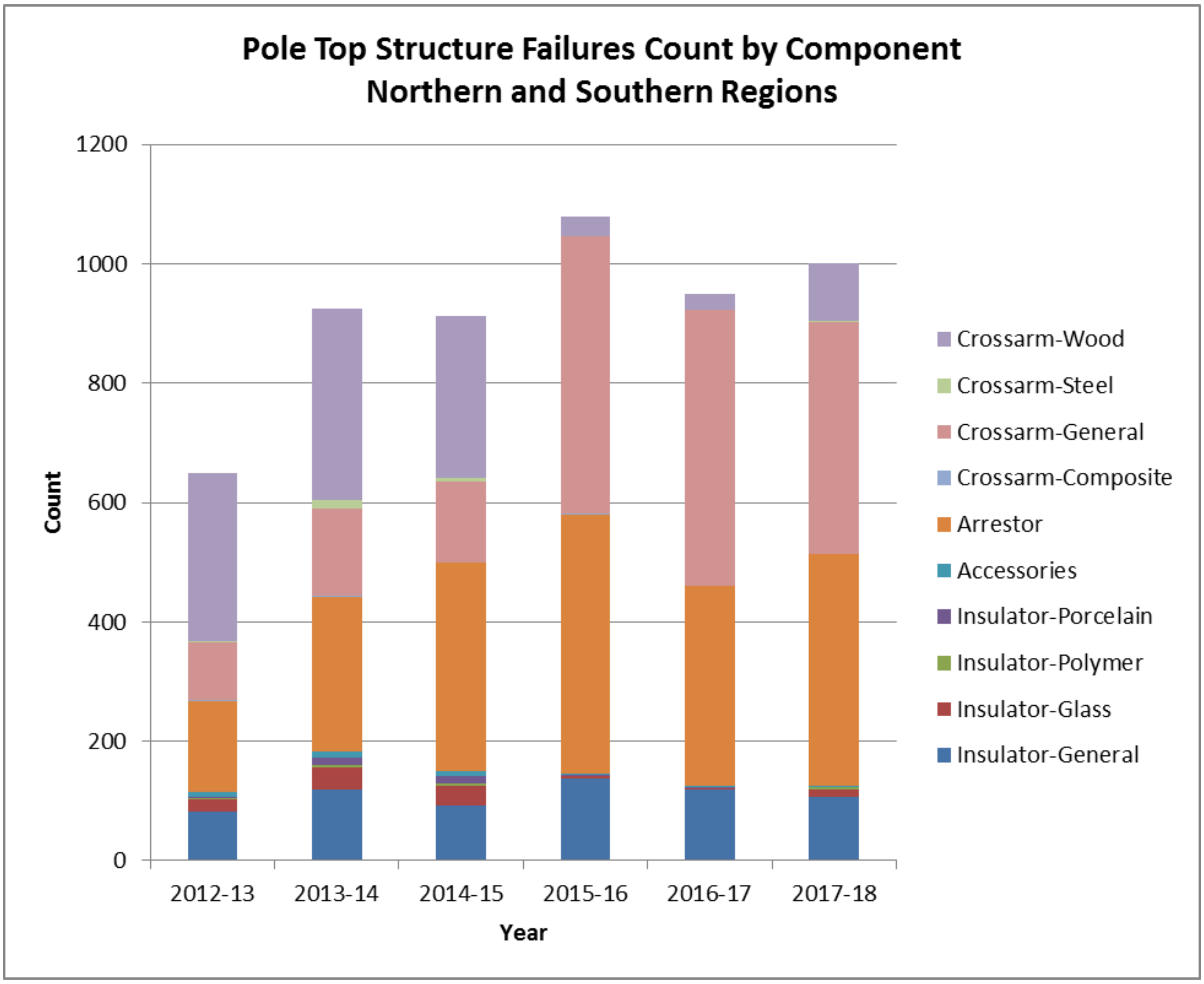


Figure 8: Northern and Southern Regions pole top failure by component

Figure 9 shows the failures in the Northern and Southern regions, broken down by the associated pole top component. Figure 9 shows that surge arrestors contribute to 38.8% of failures associated with pole top structures.

This is generally representative of the surges experienced on the network where the arrestor has operated. After surge arrestors have operated to protect live conductors and associated equipment within a network, field maintenance crews are generally required to replace the arrestors to ensure continued network protection. This replacement is not a representation of the failure of the assets to operate correctly, but a representation of necessary corrective action. Insulators also contribute to the pole top structure failures presented.

The causes of wood crossarm failures have been broken down in Figure 10. Rot/decay causes 57% of wood crossarm failures.

The causes of insulator failures are represented in Figure 11. Unknown causes present the biggest percentage of insulator failures. This highlights a data collection issue, which will need to be addressed in the future. Refer to 9.2 for further mention of data improvements required.

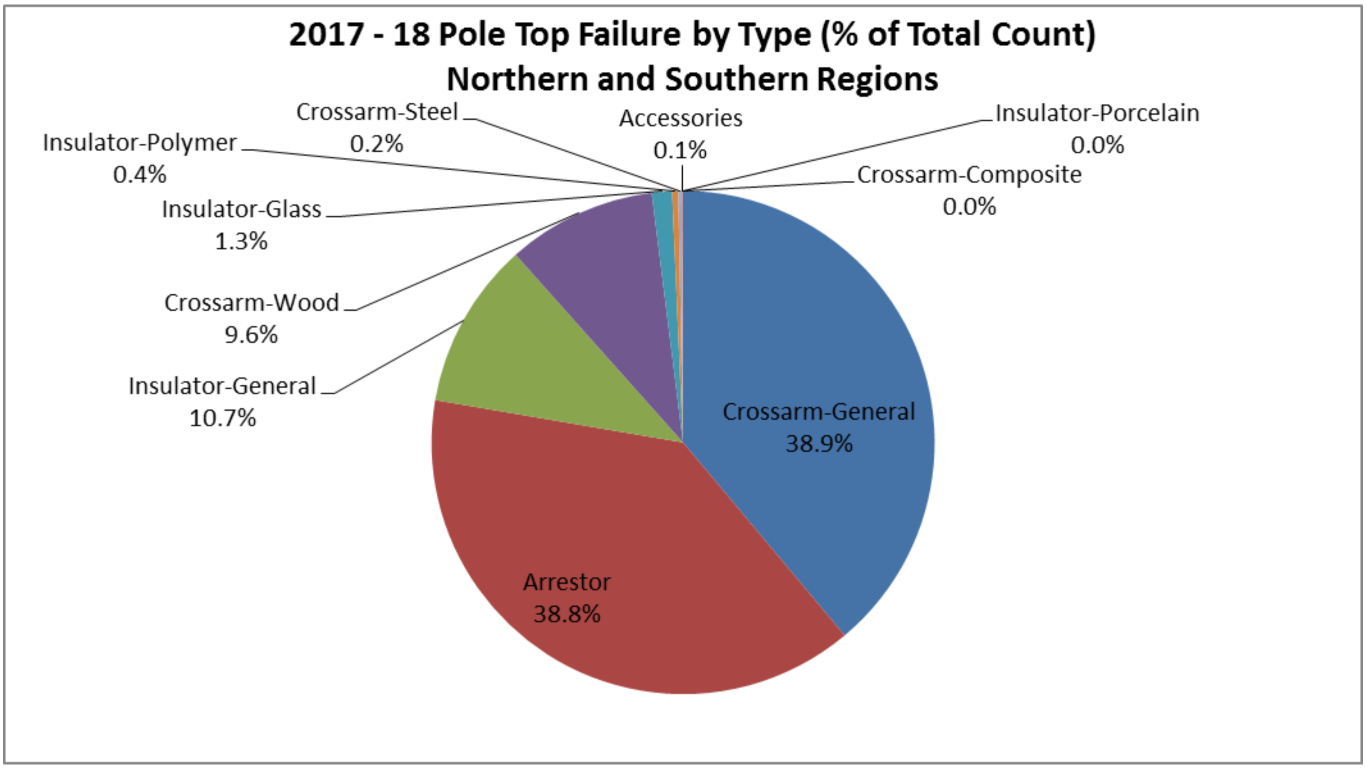


Figure 9: Northern and Southern Regions pole top failures by type

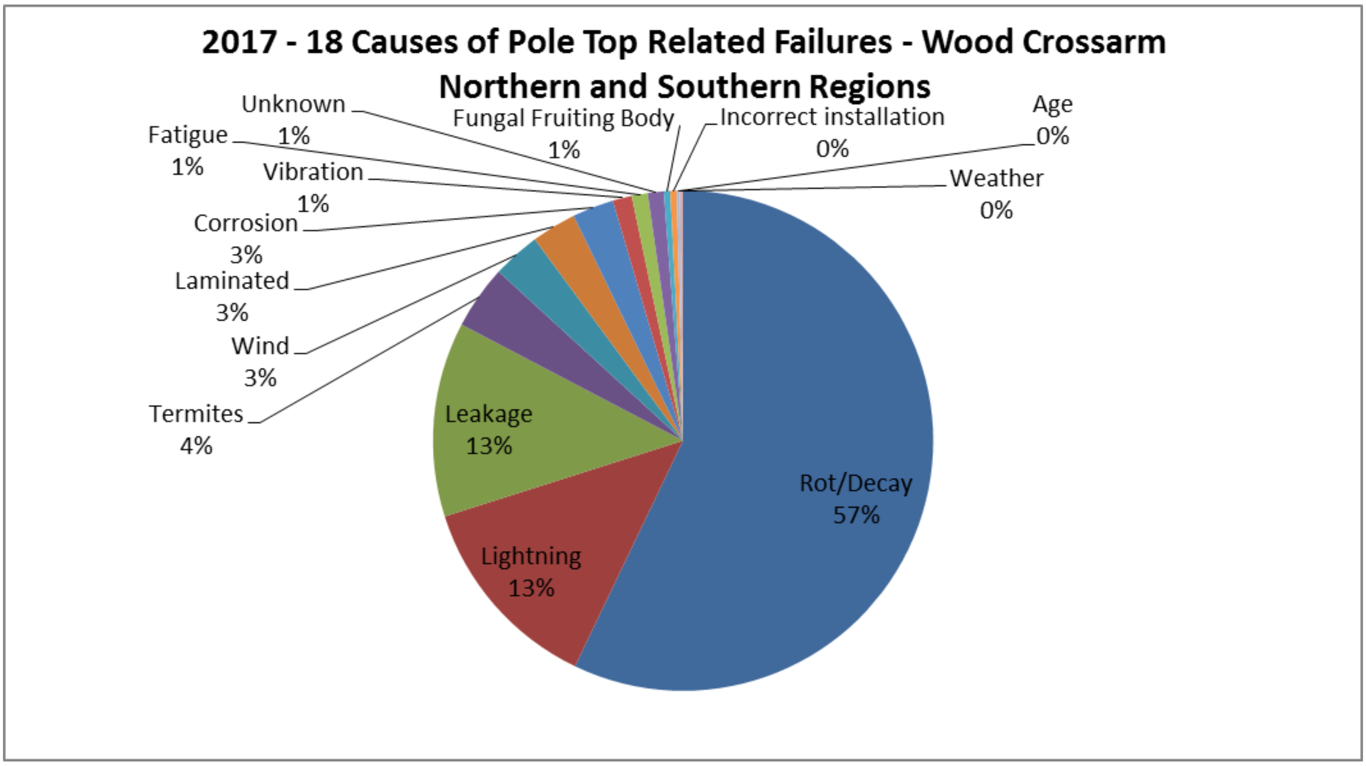


Figure 10: Northern and Southern Regions causes of wood crossarm related failures

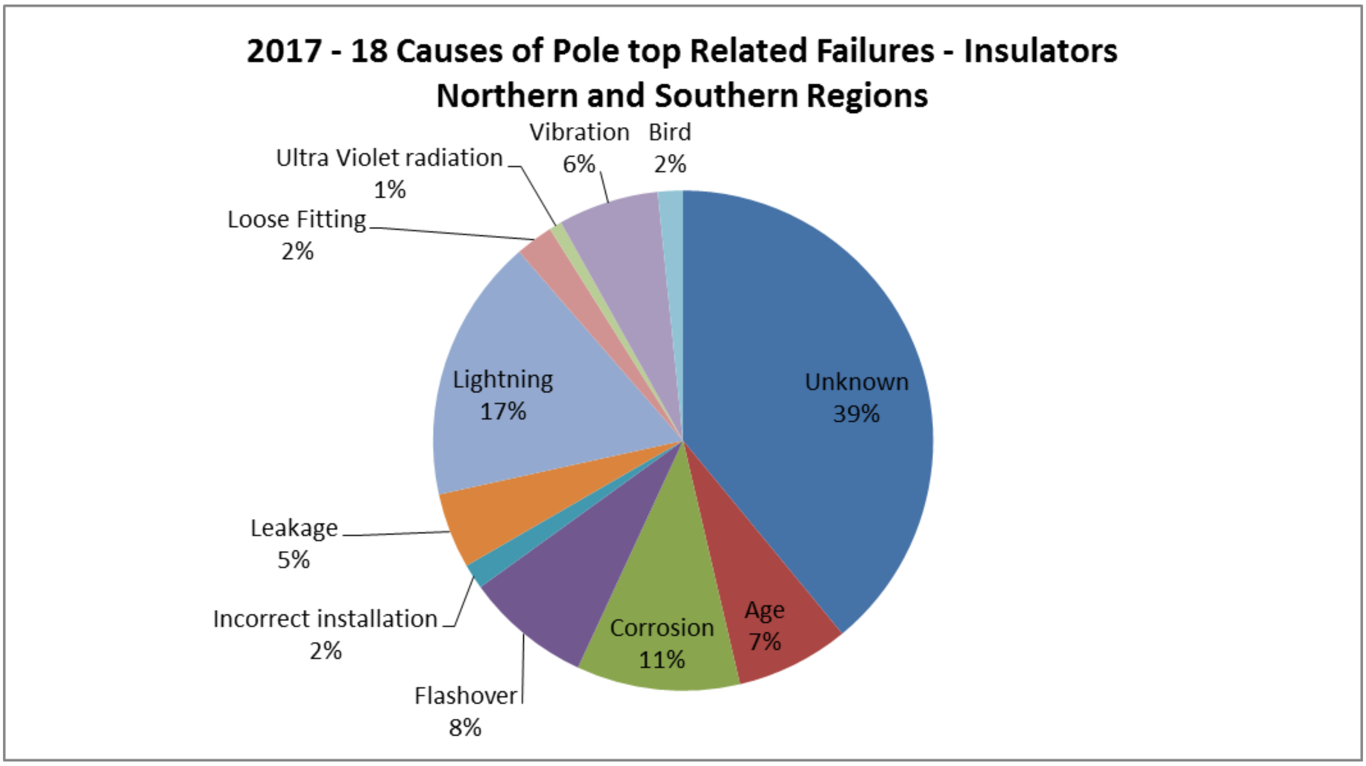


Figure 11: Northern and Southern Regions causes of insulator related failures

Corrective maintenance activities recorded in the South East region are generally associated with actions taken as a result of a failure. Figure 12 shows the pole top structure corrective maintenance activities in the South East region broken down by the associated pole top component. Wood crossarms contribute to the highest percentage of corrective maintenance.

Surge arrestors were the second highest source of corrective maintenance. Likewise, as mentioned with respect to the Northern and Southern Regions above, the South East Region surge arrestors also generally need to be reinstated through corrective activities once they have operated. The data for surge arrestors is, therefore, more representative of expected asset operations than failures.

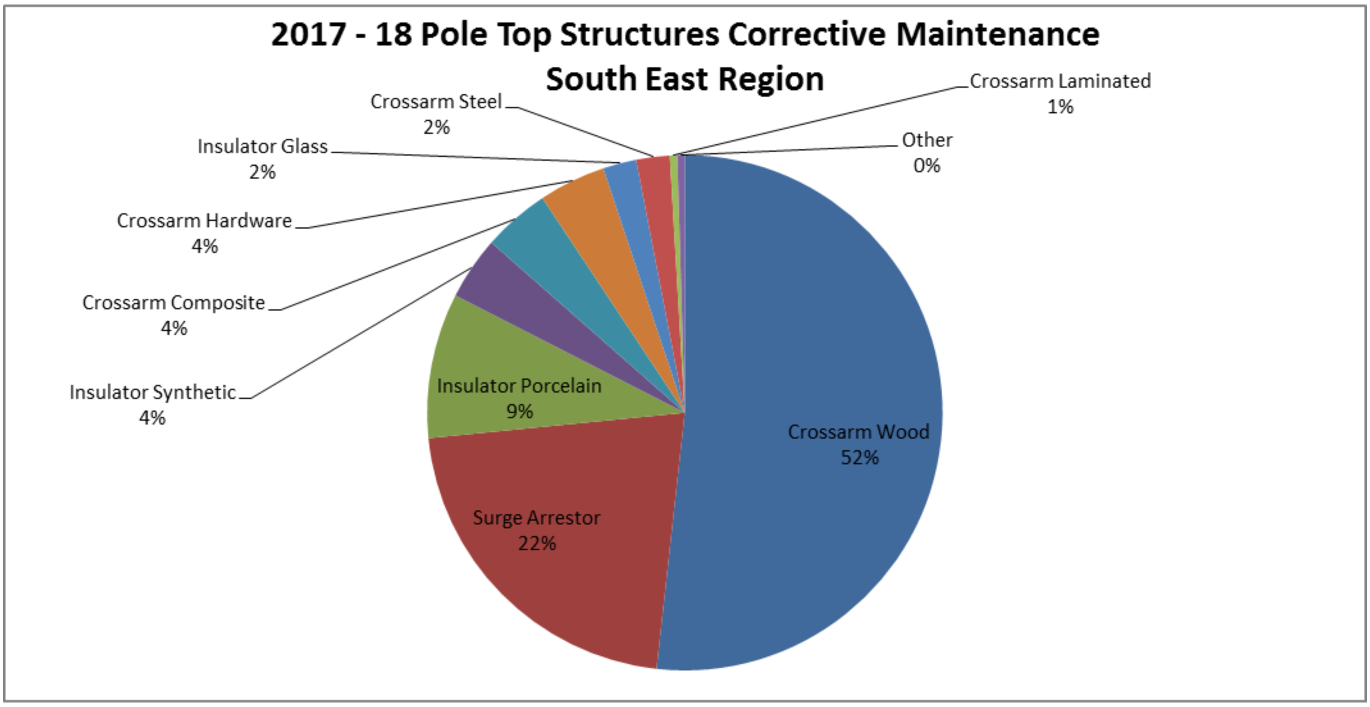


Figure 12: South East pole top structures corrective maintenance

The cause of failures for wood crossarms has been broken down in Figure 13. Similar to the Northern and Southern regions, rot/decay is the largest cause of wood crossarm corrective maintenance. The causes of insulator failures are represented in Figure 14. Lightning is the largest cause of insulator corrective maintenance.

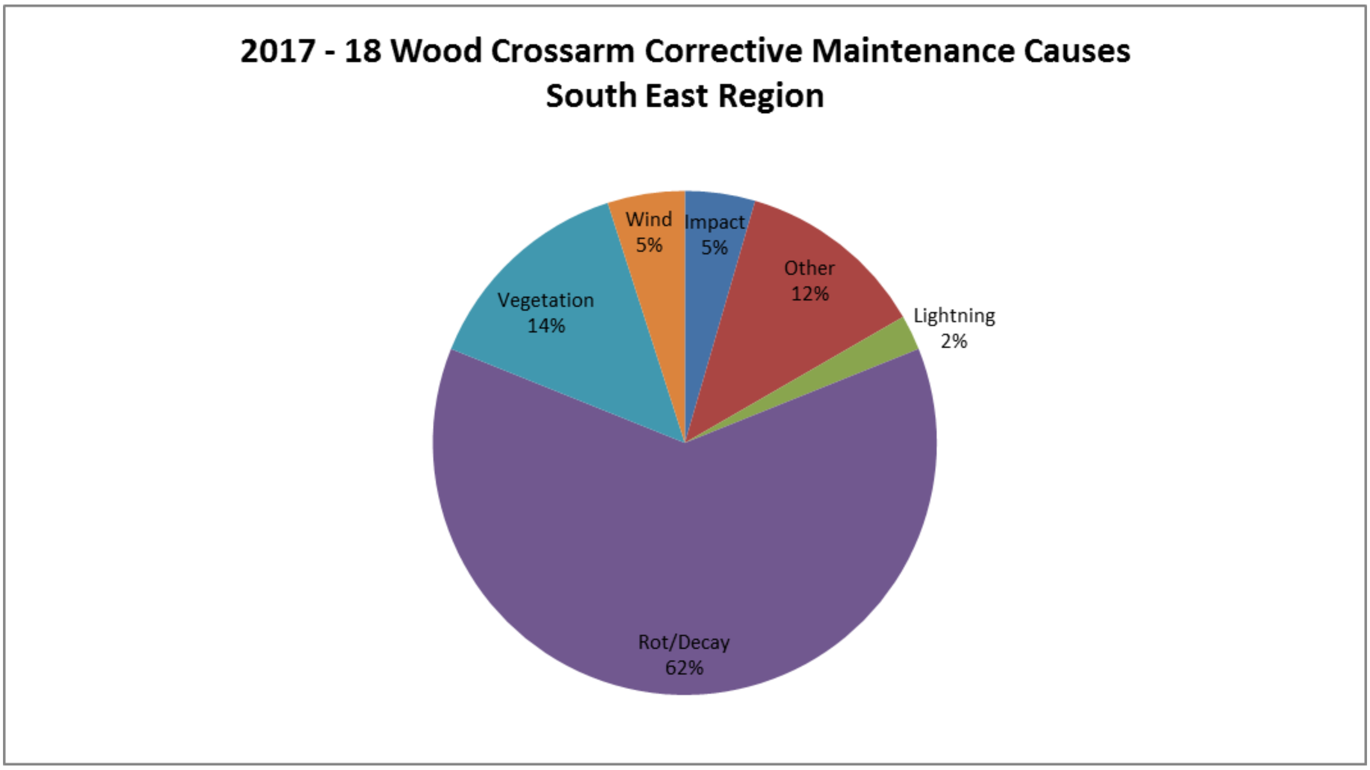


Figure 13: South East Region pole top wood crossarm corrective maintenance causes

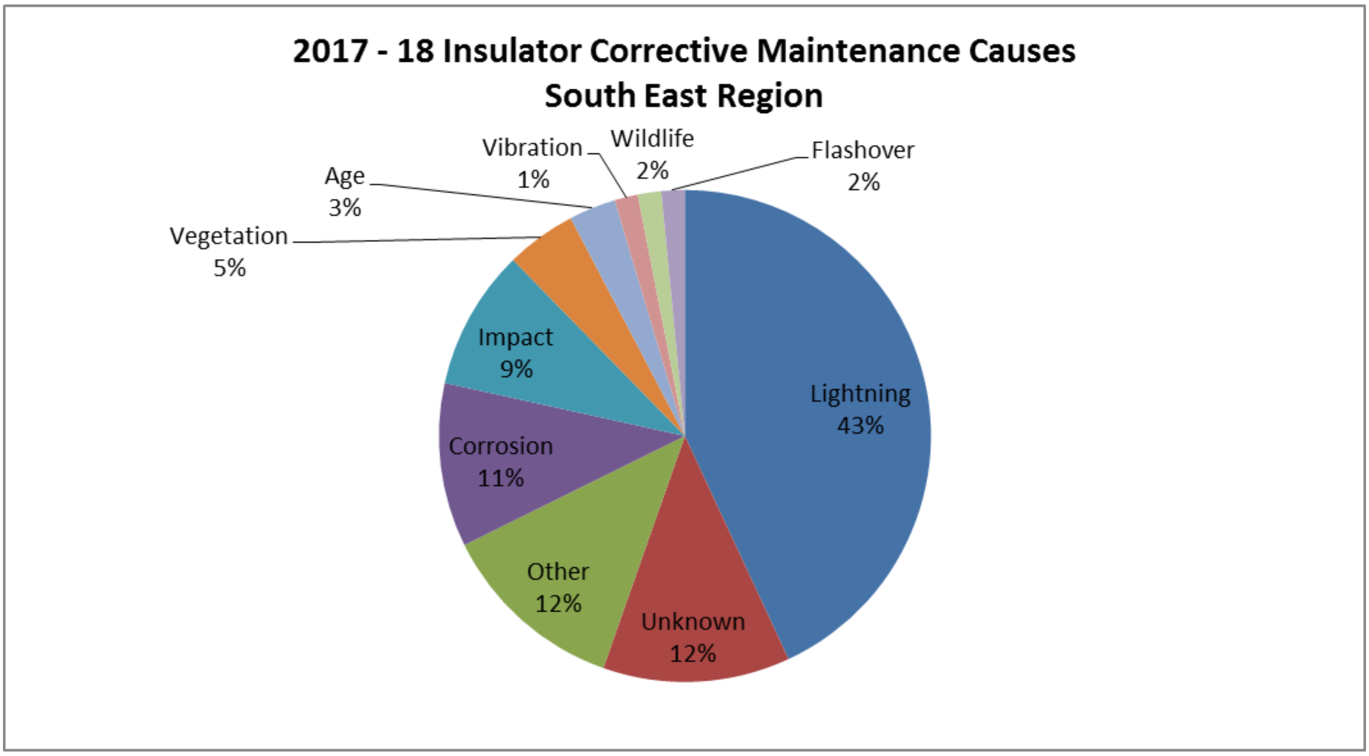
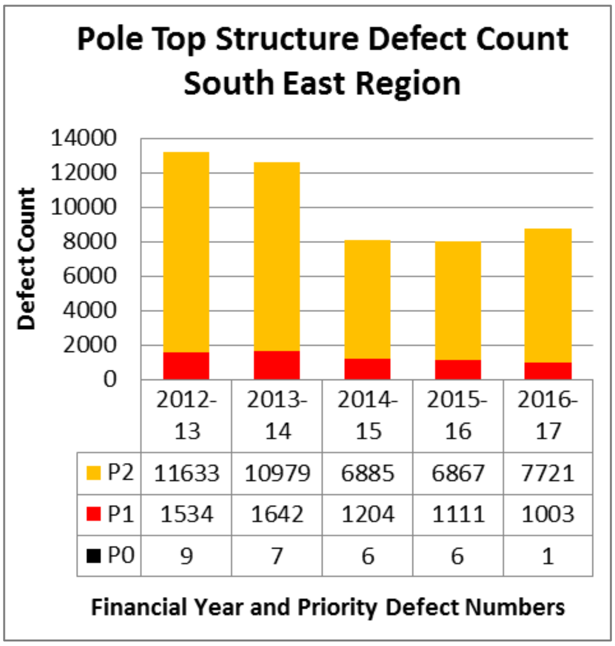
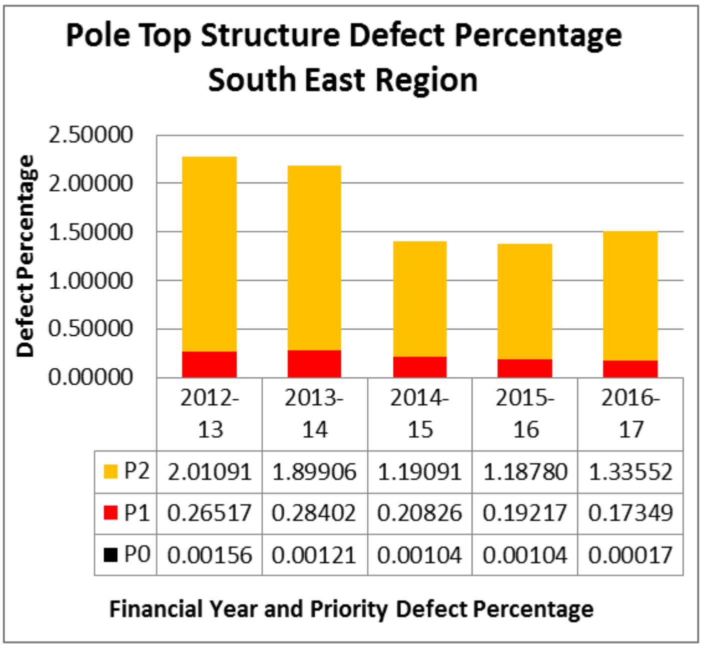
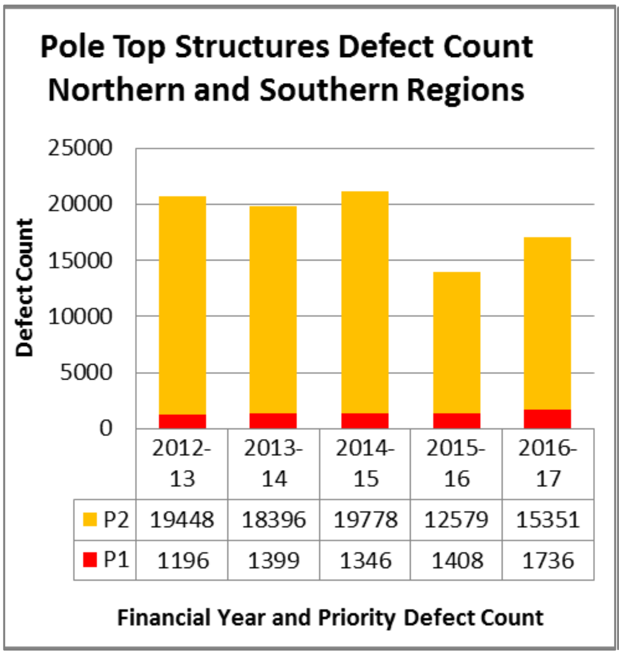


Figure 14: South East Region insulator corrective maintenance causes

Figure 15, Figure 16, Figure 17 and Figure 18 show the historical trends of defect repair works that have been completed on pole top structures. Defects are typically not failures, but indicators that failures are imminent. The P0, P1, and P2 references relate to priority of repair, which effectively dictates whether normal planning processes are employed (P2), or more urgent repair works are initiated (P1 and P0). Figure 18 utilises data from Field Mobile Computing FMC which is the overhead network inspection tool in the Northern and Southern region, to determine the number of crossarms that were inspected to create a defect percentage.







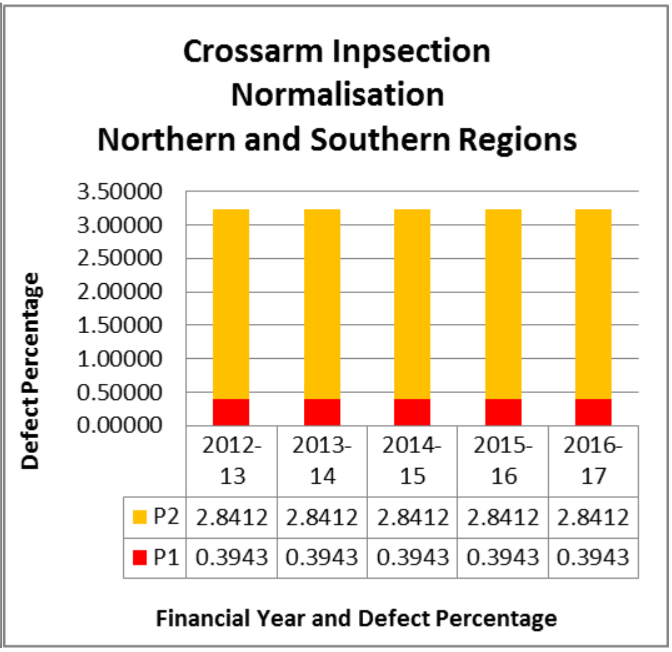


Figure 17: Northern and Southern Regions pole structures top defect count

Figure 18: Northern and Southern Regions crossarm inspection normalisation

Figure 19 shows the Northern and Southern Regions breakdown of defects by the associated pole top component. This breakdown is not available for the South East Region. Figure 20 and Figure 21 show this further broken down into crossarm and insulator related defects.

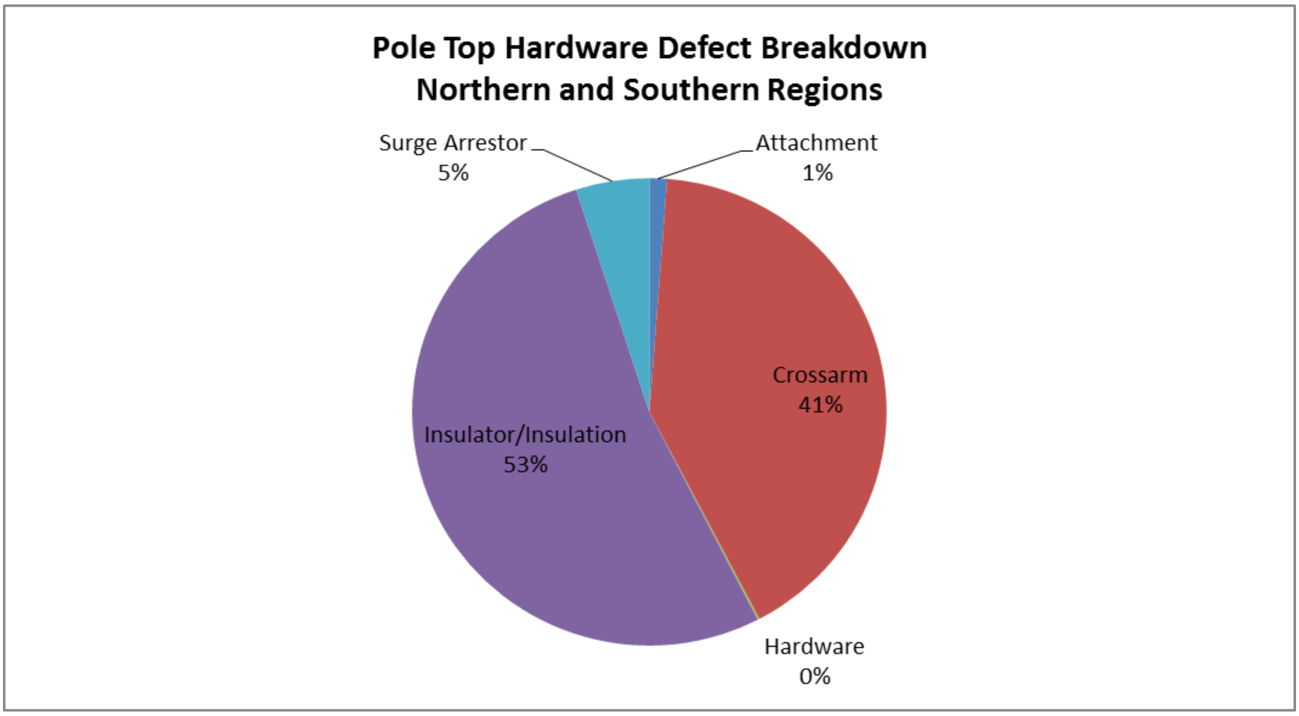


Figure 19: Northern and Southern Regions defect breakdown

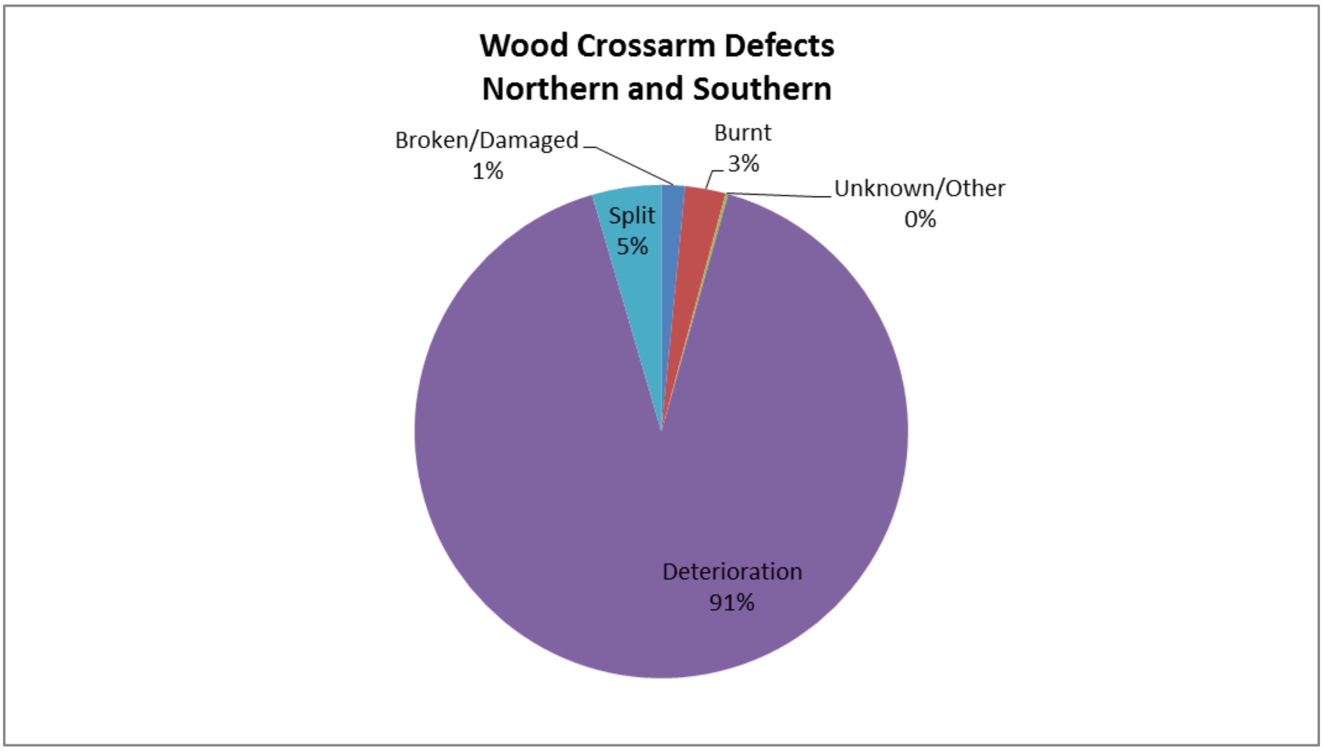


Figure 20: Northern and Southern Regions wood crossarm defect breakdown

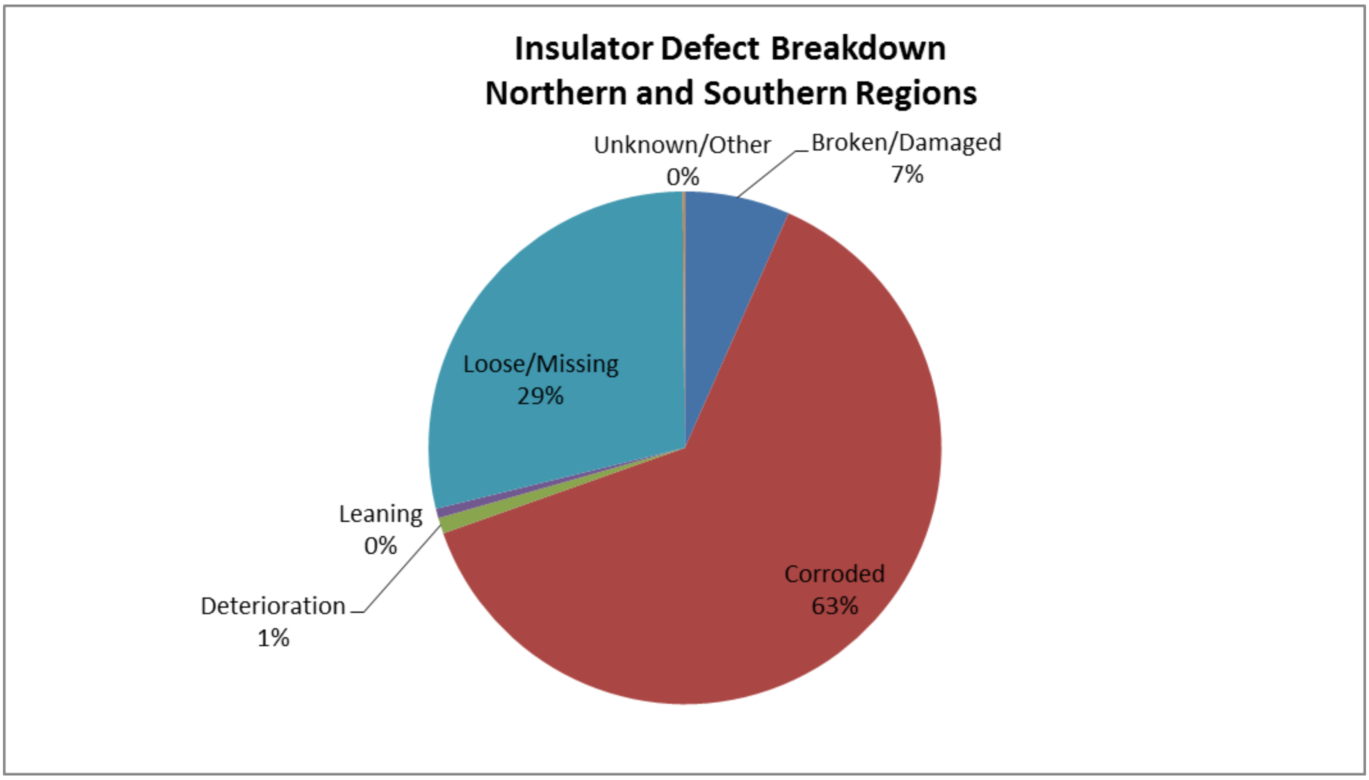


Figure 21: Northern and Southern Regions insulator defect breakdown

Dangerous electrical events are typically defined in legislation DEEs as circumstances involving a high voltage asset, where a person would not have been electrically safe had they been exposed to the event[1]. EQL assigns DEEs into two categories as follows:

- Unassisted DEEs – incidents that might have been prevented via a maintenance program
- Assisted DEEs – incidents where the root cause of failure occurs outside the control of any maintenance program (e.g. lightning strike).

The total number of asset related dangerous electrical events (DEEs) for both regions is detailed below in Figure 22, Figure 23, Figure 24 and Figure 25.

[1] Queensland Electrical Safety Act 2002, s12

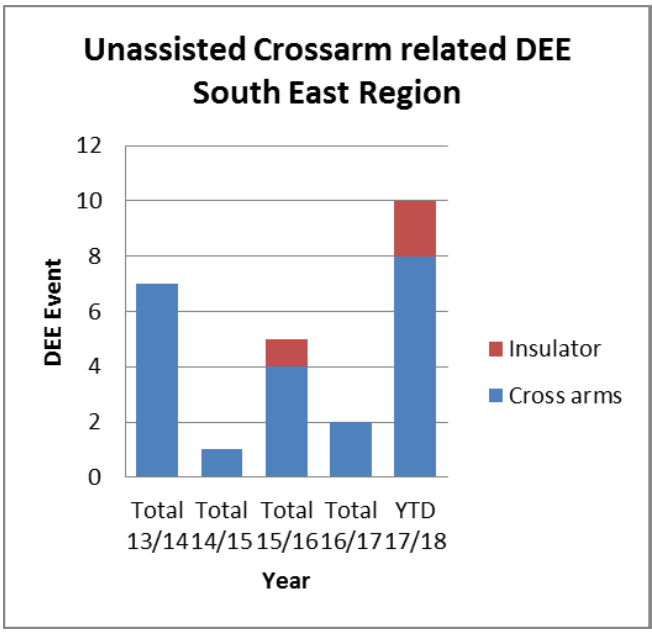


Figure 22: South East Region unassisted DEEs

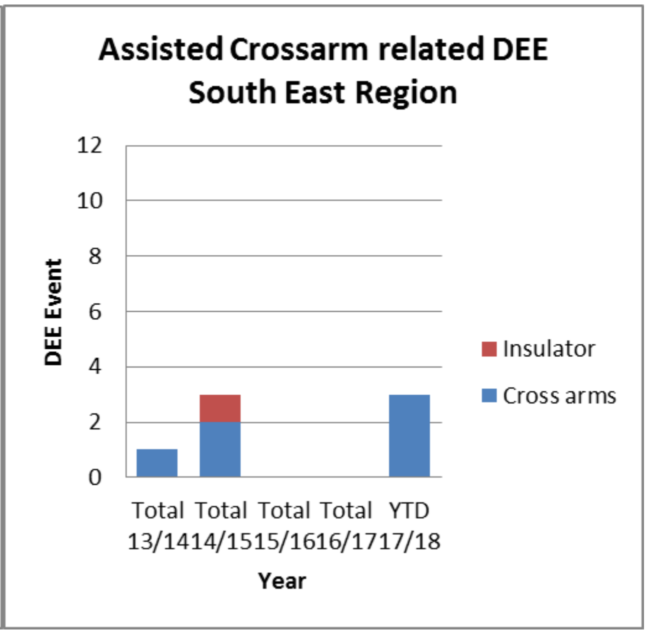


Figure 23: South East Region assisted DEEs

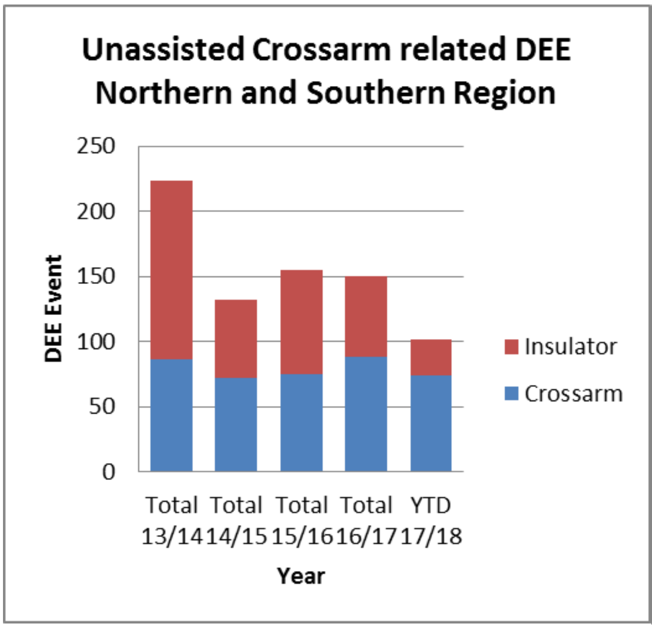


Figure 24: Northern and Southern Regions unassisted DEEs

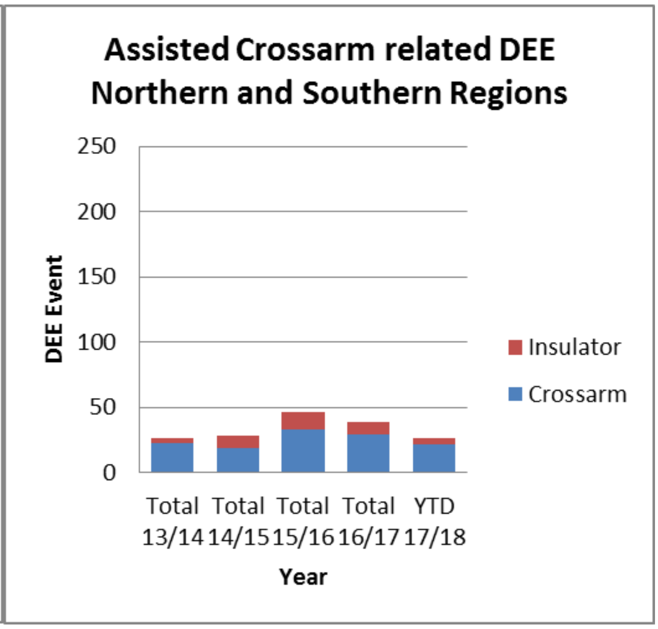


Figure 25: Northern and Southern Regions assisted DEEs

4 Asset Related Corporate Risk

As detailed in Section 3.2, Queensland legislation details that EQL has a Duty to ensure its works are electrically safe. This safety duty requires that EQL take action so far as is reasonably practicable (SFAIRP) to eliminate safety related risks, and where it is not possible to eliminate these risks, to mitigate them SFAIRP[2]. Risks in all other categories are managed to levels as low as reasonably practicable (ALARP).

[2] QLD Electrical Safety Act 2002 s10 and s29

Figure 26,

Figure 27 and

Figure 28 provides threat-barrier diagrams for pole top structures. Many threats cannot be controlled (e.g. third party damage), although EQL undertakes a number of actions to mitigate them SFAIRP. Failure of a pole top structure risks public and staff safety in several ways, most notably:

- Bringing energised electrical conductors to easily accessible heights, risking public contact, shock and electrocution
- Heavy objects physically falling, risking physical harm to anyone in the vicinity.

EQL's safety duty results in most inspection, maintenance, refurbishment and replacement works, and expenditure related to pole top structures, being entirely focused upon preventing and mitigating pole top structure failure.

The asset performance standards described in Section 3 detail EQL's achievements to date in respect of this safety duty. The following sections detail the ongoing asset management journey necessary to continue to achieve high performance standards into the future. Action items have been raised in the following sections where relevant, detailing the specific actions that EQL will undertake as part of program delivery of this Asset Management Plan.

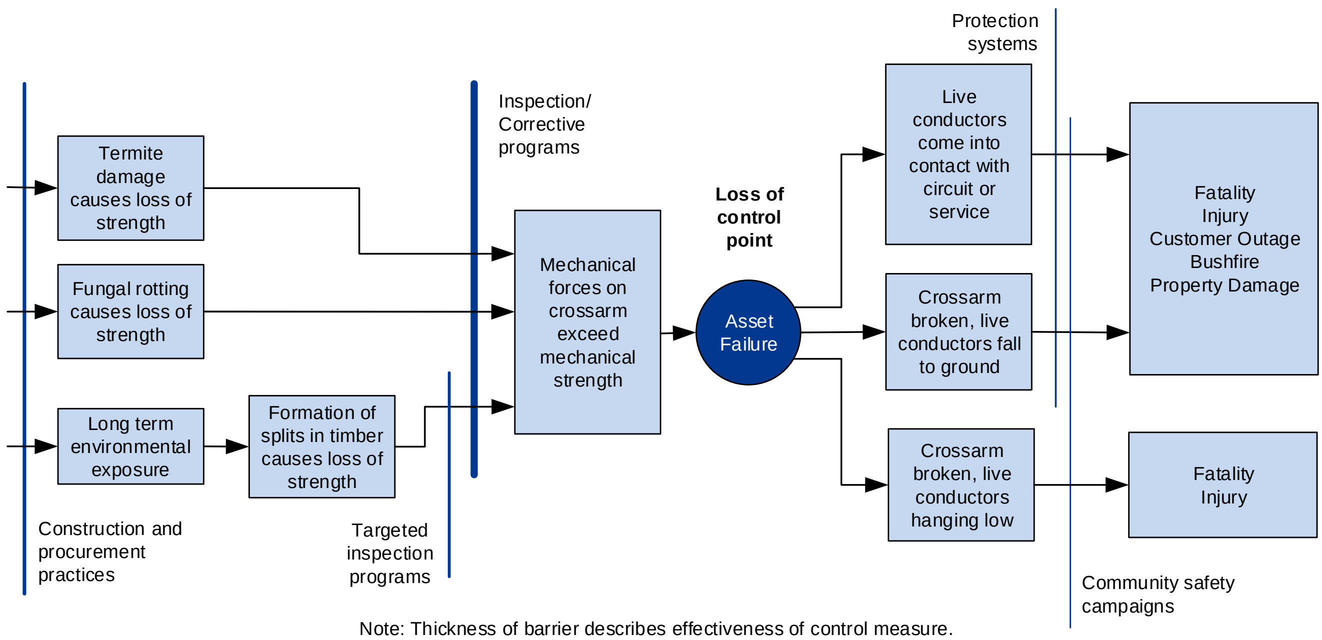


Figure 26: Threat barrier diagram for wood crossarms

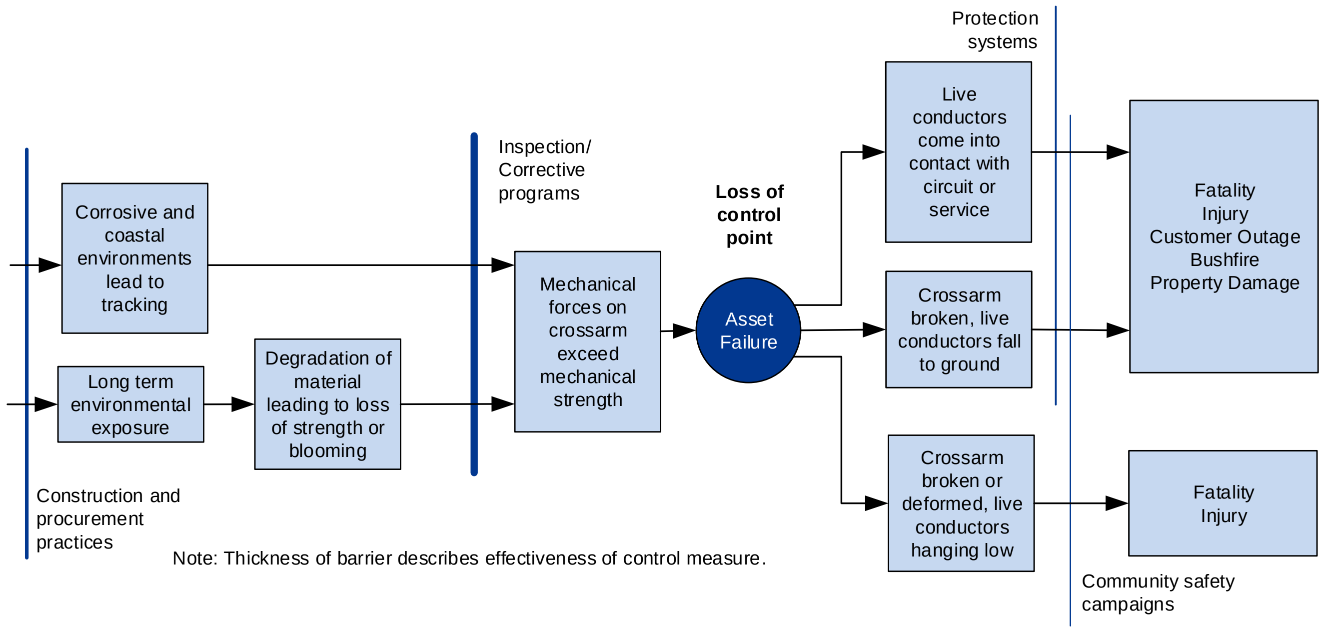


Figure 27: Threat barrier diagram for composite crossarms

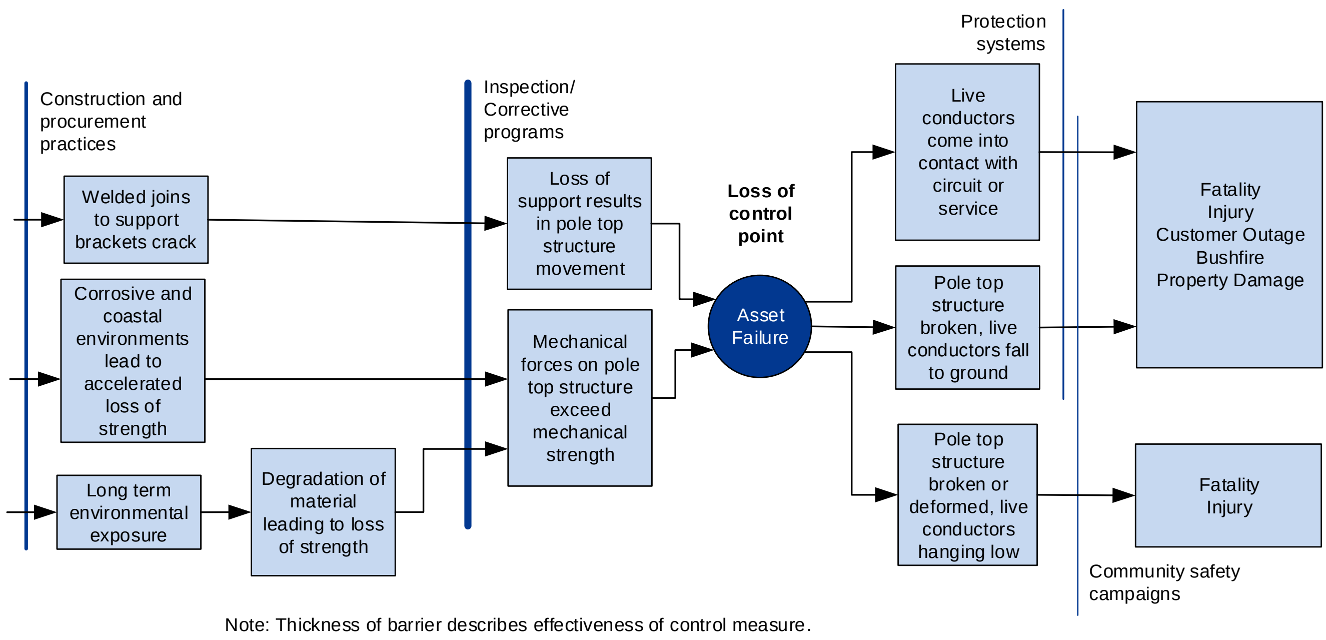


Figure 28: Threat barrier diagram for steel crossarms and other pole top metallic hardware

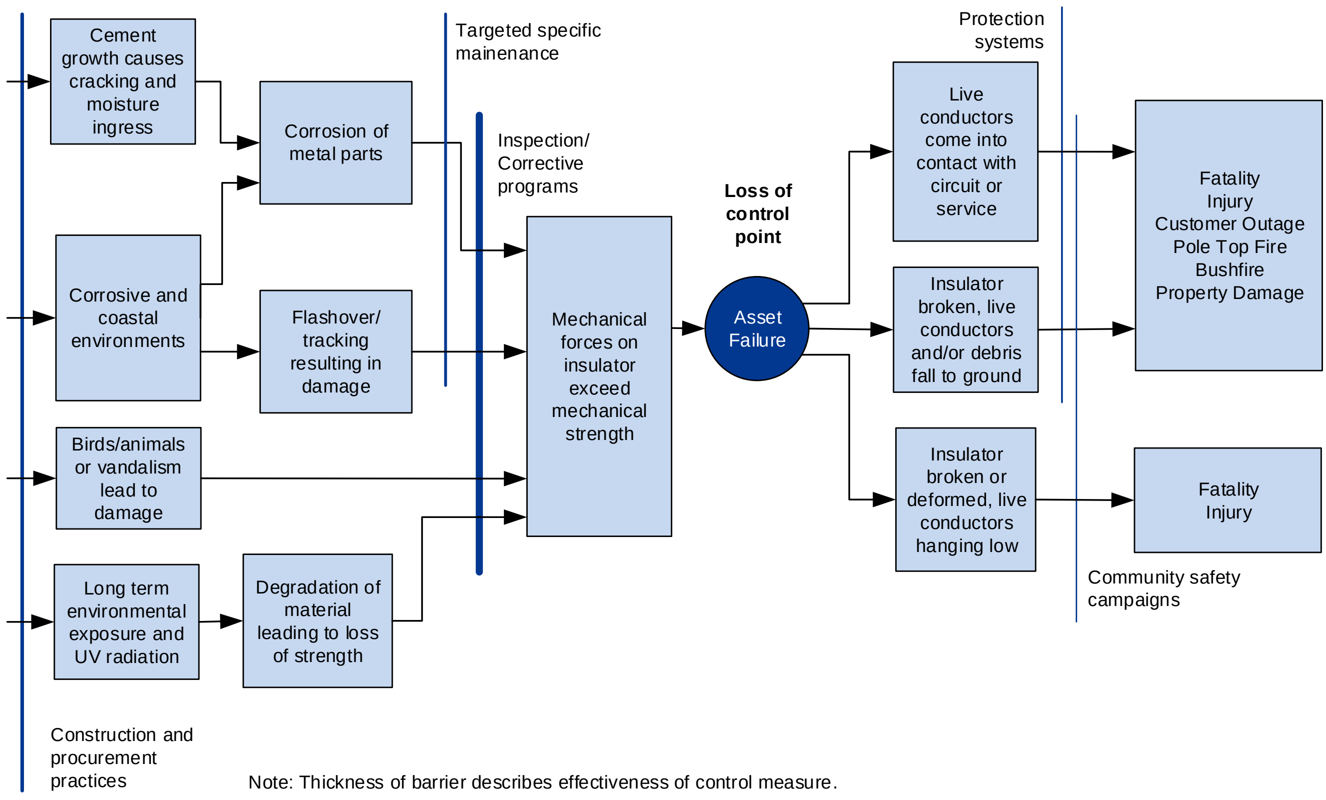


Figure 29: Threat barrier diagram for insulators

5 Health, Safety & Environment

The increasing use of light weight composite crossarms over wooden or steel crossarms has alleviated some of the manual handling requirements presented by the heavier crossarms. While these crossarms are lighter, they do present a fibreglass blooming issue, creating an irritant while working at heights. This has only been experienced in first generation composite crossarms and handling techniques have been put in place to mitigate this issue.

Similarly, the use of composite insulators has significant manual handling benefits over the equivalent porcelain line post or string of porcelain or glass disc insulators. Upon failure, composites do not shatter on impact, reducing the laceration risk to nearby personnel or the public.

6 Current Issues

The following sections outline current issues that have been identified as having the potential to impact EQL’s ability to meet corporate objectives.

6.1 Uncertainty of Laminated Crossarm Condition

Due to the hidden failure modes associated with laminated crossarms, an approach was taken in 2017 to allocate a high priority to replacement activities resulting from routine inspections for the following:

- High rainfall areas where conditions are more likely to promote rot.
- All termination or strain crossarms where the consequence of failure is higher than in other scenarios.

1.4% of the South East region pole top population are laminated crossarms. A significant portion of the pole top population in the Northern and Southern regions are laminated crossarms, therefore contributing to a large percentage of replacements. Laminated crossarms are removed from service based on external visual inspection. Feedback from field crews undertaking the replacements has indicated that in many circumstances the external deterioration has not been reflective of the internal condition and that the crossarm could have potentially remained in service for longer. Testing is to be arranged on a number of laminated crossarms removed from service to determine the residual strength of the crossarm with the aim of improving the visual condition triggers for initiating corrective replacement actions.

Action 6.1-1: Investigate the feasibility of condition-based assessment of laminated crossarms to determine the extent of degradation and estimate the in situ residual strength to inform replacement strategies.

6.2 Narrow Trident Constructions

Narrow trident construction uses very small steel arms and brackets to hold the insulators that in turn support the conductors. This construction was introduced as an alternative to using wooden crossarms and as a less visually-intrusive construction for the public. The narrow spacing of the conductors associated with this construction presents a significant risk of clashing which in turn can lead to sparks and molten metal failing to ground and potentially causing a bush fire. Narrow trident constructions have been targeted for replacement because of these risks.

EQL has adopted several best practice asset management strategies to minimise the risk of bushfires and to minimise the associated risk to its assets and to customer supply reliability during times of bushfire. This is documented in the EQL Bushfire Risk Management Plan.

7 Emerging issues

There are no identified emerging issues associated with pole tops. Issues to date are being managed through maintenance and replacement programs.

8 Improvements and Innovation

The following sections outline any improvements or innovations to asset management strategies relevant to this asset class, being investigated by EQL.

8.1 Future Technologies to Deliver Inspection Capability

Emerging technologies such as image recognition and defect classification may provide an efficient, effective, and economic solution for condition monitoring of pole top structures and other overhead assets. The pole top detailed inspection program is under implementation and will be performed using technologies that are able to provide adequate detailed imagery for condition assessment.

These technologies may include aerial inspection, elevated work platform (EWP) inspection, unmanned aerial vehicles (UAV), or other technologies.

Action 8.1-1: Investigate utilising the technological advancements in pole top asset condition assessment such as LiDAR, 3D modelling, and ultra-high resolution imaging and post processing technology, combined with EQL's existing defect classification manual to identify pole top structures in need of replacement. Partner with external providers of this technology to support development and feedback EQL's requirements to technology developers and service providers.

8.2 Future Technologies as an Alternative to Replacement

Technology advancement in areas which present an alternative to traditional network is currently increasing at an unprecedented rate. Technologies such as distributed generation, batteries and isolated grids may present a viable alternative to like-for-like replacement in order to mitigate risk; particularly in rural areas.

It is recommended that Energy Queensland continue to investigate technology-based techniques to provide an alternative to like-for-like replacement to deliver greater risk reductions at lower cost.

Action 8.2-1: Investigate the use of technology-based solutions such as distributed generation, batteries, and isolated grids as an alternative like-for-like replacement in overhead distribution networks.

9 Lifecycle Strategies

The following sections outline the approach of EQL to the lifecycle asset management of this asset class.

9.1 Philosophy of approach

EQL actively manages pole tops using a condition-based approach including:

- Visual inspection of physical condition from ground level.
- Aerial visual inspection carried out from helicopters/aircraft.
- Pole top inspection carried out from elevated work platform or climbing.

Physical defects identified through inspection are repaired or the asset is replaced. Failed assets are replaced on failure.

9.2 Supporting Data Requirements

Pole tops (including crossarms and insulators) are not recorded as individual assets in the corporate system. They are also not uniquely identified in the field. Information such as age, date of installation, material and condition is therefore hard to track.

Corporate data systems hold the initial construction type of each pole top attached to a pole. This is not generally updated if a pole top is replaced unless the replacement goes through a design process. The construction type gives insight into the type of crossarms and insulators used on the pole top. Pole tops are generally replaced at least once in the lifetime of the pole; therefore initial construction data is not always reflective of the in-service pole top asset. Generally, pole tops are replaced like for like, but with the move from wood to composite construction materials, this is not always the case. Where possible, low voltage (LV) construction types that have typically included a wood crossarm are now replaced with LV ABC instead of like-for-like.

Limited pole top data is stored against the pole which, is identified as an individual asset in the corporate system. Pole top replacement work orders are also associated with the pole. This information is utilised to infer/determine the age of the pole top and its condition.

In order to more effectively manage the lifecycle of pole tops, it is recommended that pole tops be uniquely identified in the new Enterprise Asset Management system. This will eliminate the need to infer data about the age, date of installation, material, and condition of pole tops.

Further to this asset requirement, the way in which condition, defect, and failure data are captured needs to be made consistent across all of EQL. Improving data capture to reduce the number of ‘unknown’ causes of defect and failure would provide a significant opportunity for improvements in asset management.

The FMC upgrade that is being implemented in early 2019 will capture more crossarm data in the Northern and Southern Regions. This data will be stored in FMC data tables until the new Enterprise Asset Management system is implemented.

Due to inconsistent data capturing practice in EQL, the actual historical failure data cannot be obtained without comprehensive manual assessment.

Action 9.2-1: Incorporate asset data structure changes in the new Enterprise Asset Management system being proposed for EQL, to capture crossarms as equipment rather than a component. This will improve asset data, cost capture, failure, and condition monitoring capability to support the asset management objectives.

Action 9.2-2: Review the potential to use available construction data, pole attributes, and other information currently stored in corporate systems to develop a better understanding of material types and age distribution as a tactical solution, until the new Enterprise Asset Management system is established.

Action 9.2-3: Review and align condition, defect, failure, and DEE data to provide consistency across EQL.

Action 9.2-4: Review data collection processes to determine if data can be more effectively captured, to reduce the incidence of unknown data records.

9.3 Acquisition and Procurement

Asset creation is driven by the upgrade of existing lines and replacement activities.

Pole top structures selected for use are dependent on the current construction standards for that voltage and the requirements of the individual design.

The transition from the use of wood crossarms to composite crossarms is likely to increase the composite crossarm demand by around 9,000 per year. This poses a potential supply concern, especially in the cases where design has catered for the extra strength of composite crossarms, meaning that wood crossarms cannot be used as an alternative supply.

Action 9.3-1: Review supply arrangements for composite crossarms to ensure the forward demand associated with the change in standard can be met.

9.4 Operation and Maintenance

Operation and maintenance include planned and corrective maintenance. Operation and maintenance procedures are supported by a suite of documentation which describes in detail the levels of maintenance applicable, the activities to be undertaken, the frequency of each activity, and the defect and assessment criteria to which the condition and testing are compared to determine required actions. The relevant documents are included in Appendix 1 1 for reference.

The following sections provide a summary of the key aspects of the operation and maintenance of pole top structures as they relate to the management of the asset lifecycle.

EQL has commenced the ongoing process of alignment of maintenance practices between regions where it is prudent and efficient. This alignment will occur over a number of years to maintain compliance with maintenance tolerances during any transition.

9.4.1 Preventive maintenance

The maintenance standards for overhead pole lines and overhead tower lines provide detail of the preventive maintenance programs and associated activities relating to pole top structures. Pole top structures are referred to as part of the crossarm assembly.

Associated maintenance activities include:

- Patrol/security and hazard inspections:
    - Summer Preparedness patrol
- In-service condition assessments:
    - Ground inspection
    - Aerial inspection (subject to requirements)
    - Wood pole top inspection:
        - Pole top inspection program (high rainfall areas) – based on age and rainfall criteria – Northern and Southern Regions
        - Targeted Wood Crossarm Inspection Program – based on age criteria – South East Region
- Other specific maintenance
    - LiDAR (light detection and ranging)
    - Insulator cleaning
    - Removal of insulators to check corrosion

Routine in-service condition assessments of pole tops are carried out to identify any unacceptable safety risk to personnel and the general public, to detect any defects requiring action, and to collect condition data for performance/risk analysis and replacement programs. Maintenance activity frequencies are provided in the Maintenance Activity Frequencies Spreadsheet.

Defects found during routine inspection or maintenance activities are risk assessed, classified and prioritised in accordance with the Lines Defect Classification Manual (LDCM). An example of this is the replacement of laminated crossarms, particularly those in Wet Tropics area. Known augmentation and replacement plans are considered prior to carrying out repairs or replacement.

In addition to routine ground and aerial inspections, an annual high level preventative ‘Summer Preparedness Patrol’ is also undertaken on critical feeders to mitigate the risk of storm/bushfire damage and to identify obvious line components that have failed or are at imminent risk of failure prior to the storm/bushfire season.

Wood pole top inspection programs are also carried out based on criteria. These inspections are carried out by climbing the pole, with aid of an EWP, or by means of aerial photography where prudent.

Insulator cleaning may also be performed on sub-transmission and transmission lines where there has been a history of contamination and flashover, particularly in the dry season when they are not cleaned naturally by rainfall. Removal of insulators for corrosion assessment is conducted on an ad-hoc basis, based on routine inspection findings.

Maintenance tasks are contained in the following Maintenance Standard documents (refer to References for document numbers):

- Maintenance Standard for Overhead Tower Lines.
- Maintenance Standard for Overhead Pole Lines.

9.4.2 Corrective maintenance

Corrective maintenance is generated from preventive maintenance programs, ad-hoc inspections and public reports.

Any corrective or forced action identified must be remediated by an authorised crew. Asset inspectors who carry out the overhead and underground line inspections are not authorised to perform any maintenance on pole tops. Asset inspection crews who carry out the EWP or climbing pole top inspections are authorised to perform chemical treatments at the time of inspection.

Where customer notification or ad-hoc inspections identify issues, rectification occurs through scheduled corrective maintenance.

For forced and corrective maintenance, pole tops are repaired if cost-effective, or replaced with like-for-like to the current standard.

9.4.3 Spares

EQL does not currently have a documented spares strategy for this asset. A minimum warehouse stock level of this asset is maintained based on historical usage and known future requirements.

9.5 Refurbishment and Replacement

The following sections outline the practices used to either extend the life of the asset through refurbishment or to replace the asset at the end of its serviceable life.

9.5.1 Refurbishment

All defects identified through the Overhead Line Inspection Program, the Line Patrol Program, and the Wood Pole Top Inspection Programs are remediated as part of the Defect Refurbishment Program.

9.5.2 Replacement

Pole top assemblies are replaced based upon condition, consistent with the requirements specified under the Asset Inspection and Defect management process. Pole top replacements may also occur in association with other works such as network augmentation or associated network asset replacement programs.

Where individual insulators have failed in service, it is common practice to inspect the remaining pole top assembly, as it is likely to be of a similar age and condition. Insulators are typically replaced with the crossarm unless they are relatively new and assessed as being in good condition.

9.6 Disposal

There are no special requirements for the disposal of pole top structures. Pole top structures are disposed of according to business disposal guidelines.

10 Program Requirements and Delivery

The programs of maintenance, refurbishment, and replacement required to outwork the strategies of this AMP are documented in Network Program Documents and reflected in corporate management systems. Programs are typically coordinated to address the requirements of multiple asset classes at a higher level, such as a substation site or feeder, to provide delivery efficiency and reduce travel costs and overheads. The Network Program Documents provide a description of works included in the respective programs as well as the forecast units.

Program budgets are approved in accordance with Corporate Financial Policy. The physical and financial performance of programs is monitored and reported on a monthly basis to manage variations in delivery and resulting network risk.

11 Summary of Actions

The following provides a summary of the specific actions noted throughout this AMP for ease of reference.

Action 6.1-1: Investigate the feasibility of condition-based assessment of laminated crossarms to determine the extent of degradation and estimate the in situ residual strength to inform replacement strategies.

Action 8.1-1: Investigate utilising the technological advancements in pole top asset condition assessment such as LiDAR, 3D modelling, and ultra-high resolution imaging and post processing technology, combined with EQL's existing defect classification manual to identify pole top structures in need of replacement. Partner with external providers of this technology to support development and feedback EQL's requirements to technology developers and service providers.

Action 8.2-1: Investigate the use of technology-based solutions such as distributed generation, batteries, and isolated grids as an alternative like-for-like replacement in overhead distribution networks.

Action 9.2-1: Incorporate asset data structure changes in the new Enterprise Asset Management system being proposed for EQL, to capture crossarms as equipment rather than a component. This will improve asset data, cost capture, failure, and condition monitoring capability to support the asset management objectives.

Action 9.2-2: Review the potential to use available construction data, pole attributes, and other information currently stored in corporate systems to develop a better understanding of material types and age distribution as a tactical solution, until the new Enterprise Asset Management system is established.

Action 9.2-3: Review and align condition, defect, failure, and DEE data to provide consistency across EQL.

Action 9.2-4: Review data collection processes to determine if data can be more effectively captured, to reduce the incidence of unknown data records.

Action 9.3-1: Review supply arrangements for composite crossarms to ensure the forward demand associated with the change in standard can be met.

Appendix 1. References

It takes several years to integrate all standards and documents after a merger between two large corporations. This table details all documents authorised/approved for use in either legacy organisation, and therefore authorised/approved for use by EQL, that supports this Management Plan.

Legacy Organisation	Document Number	Title	Type
Ergon Energy **Energex**	EPONW01 EX 03595	Network Asset Management Policy	Policy
Ergon Energy **Energex**	PRNF001 EX 03596	Protocol for Network Maintenance	Protocol
Ergon Energy **Energex**	PRNF003 EX 04080	Protocol for Refurbishment and Replacement	Protocol
Ergon Energy **Energex**	STNW0330 EX 03918	Standard for Network Assets Defect/Condition Prioritisation	Standard
Ergon Energy **Energex**	STNW1160 EX STD00299	Maintenance Acceptance Criteria	Manual
Ergon Energy **Energex**		Lines Defect Classification Manual	Manual
Energex	EX 00302	Overhead Design Manual	Manual
Ergon Energy **Energex**	EX 04920	Overhead Construction Manual	Manual
Ergon Energy	EP51	Defect Management Policy	Policy
Ergon Energy	SGNW0004	Network Optimisation Asset Strategy	Strategy
Ergon Energy	SGNW0038	Poles and Towers Inspection Strategy	Strategy
Ergon Energy	STNW0717	Standard for Preventive Maintenance Programs for 2017-18	Standard
Energex	00569	Network Risk Assessment	Procedure
Energex	354	Overhead Network Condition Assessment Manual	Manual
Energex	502	Lines Defect Classification	Standard
Energex **Ergon**	EX STD01121 EE STNW1139	Maintenance Standard for Overhead Tower Lines	Standard
Energex **Ergon**	EX STD01117 EE STNW1140	Maintenance Standard for Overhead Pole Lines	Standard
EQL		Bushfire Risk Management Plan	Plan
Ergon Energy	EP26	Risk Management Policy	Policy

Appendix 2. Definitions

Term	Definition
Corrective maintenance	This type of maintenance involves planned repair, replacement, or restoration work that is carried out to repair an identified asset defect or failure occurrence, in order to bring the network to at least its minimum acceptable and safe operating condition. An annual estimate is provided for the PoW against the appropriate category and resource type.
Distribution	LV and up to 22kVnetwork, all SWER networks
Sub transmission	33kV and 66kV networks
Transmission	Above 66kV networks
Forced maintenance	This type of maintenance involves urgent, unplanned repair, replacement, or restoration work that is carried out as quickly as possible after the occurrence of an unexpected event or failure; in order to bring the network to at least its minimum acceptable and safe operating condition. Although unplanned, an annual estimate is provided for the PoW against the appropriate category and resource type.
Preventive maintenance	This type of maintenance involves routine planned/scheduled work, including systematic inspections, detection and correction of incipient failures, testing of condition and routine parts replacement designed to keep the asset in an ongoing continued serviceable condition, capable of delivering its intended service.

Appendix 3. Acronyms and Abbreviations

The following abbreviations and acronyms may appear in this asset management plan.

Abbreviation or acronym	Definition
ABC	Aerial Bundled Conductor
AIDM	Asset Inspection & Defect Management system
AMP	Asset Management Plan
Augex	Augmentation Expenditure
CBRM	Condition Based Risk Management
CB	Circuit Breaker
CT	Current Transformer
CVT	Capacitor Voltage Transformer
DEE	Dangerous Electrical Event
DGA	Dissolved Gas Analysis
DLA	Dielectric Loss Angle
EPDM	Ethylene Propylene Diene Monomer
EGM	Executive General Manager
EQL	Energy Queensland Limited
ESCOP	Electricity Safety Code of Practice
ESR	Queensland Electrical Safety Regulation (2013)
FFA	Field Force Automation
HV	High Voltage
IoT	Internet of Things
ISCA	In-Service Condition Assessment
LiDAR	Light Detection and Ranging
LDCM	Lines Defect Classification Manual
LV	Low Voltage
MSSS	Maintenance Strategy Support System
MU	Metering Unit
MVAr	Mega-VAr, unit of reactive power
NER	Neutral Earthing Resistor
NER	National Electricity Rules
NEX	Neutral Earthing Reactor
NFM	Network Facilities Management
OLTC	On-load tap -changers

Abbreviation or acronym	Definition
OTI	Oil Temperature Indicators
PCB	Polychlorinated Biphenyls
POC	Point of Connection (between EQL assets and customer assets)
POEL	Privately owned Electric Line
PRD	Pressure Relief Device
QLD	Queensland
REPEX	Renewal Expenditure
RIN	Regulatory Information Notice
RMU	Ring Main Unit
SCAMS	Substation Contingency Asset Management System
SDCM	Substation Defect Classification Manual
SEI	Serious Electrical Incident
SFAIRP	So Far As Is Reasonably Practicable
STPIS	Service Target Performance Incentive Scheme
SHI	Security and Hazard Inspection
SM	Small
SVC	Static VAR Compensator
SWER	Single Wire Earth Return
VT	Voltage Transformer
WCP	Water Content of Paper
WTI	Winding Temperature Indicators
WTP	Wet Transformer Profile