Asset Management Plan Control Systems 2020-25

January 2019

Part of the Energy Queensland Group

Executive Summary

This Asset Management Plan (AMP) covers the class of assets known as control systems.

Control systems facilitate automatic control, remote operator control and local operator control across the widely distributed electric network in Queensland. The control system asset class includes all substation automation and control systems, other than those found in a protection scheme such as protection relays, as well as the controls for field-based switch equipment. These controls are inclusive of the equipment dedicated to enabling supervisory control and data acquisition (SCADA) to the field-based switch equipment such as distributed system SCADA (DSS) radios, radio repeaters and modems.

Energy Queensland Limited (EQL) manages approximately 21,000 control system assets comprising of 3,000 assets in the Northern and Southern Regions (Ergon Energy) and 18,000 assets in the South East Region (Energex).

EQL employs several types of control system assets, including:

- Remote terminal units (RTUs).
- Data concentrators.
- Intelligent electronic devices.
- Human machine interfaces (HMI).
- Control boards for field based switch equipment.
- Distribution system SCADA (DSS) radios, radio repeaters and modems for field based switch equipment.

Failure of a control system asset risks public and staff safety in various ways, most notably:

- Failure to regulate substation voltage, risking public safety for customers connected to the network.
- Mal-operation of equipment, risking public and staff safety.
- Loss of supply to customers.

The control system asset class is comprised of a variety of substation and field-based assets and are typically asset managed on asset population basis using various strategic approaches including risk evaluation analysis based on risk factors influencing the assets to determine program requirements, and the systemic review of recorded performance.

EQL faces a variety of challenges in keeping the fleet operational throughout the state. The primary challenge is to address the lack of availability and purchasing options of spares for obsolete assets in the fleet. There are also the added challenges of ageing assets and the alignment of asset lifecycle management strategies across both organisations to form a unified approach for the control system fleet across all regions.

The strategies discussed in this Asset Management Plan will be ongoing to address the challenges facing the control system population to mitigate the risks of in-service failure of the asset. These strategies will also lay the foundation for a future intelligent grid for EQL.

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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 the EQL regions as a result of geographic influences, market operation influences and legacy organisation management practices. The EQL regions and their boundaries are clarified in Appendix 4. This Asset Management Plan (AMP) reflects the current practices and strategies for all control system assets managed by EQL, recognising the differences that have arisen due to legacy organisation management. These variations are expected to diminish over time with integration of asset management practices.

1.1 Purpose

The purpose of this document is to demonstrate the responsible and sustainable management of control systems 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 to regulatory requirements.
4. Manage the risk associated with operating the assets over their lifespan.
5. Optimise the value EQL derives from the asset class.

This AMP 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 AMP is guided by the following legislation, regulations, rules and codes:

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

This AMP forms part of EQL's strategic asset management system 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. **Error! Reference source not found.** contains references to other documents relevant to the management of the asset class covered in this plan.

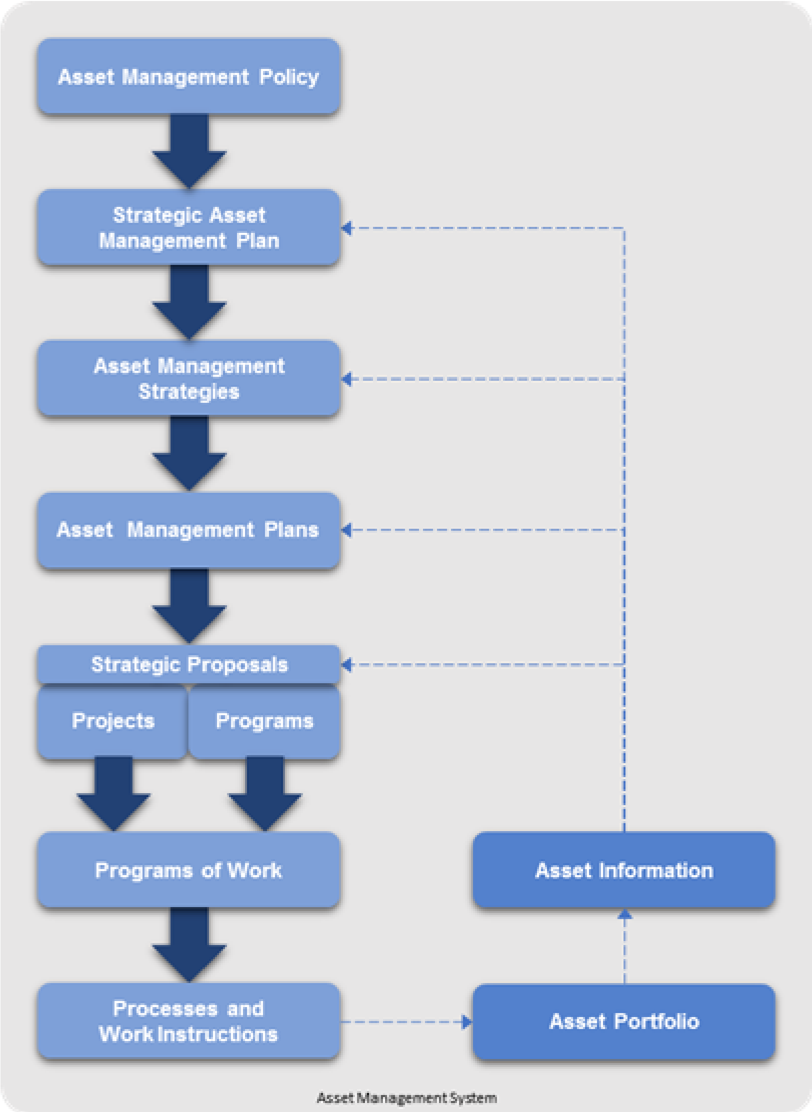


Figure 1: EQL Asset Management System

1.2 Scope

This plan covers the following assets:

- Remote terminal units.
- Data concentrators.
- Intelligent electronic devices.
- Human machine interfaces.
- Control boards for field-based switch equipment.
- DSS radios, radio repeaters and modems for field-based switch equipment.

Excluded from this plan are the following:

- Batteries found within the control units for field-based switch equipment.

- Lifecycle management strategies for field-based switch equipment. This will be covered under the following plans:
    - EQL circuit breaker and recloser AMP.
    - EQL switches AMP.
- Current programs for proactive replacements.
- Wiring between plant items, field devices and remote terminal units.

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

1.3 Total Current Replacement Cost

Control system assets within the South East Region fall into the field devices category and are typically asset managed on a population basis based on historical performance, spares availability, risk evaluation analysis based on risk factors and manufacturer support and sale status.

Based on asset quantities and replacement costs, EQL field devices have a replacement value of the order of $820 million. This valuation is the gross replacement cost of the assets, based on the cost of replacement of modern equivalents, without asset optimisation or age assigned depreciation. Figure 2 provides an indication of the relative financial value of EQL control systems compared to other asset classes.

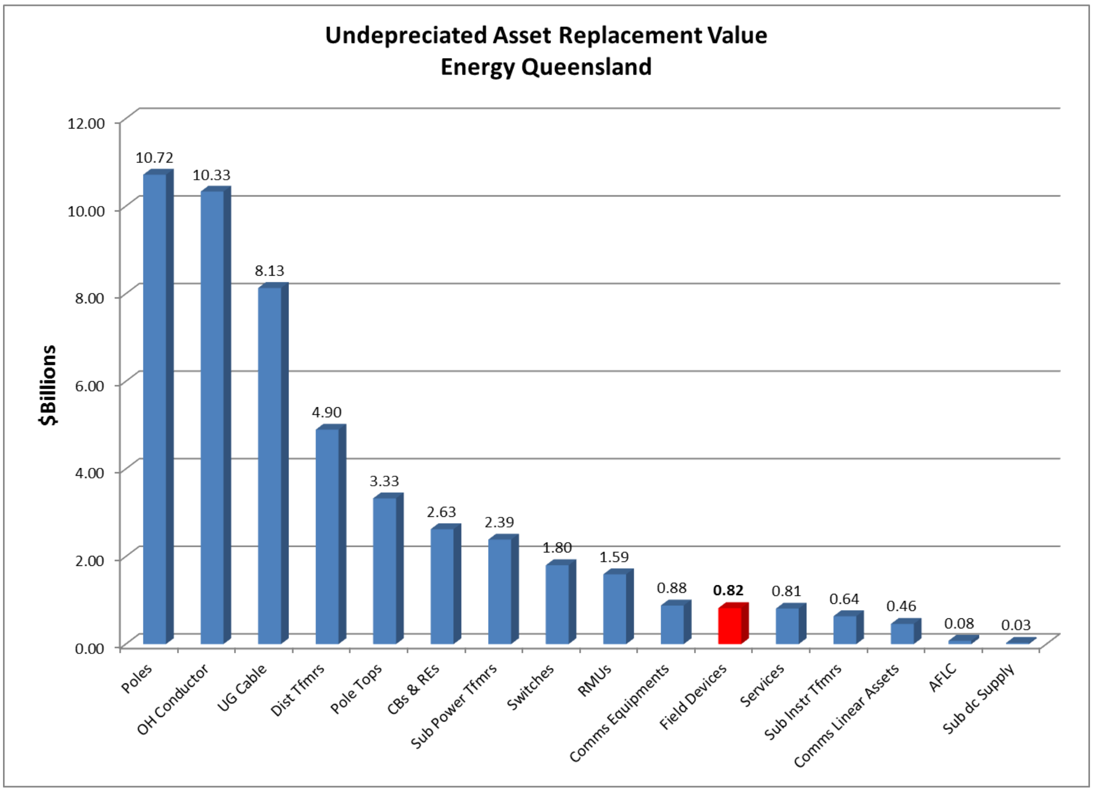


Figure 2: EQL – Total Current Asset Replacement Cost

1.4 Asset Function and Strategic Alignment

Control system assets provide important functionality to enable safe operational control and monitoring of the network. These assets provide automatic, remote operator and local operator control for the electric network across Queensland. They also form the backbone of the larger supervisory control and data acquisition (SCADA) systems relied upon by the business.

Table 1 details how control system assets contribute to the corporate strategic asset management objectives of EQL.

Relevant Asset Management Objectives	Relationship of Asset to Asset Management Objectives
Ensure network safety for staff, contractors and the community	Diligent and consistent maintenance and operations support control system asset performance and hence safety for all stakeholders
Meet customer and stakeholder expectations	Continued control system asset serviceability supports network reliability and promotes delivery of a standard quality electrical energy service.
Manage risks, performance standards and asset investment to deliver balanced commercial outcomes	Failure of a control system asset can result in increased public safety risk and disruption of the electricity network. Asset longevity assists in minimising capital and operational expenditure.
Develop asset management capability & 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 the replacement of control system assets at end of economic life as necessary to suit modern standards and requirements

Table 1: Asset Function and Strategic Alignment

1.5 Owners and stakeholders

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

Control system assets form the framework relied upon for the SCADA system. In the South East Region, this system is known as the Distribution Management System (DMS) while in the Northern and Southern Regions a different variation is used to provide similar functions. Both are computer systems used by network controllers for monitoring, controlling, and optimising the performance of the electricity distribution system.

Within the EQL network, control system assets are of various model types and perform different functions. As the network has expanded, these assets have either been maintained or replaced as per the network augmentation requirements. Furthermore, as network technology has evolved so have the control systems implemented in the network.

These assets provide the important functions of plant overload protection, monitoring, remote control, and a platform for safe operation of the electric network. The following section provides an overview of the control systems population and other factors that influence the management of these assets.

2.1 Asset Description

Due to the differences in control system architectures, hierarchies, and SCADA systems, the assets in the South East Region and Northern and Southern Regions vary in their selected functionalities. The functionality of different assets is summarised in the following sections.

2.1.1 Remote Terminal Units

A remote terminal unit (RTU) is an embedded computer that provides a specialised input/output interface and protocols. The device interfaces with physical objects and a SCADA system by transmitting telemetry data to the system. These devices perform local and remote automation functions within a substation.

Listed below are some key functions performed by RTUs in EQL.

EQL RTU Functionality
Control & Monitoring
On Load Tap Changer Voltage Regulation
Auto-Reclose
Plant Overload Protection
Diagnostics
Auto-Changeover

Table 3: RTU functionality

2.1.2 Data Concentrators

Data concentrators have the same physical hardware and operating system as a RTU, but without any of the control or automation functionality. The data concentrator infrastructure in the South East Region includes remote data concentrators (RDCs) and master data concentrators (MDCs). In the Northern and Southern Regions, the only data concentrators are MDCs.

In the South East Region, the primary function of RDCs is to process and format incoming data from RTUs into a common digital format, which can then be received by MDCs, that also perform the function of processing and formatting incoming data, before passing the data onto systems higher in the control system architectural hierarchy.

In the South East Region RDCs are a mid-level node in Energex's SCADA data communication hierarchy. MDCs are a high-level node in the hierarchy in all regions.

2.1.3 Intelligent Electronic Devices

Intelligent electronic devices (IEDs) make up the majority of the control systems population. An intelligent electronic device is a microprocessor-based controller of power system equipment. It can perform electrical protection functions, advanced local control intelligence, monitor and record sensor values, and provide communications directly to a SCADA system or other applications.

Although not currently implemented throughout the Northern and Southern Regions, the functionality provided by proposed future IEDs is expected to be similar to those in the South East Region, in regards to communication functions performed.

2.1.4 Human Machine Interfaces

Human machine interfaces (HMIs) are an operator console allowing for localised control of plant items and the electric network by a substation technician within a substation. HMIs serve the purpose of presenting an overview of plant items and the electric network as well as displaying any alarms at the substation. Within the Northern and Southern Regions, HMIs are known as local master stations or local control facilities (LCFs).

2.1.5 Control Boards for Field Based Switch Equipment

Control boards can be found on plant items within the distribution network such as automatic reclosers, regulators, load break switches, and capacitor banks. EQL control board assets enable the protection of the electrical distribution network and provide the following key functions:

- Remote control.
- Monitoring (voltage, current, status).
- Auto reclose and restore.
- Diagnostics (limited data points).
- Over-current protection and sensitive earth fault protection.
- Reactive VAR control.

2.1.6 DSS Radios, Radio Repeaters, and Modems for Field Based Switch Equipment

Some of the field-based switch equipment (FBSE) in the distribution network with automated functionality will utilise a communication enabling device. In the South East Region, radios and radio repeaters are used to receive and transmit radio signals throughout the distribution network and through the control system hierarchy to the DMS.

In the Northern and Southern Regions, modems are utilised to communicate over a variety of networks depending on the location, including the Ergon Energy cellular network and Telstra Next G network. Modems are utilised to also receive and transmit data and control instruction, via an IP gateway, from the SCADA system.

The primary function of these assets is to enable remote control of plant items, monitoring of equipment and the network. This also allows for diagnostics which form part of the SCADA system in the respective regions.

2.2 Asset Quantity and Physical Distribution

The EQL control system asset class population is distributed across the regions as outlined below.

Asset Type	Northern	Southern	South East	Total
Remote Terminal Units	342	429	343	1,114
Data Concentrators	3	0	27	30
IEDs	-	-	11,551	11,551
HMIs	44	60	281	385
Control Boards for FBSE	810	1,107	3,366	5,283
DSS Radios and Radio Repeaters for FBSE	-	-	2,671	2,671
Modems for FBSE	794	1,085	-	1,879
Total	1,993	2,681	18,239	22,913

Table 4: Asset Quantity

2.3 Asset Age Distribution

This section outlines the age distribution of the EQL control system population by asset type, and outlines the various types of equipment models currently in service from legacy programs or network augmentation. Due to the nature of the control system asset class being dependent, such as substation equipment and SCADA for FBSE, the age profile for various control system asset types display similar trends.

Likewise, legacy programs of work that have influenced the asset class and are the cause of recent trends in the Northern and Southern Regions include:

- Phase 1 and 2 of SGNW0025, Automatic Circuit Recloser (ACR) Remote Communication Strategy to roll out SCADA to field-based switch equipment.
- Other network augmentation programs throughout the Northern and Southern regions that have led to the opportunistic bundling of control systems asset installations and upgrade replacements.

Legacy programs of work that have influenced the asset class and are the cause of recent trends in the South East Region include:

- The adoption of voltage variance regulation 5 (VVR5) operating system as the new standard to meet legislative requirements for voltage regulation.
- The upgrading of obsolete SCADA equipment in the South East region to meet the latest standards.

- Other network augmentation programs throughout the South East region that have led to the opportunistic bundling of control systems asset installations and upgrade replacements.

1.1.1 Remote Terminal Units

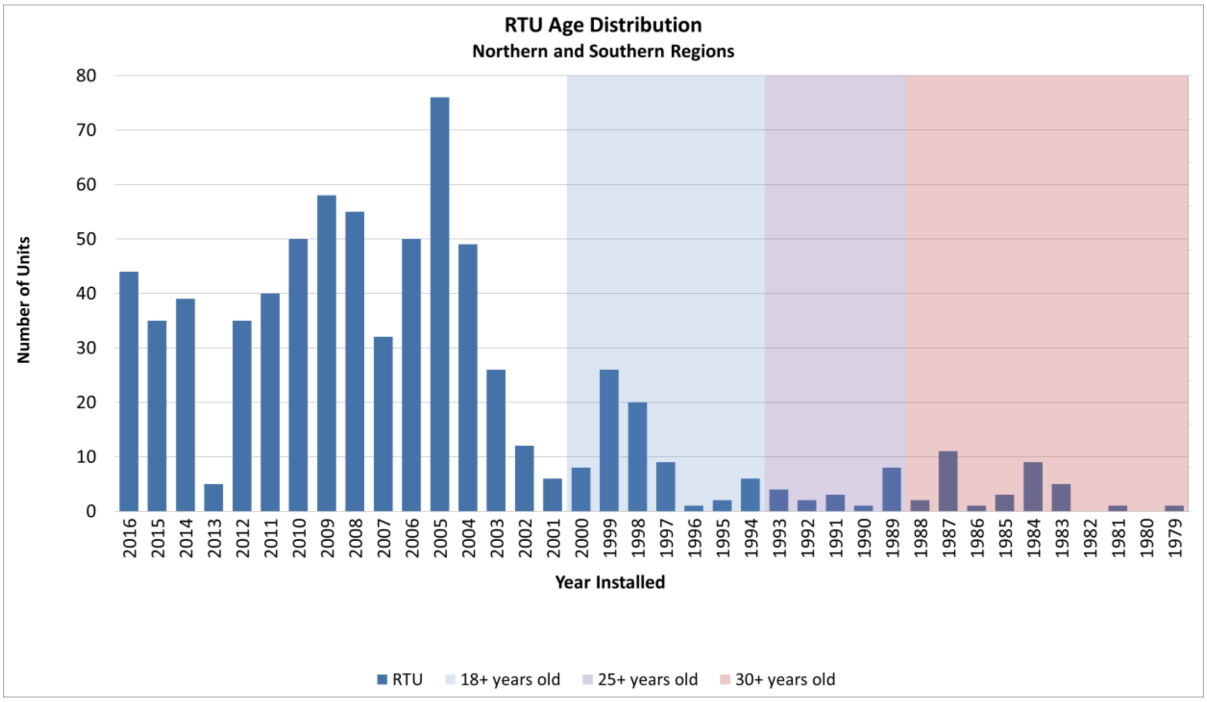


Figure 3: RTU Age Distribution (Northern and Southern Regions)

Figure 3 illustrates RTU quantities in the Northern and Southern Regions, by installation year. The age distribution highlights an overall trend in maintaining assets in service if the asset continues to perform. The larger population below the age of 18 is driven by network augmentation and technology requirements.

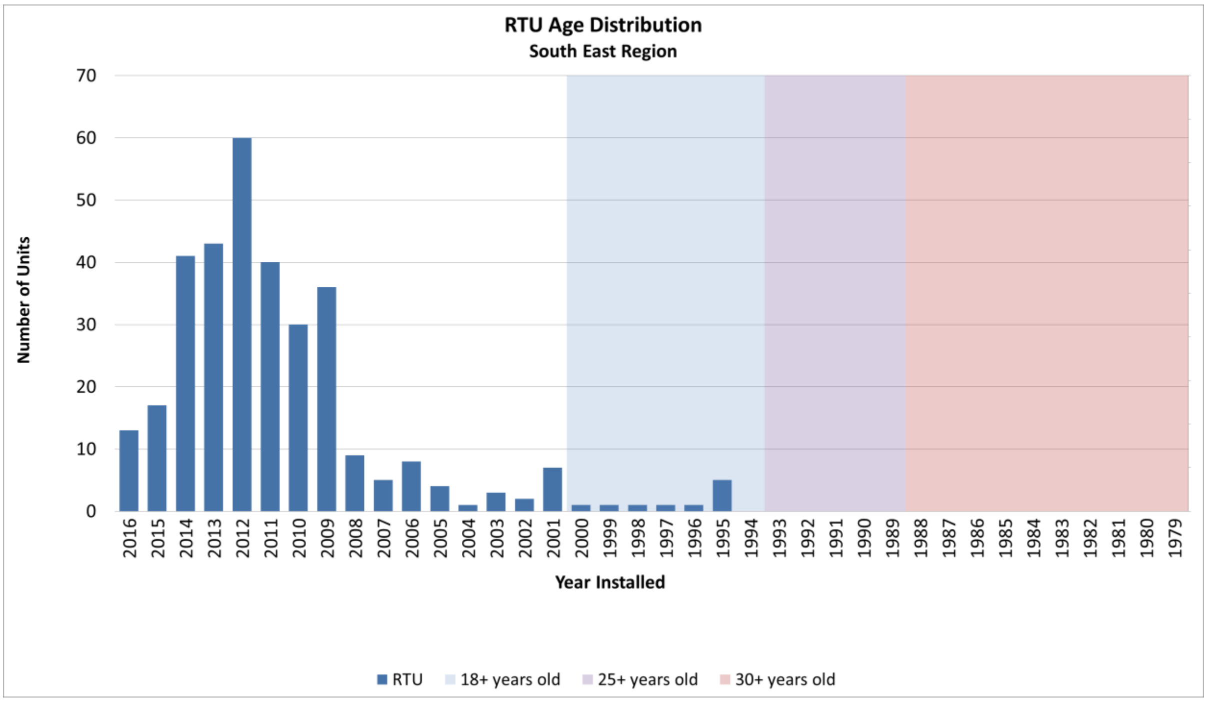


Figure 4: RTU Age Distribution (South East Region)

The RTU age distribution for the South East Region in Figure 4 illustrates the rise in network augmentation in the 2012 to 2013 period. Furthermore due to the shift to latest standard equipment, as a result of meeting legislative requirements, the RTU age distribution is primarily below the age of 15 years.

2.3.1 Data Concentrators

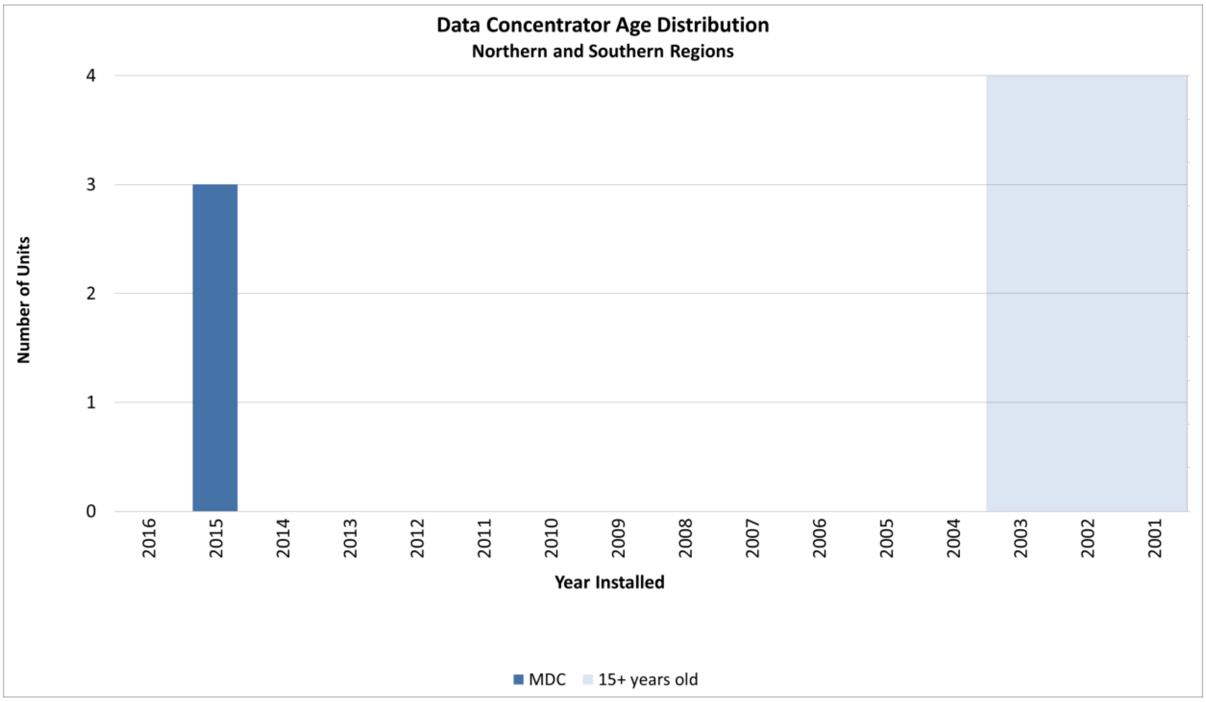


Figure 5: Data Concentrator Age Distribution (Northern and Southern Regions)

In the Northern and Southern Regions data concentrators are not widely used, due to the technology type and deployment architecture used for RTUs in the region. As a result, the population is quite small with only 3 units in service, installed recently.

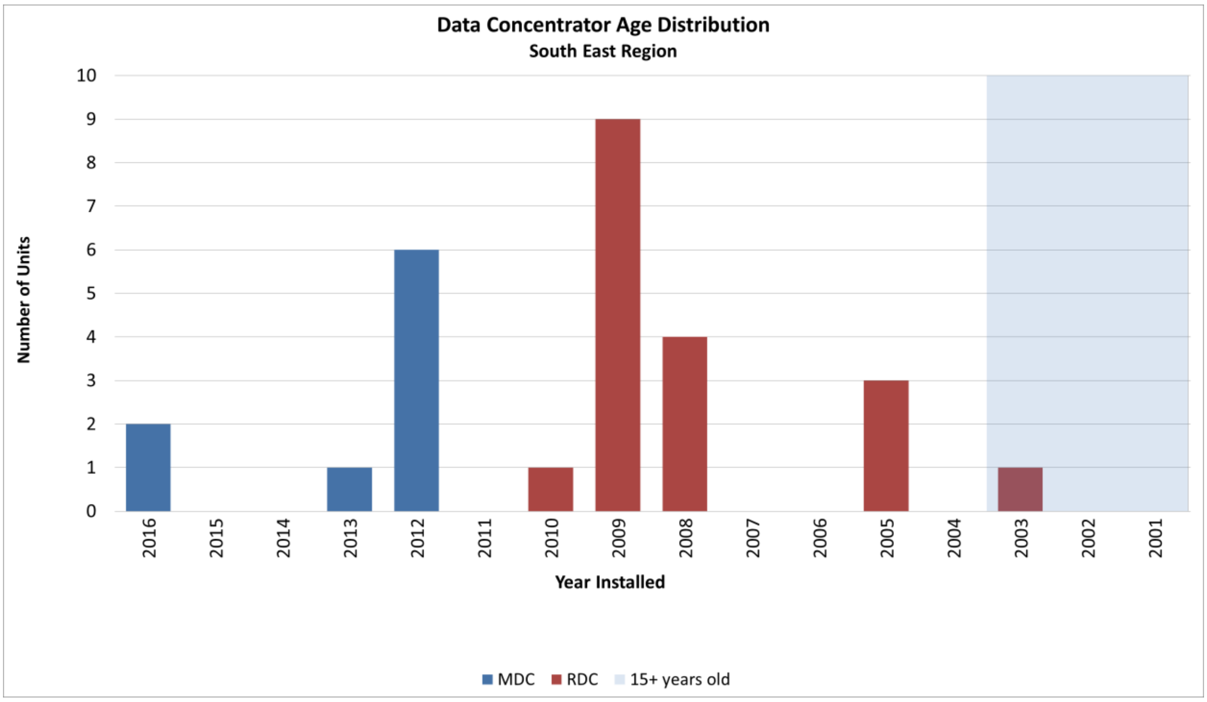


Figure 6: Data Concentrator Age Distribution (South East Region)

In the South East Region, the technology type of RTUs and most recent deployment architecture required data concentrators across the region. Figure 6 illustrates the trend towards remote data concentrators was driven by network augmentation requirements and RTU installations. While the rise in master data concentrators in 2012 was is due to the high number of RTU installations.

2.3.2 Intelligent Electronic Devices

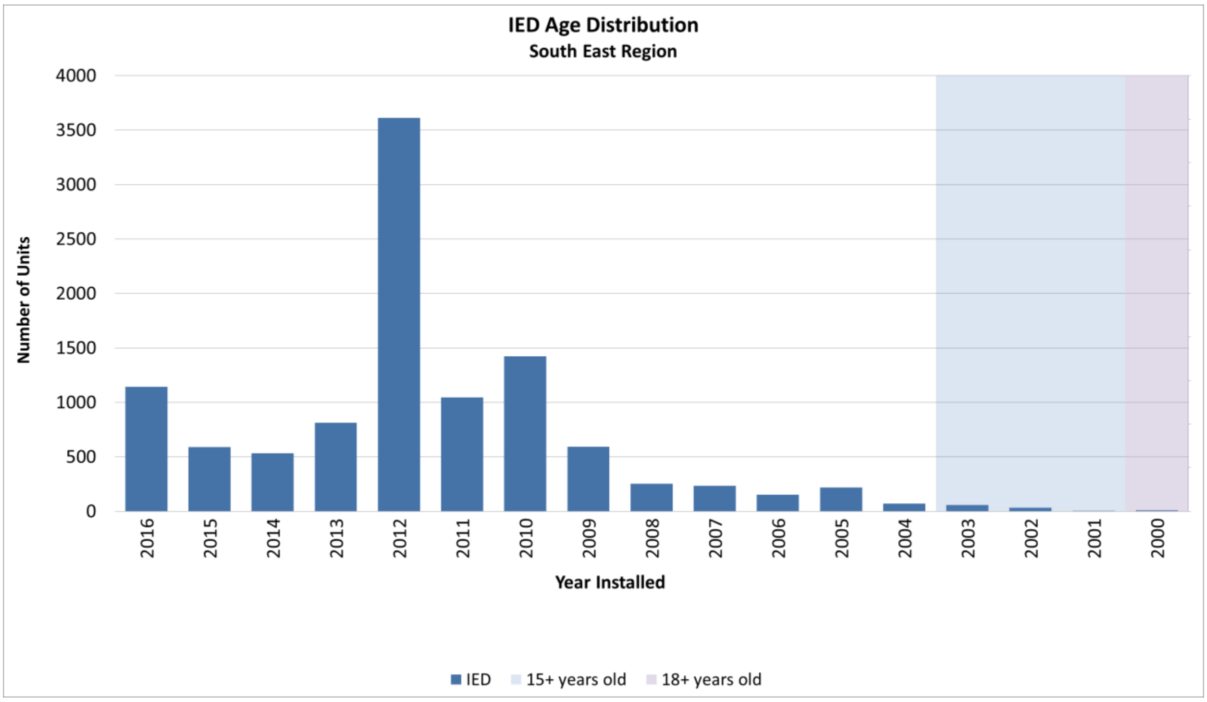


Figure 7: IED Age Distribution (South East Region)

The IED age distribution in Figure 7 illustrates the tight integration with RTUs. This can be seen in the high number of installations in 2012 similar to the RTU fleet. Furthermore, the high number of installations in 2012 is due to the trend of moving away from obsolete technology towards latest standard series IEDs.

2.3.3 Human Machine Interfaces

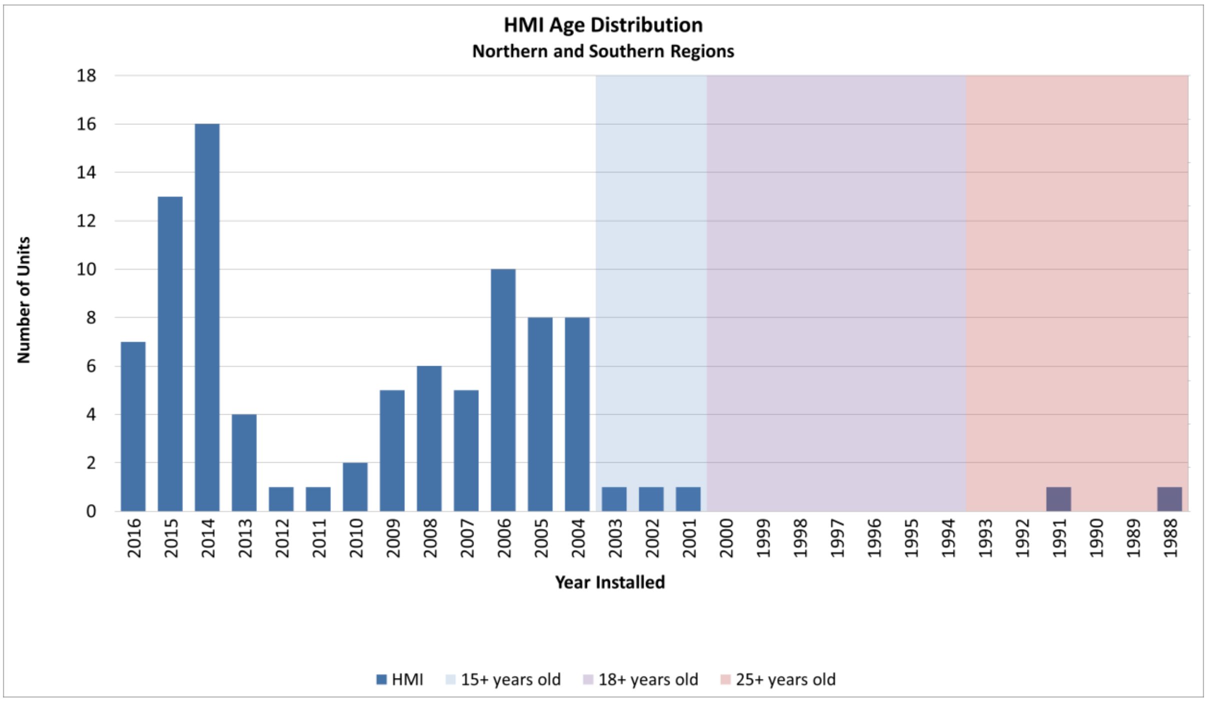


Figure 8: HMI Age Distribution (Northern and Southern Regions)

In the Northern and Southern Regions, RTUs are not always accompanied by a HMI, although the assets are tightly integrated. However, Figure 8 shows the increasing trend towards HMI installations, due to new RTU technology requirements and replacement of older RTU assets that previously did not require a HMI.

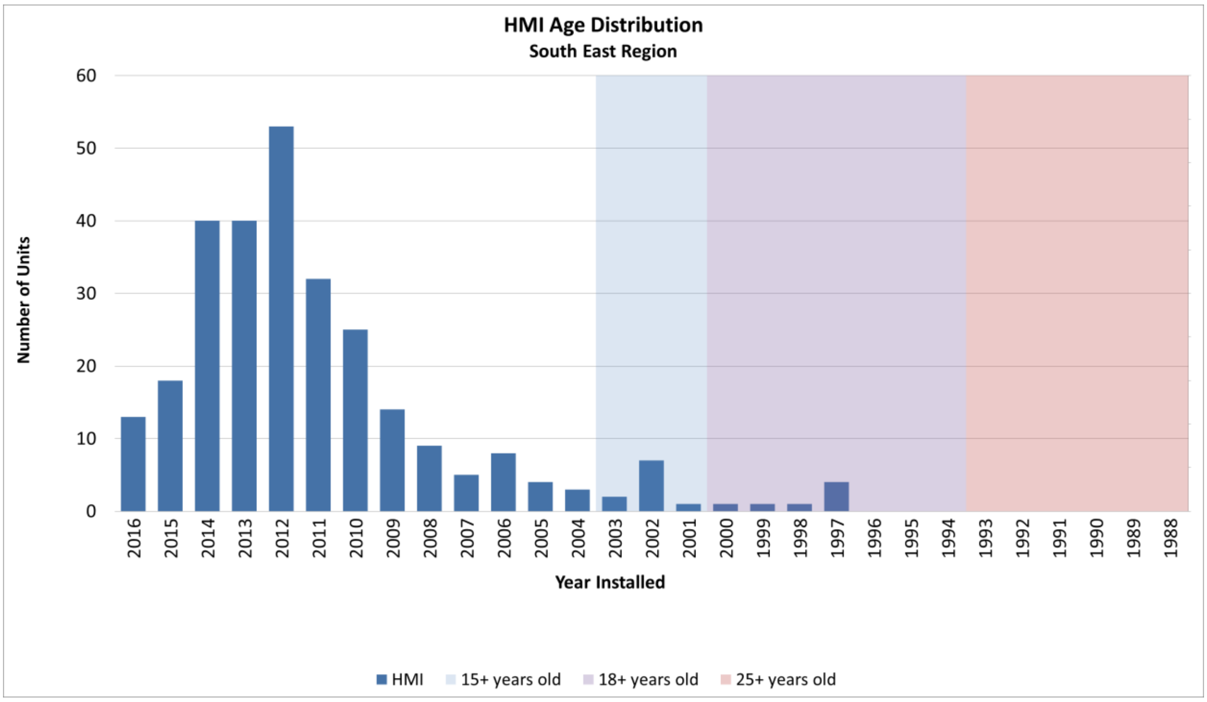


Figure 9: HMI Age Distribution (South East Region)

Figure 9 depicts the HMI age distribution for the South East Region. In the South East Region, HMI and RTU assets are also tightly integrated. Historically deployment architecture has required most RTUs to also have a HMI at the site; this can be seen in the similar installation trends for both assets. Therefore, trends in the HMI installation are nominally driven by RTU requirements and network augmentation.

2.3.4 Control Boards for Field Based Switch Equipment

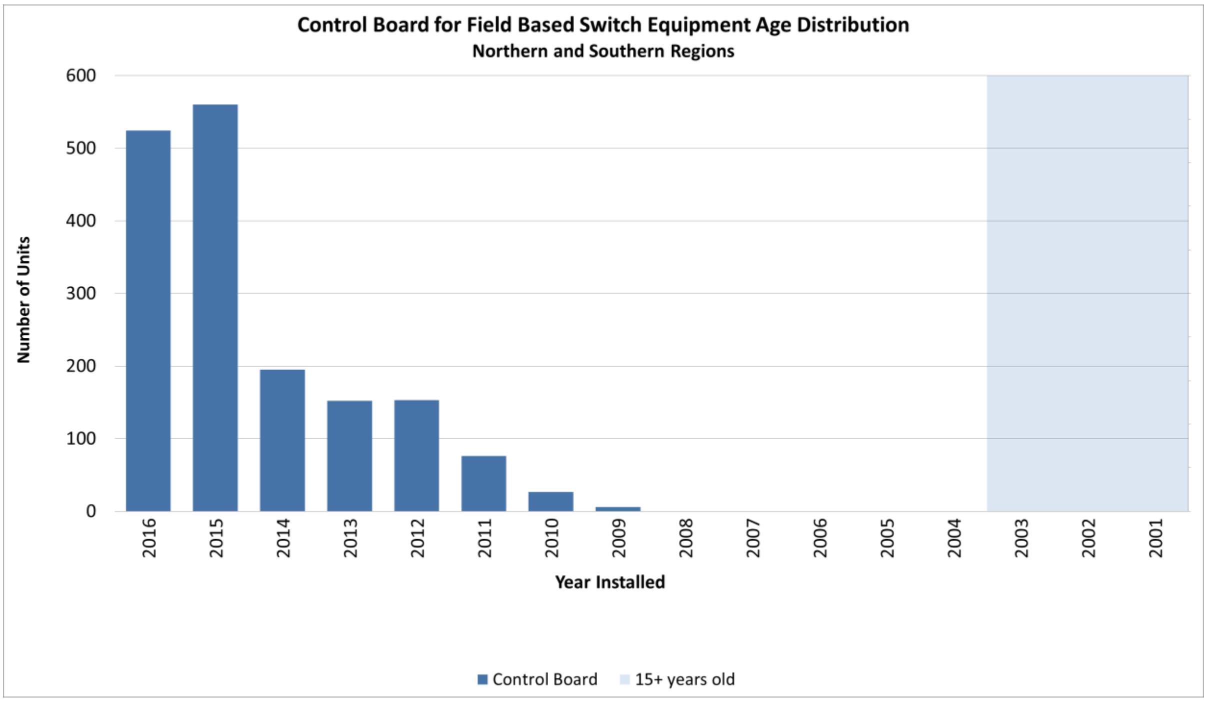


Figure 10: Control Board Age Profile (Northern and Southern Regions)

In the Northern and Southern Regions, there is a variety of legacy FBSE types. This includes older technology that previously did not use electronics, such as control boards, but instead was electro-mechanical. The age distribution of control boards in Figure 10 demonstrates the recent change in business strategy to enable remote control of FBSE in the network. This recent installation trend is also driven by improving the reliability of the network in the regions by installing more FBSE and thus control boards.

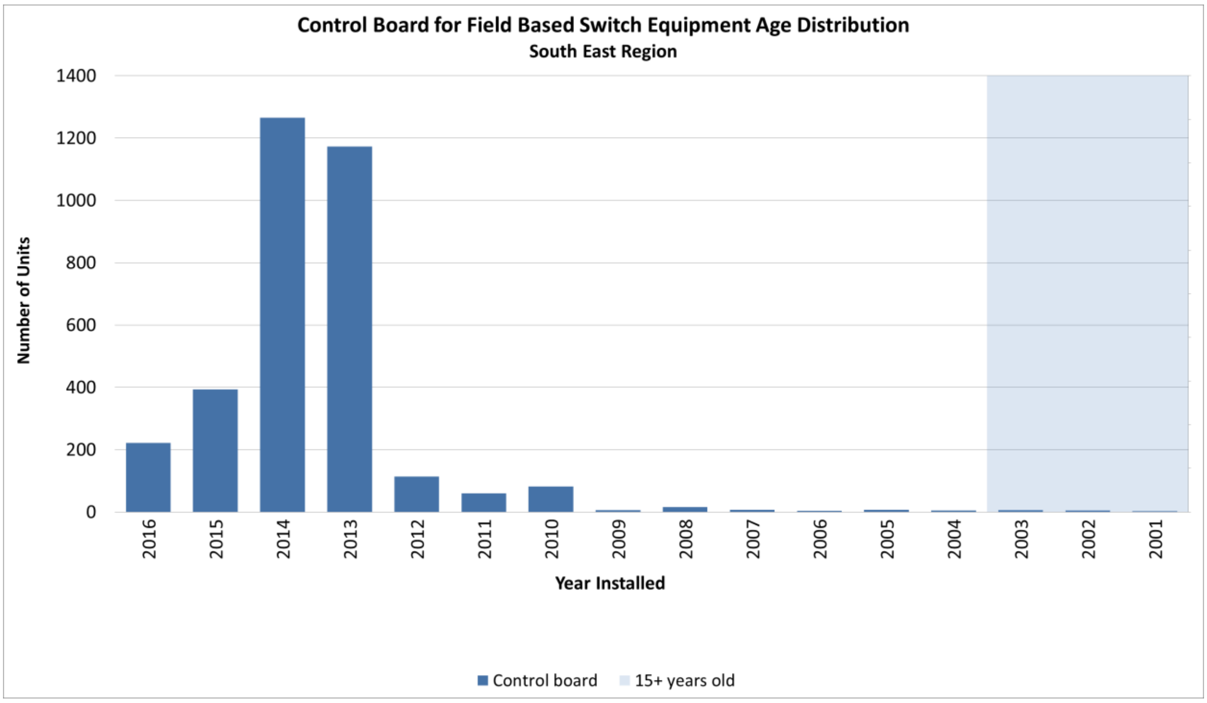


Figure 11: Control Board Age Profile (South East Region)

The age distribution of control boards in the South East Region, depicted in Figure 11, shows the increasing trend towards enabling SCADA to FBSE, allowing remote control of equipment. Furthermore, the age distribution is a result of a wide variety of control board types currently in service throughout the region, which is driven by the various legacy FBSE types.

2.3.5 DSS Radios, Radio Repeaters and Modems for Field Based Switch Equipment

Previously in the Northern and Southern Regions, remote communications were not enabled on FBSE. This is highlighted in Figure 12 with no installations prior to 2014. However, the trend in increasing modem installations is a direct result of new business strategies and legacy programs implemented in the regions.

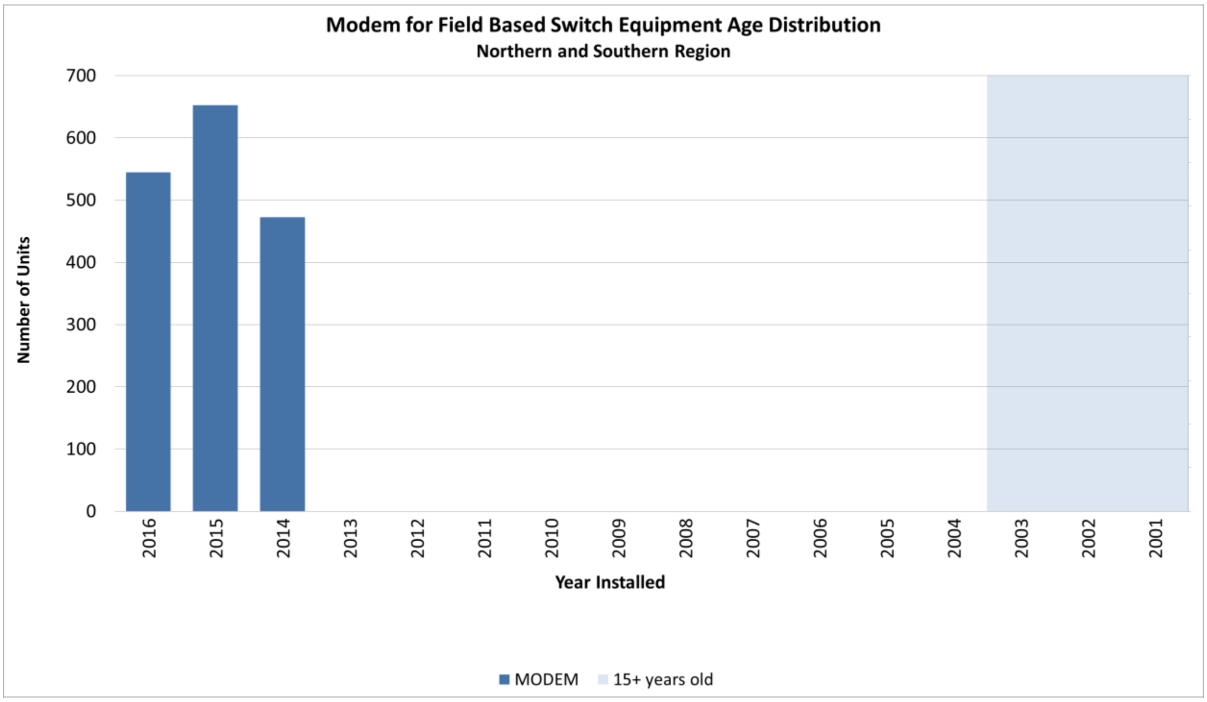


Figure 12: Modem Age Distribution (Northern and Southern Regions)

As these assets are not currently recorded or tracked in the Northern and Southern Regions the following assumption has been made to develop the age distribution:

- Modems have been installed at the same time as the control board was commissioned in the Northern and Southern Regions, due to the tight integration of both assets as part of the controls on field-based switch equipment.
- The modems began to be rolled out as part of the ACR Remote Communication Strategy on Nulec and Schneider field-based switch equipment, starting with phase 1 at the end of 2014.
- A total of 1879 field-based switch equipment with communications facilitated by a modem, extracted from the Northern and Southern Regions SCADA system.

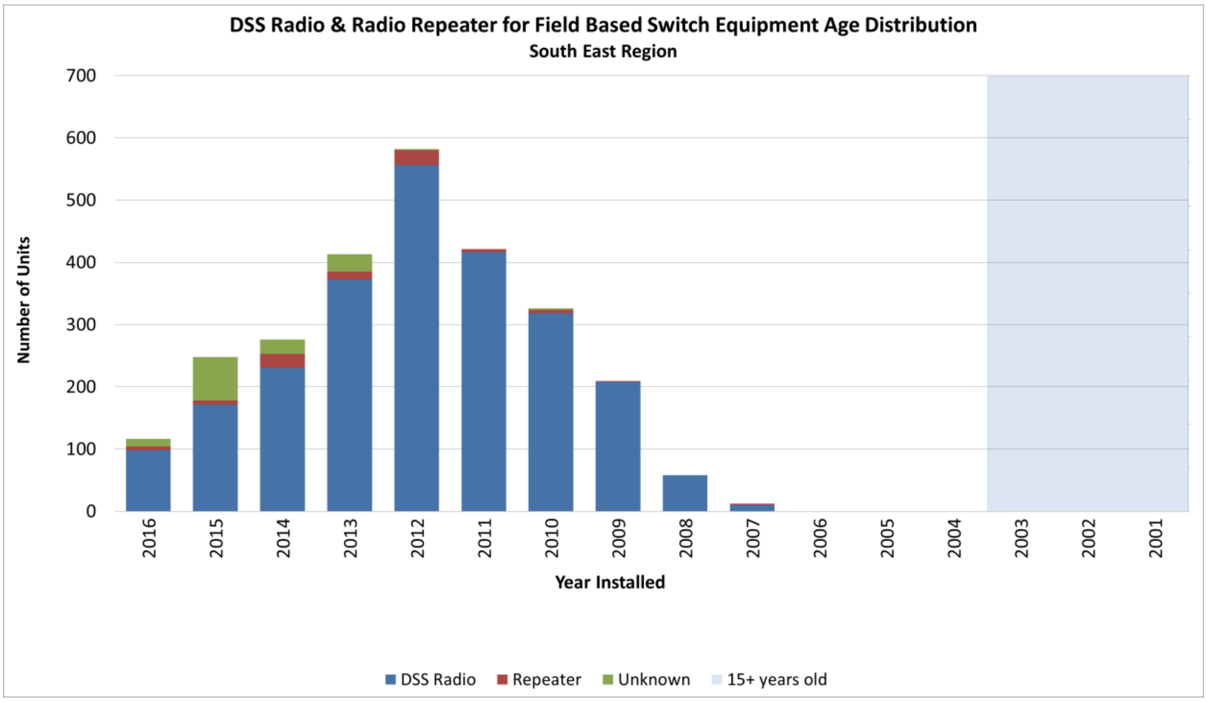


Figure 13: DSS Radio and Radio Repeater Age Profile (South East Region)

Figure 13 depicts the DSS radio and radio repeaters age distribution by year of installation. The age distribution highlights a strong trend towards DSS radios, with only a small number of repeaters in the network.

2.4 Population Trends

Table 5 lists the installation profile for all asset types across the regions over the current regulatory period.

In the Northern and Southern Regions, the installations for most asset types decreased after the 2015/16 period, as maintaining the network became the focus and network augmentation reduced, with the exception of control boards and modems. The rise in installations over the 2015/16 to 2016/17 period was driven by business strategies for rolling out remote communications to ACRs in the region and this can be seen in Table 5.

In the South East Region, the majority of asset installations also reduced after the 2015/16 period, as the focus shifted from network augmentation to maintenance of the operational fleet. The recent increase in IED installations is due to the replacement of obsolete equipment with new standard equipment throughout the network. This trend is also a result of responding to emerging issues with other systems or standards that may affect the safe operation of the distribution network and require an IED.

Asset	Northern and Southern Region			South East Region		
	Installed Assets 2017/18	Installed Assets 2016/17	Installed Assets 2015/16	Installed Assets 2017/18	Installed Assets 2016/17	Installed Assets 2015/16
Remote Terminal Unit	36	44	35	14	13	17
Data Concentrator	0	0	3	0	2	0
IED	-	-	-	782	1,141	588
HMI	13	7	13	13	18	40
Control Boards	215	524	560	177	221	393
DSS Radio & Radio Repeaters	-	-	-	10	116	248
Modems	210	545	652	-	-	-

Table 5: Installation Trend for all EQL Regions

2.5 Asset Life Limiting Factors

For the asset classes listed in this AMP, the life of the asset will primarily depend upon the reliability of electronic components. In some cases, failed hardware can be repaired, extending operational life of the asset. However, in other cases such as the malfunction of electronic components, a complete unit replacement is required. Determination of whether an asset continues in-service also depends upon the availability of spares or its obsolescence within the marketplace.

The control system asset class has certain factors that may influence service life and as a result, have a significant bearing on the programs of work implemented to manage the lifecycle. The life limiting factors described in Table 6 are applicable to all assets in the control system fleet.

Factor	Influence	Impact
Moisture ingress	Corrosion of surfaces on input and output terminals.	Rise in number of faults recorded against the asset, corrective maintenance works and SCADA downtime.
Lightning	Voltage surge through electronics within equipment.	Single or multiple device loss of control and monitoring, SCADA outage and replacement of components/asset.
Environmental Impacts	Overheating (for pole mounted equipment in distribution networks)	Single or multiple device loss of control and monitoring, SCADA outage and replacement of components/asset.
Age (Deterioration of equipment)	Failure of electronic components (e.g. central processing unit (CPU), hard drive).	Complete failure results in the total loss of remote control and monitoring of the entire substation, single or multiple devices.
	Failure of firmware to reboot	Inability to make future configuration changes and resulting failure of hardware.
Manufacturer declaring equipment end-of-life	Obsolescence	Inability to procure replacement equipment and spares.

Table 6: Control System Equipment Life Limiting Factors

3 Current and Desired Levels of Service

EQL operates a dispersed electric network across all the regions in Queensland and is bound by legislation as outlined by the National Electricity Rules (NER) and other regulatory defined standards.

In doing so EQL's business practices and key management processes centre upon the following themes:

- Health and Safety of personnel, the public, and public sites
- Network reliability
- Security of electricity supply
- Protection of plant and equipment
- Customer interests and service
- Environmental protection and security.

3.1 Desired Levels of Service

This control system 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, mitigated SFAIRP. All other risks associated with this asset class will be managed as low as is 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 contemplated 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 intent to achieve 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 typically become obsolete before end of life. Once the asset type is obsolete, assets will be managed, replaced, and reallocated as appropriate to achieve appropriate risk management and optimum asset class longevity and performance.

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 it works:
    a. are electrically safe,
    b. are operated in a way that is electrically safe.
2) Without limiting subsection (1), the duty includes the requirement that the electricity entity inspects, test and maintain the works.

EQL control system assets are also bound to meet legislative requirements, as outlined in the NER. Maintaining the serviceability of the control system asset class not only allows EQL to meet legislative obligations but also enables other asset classes to meet requirements.

The relevant sections and schedules of the NER that directly apply to or are enabled by the control system asset class include:

- Section 4.2.6 General principles for maintaining power system security.
- Section 4.2.7 Reliable Operating State.
- Schedule 5.1a.3 System Stability.
- Schedule 5.3a.4.1 Remote Control, Monitoring and control requirements.

3.3 Performance Requirements

As part of meeting the obligations as a network operator, Ergon Energy and Energex have a joint standard, STMP001, Standard for Network Performance. Outlined in this are performance requirements for voltage variance and reliability requirements of the network.

Under the Queensland Electricity Industry Code (EIC) Ergon Energy and Energex have existing service obligations including:

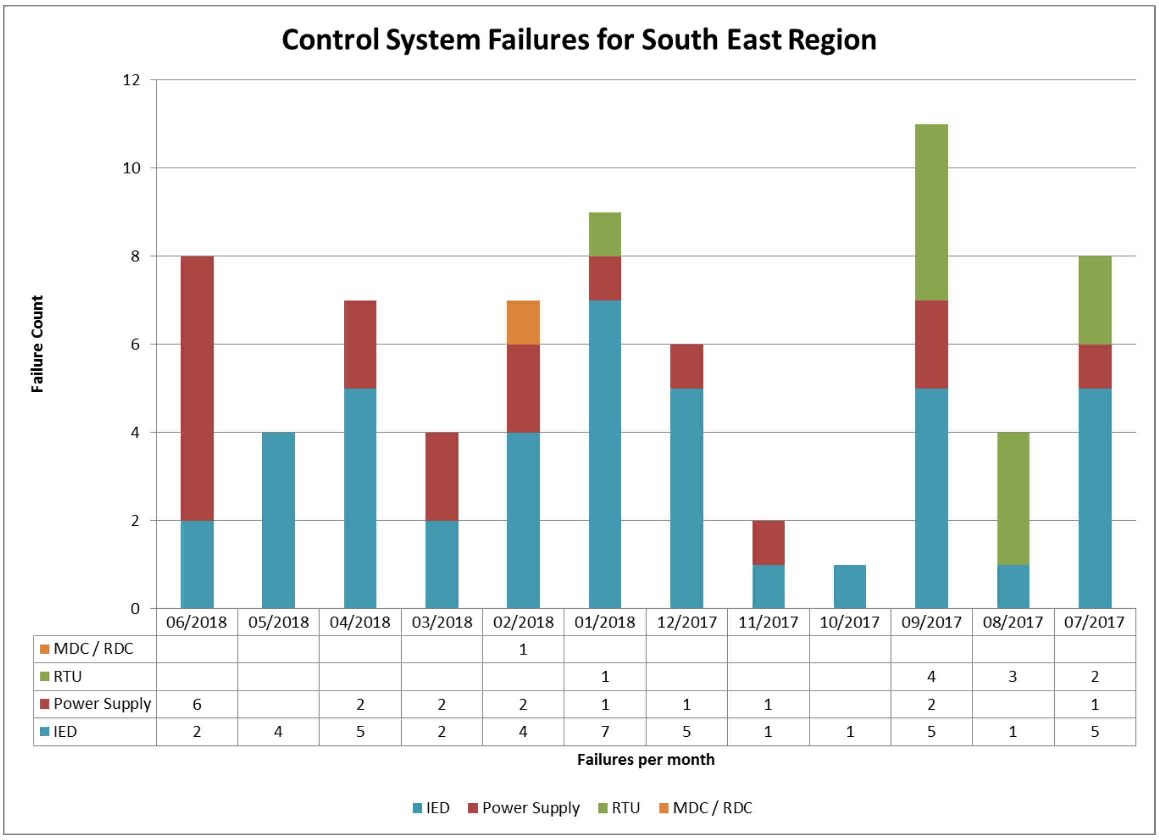
- Minimum service standards (MSS) covering average performance levels delivered to customers
- Guaranteed service levels (GSL) covering the performance standards applicable to individual customers.

Therefore, the control system asset class greatly impacts Ergon Energy's and Energex's ability to meet targets for MSS and GSL to customers. This is due to the relied upon functionality provided by control system assets that allow for safe remote control of the network during faults for agile restoration of healthy parts of the network.

Furthermore, in accordance with this standard, voltage variance to customers on the low voltage network must be kept to within legislated limits and as per internal standards for Ergon Energy and Energex. Therefore, the performance of the control systems asset class is vital in meeting this legislative requirement.

3.4 Current Levels of Service

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 mitigate. The following graph, Figure 14 shows the trend in work orders raised to replace failed control system assets within the substation environment, including power supplies of these assets in the South East Region over the last financial year.



	06/2018	05/2018	04/2018	03/2018	02/2018	01/2018	12/2017	11/2017	10/2017	09/2017	08/2017	07/2017
MDC / RDC					1							
RTU						1				4	3	2
Power Supply	6		2	2	2	1	1	1		2		1
IED	2	4	5	2	4	7	5	1	1	5	1	5

Figure 14: Control System Failure History for 2017/18 Year (South East Region)

Further analysis of corrective maintenance work orders for the RTU asset class reveals an increasing trend in intrusive maintenance when the asset is greater than 18 years old. At this point in the lifecycle, maintaining the asset in-service is no longer cost effective, and the asset should instead be replaced.

Figure 15 illustrates the failure rate for RTUs in the South East Region where a low-level of failures are observed up to the 15 year age mark, with the subsequent escalating failures indicating end-of-life.

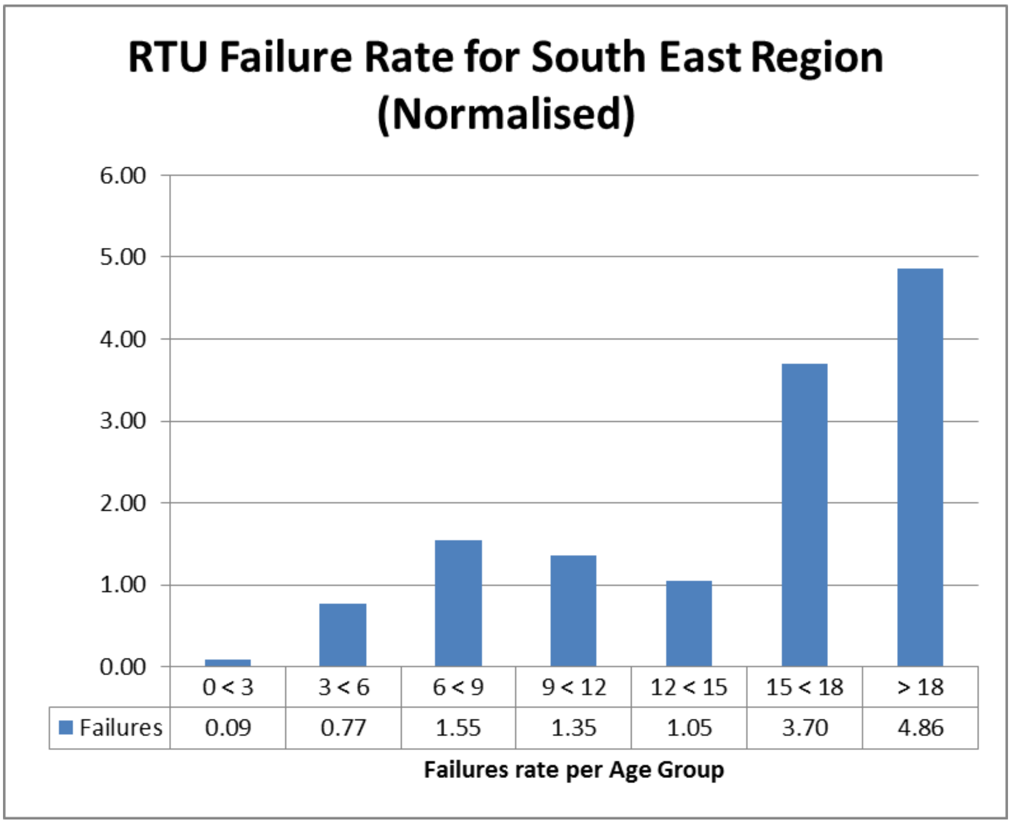
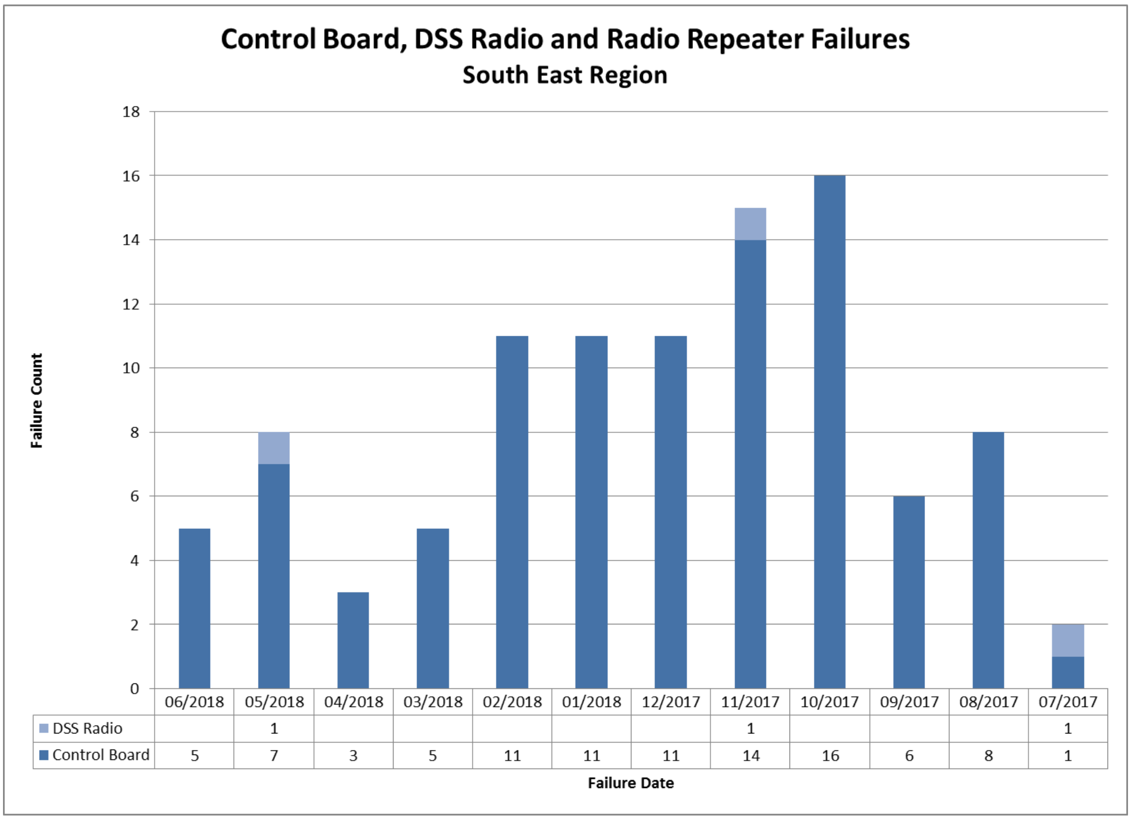


Figure 15: Failure Rate for RTUs (South East Region)

Figure 16 provides an overview of the trend in work orders raised to replace failed control board, DSS radio, and radio repeater assets that are found in the distribution network throughout the South East Region over the 2017-18 year.



	06/2018	05/2018	04/2018	03/2018	02/2018	01/2018	12/2017	11/2017	10/2017	09/2017	08/2017	07/2017
DSS Radio		1						1				1
Control Board	5	7	3	5	11	11	11	14	16	6	8	1

Figure 16: Distribution Assets Failure History for 2017-18 Year (South East Region)

A breakdown of recorded failures for the control board asset class by manufacturer is visible in Figure 17. This highlights the trend of problematic Noja, formerly Tavrida, control boards.

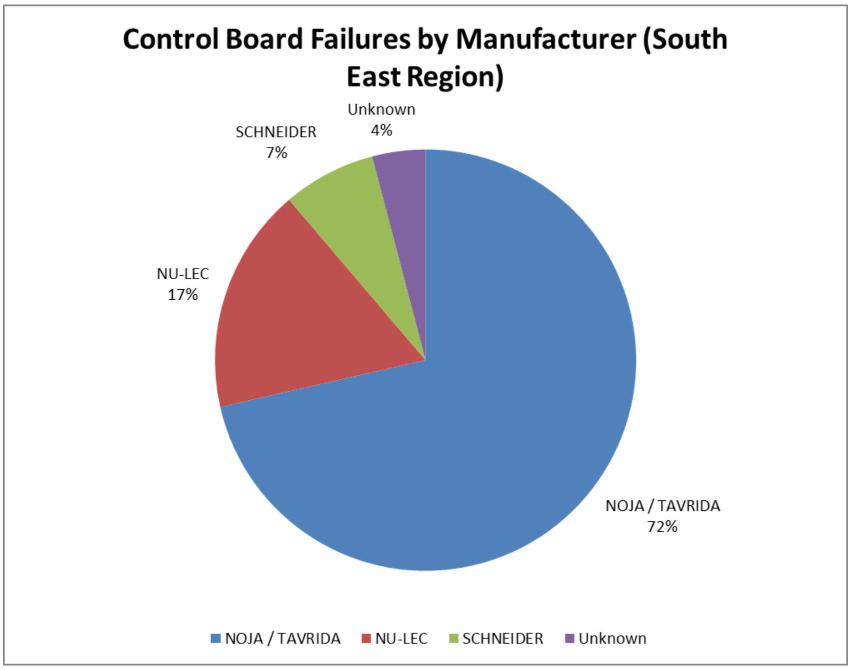
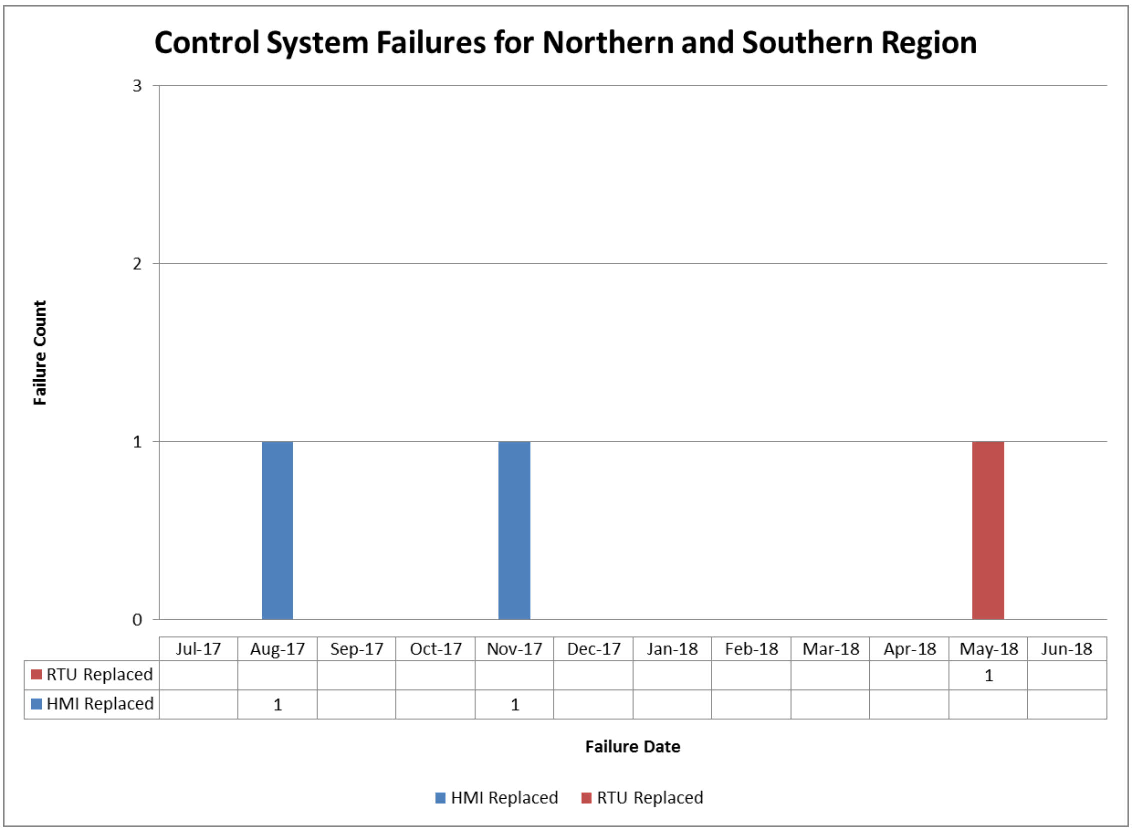


Figure 17: Control Board Failure History by Manufacturer (South East Region)

In the Northern and Southern Regions asset failure data has not yet reached maturity for proper analysis and identification of trends for control system assets. Figure 18 represents the in-service failures of RTU and HMI assets in the Northern and Southern Regions over the 2017-18 year.



	Jul-17	Aug-17	Sep-17	Oct-17	Nov-17	Dec-17	Jan-18	Feb-18	Mar-18	Apr-18	May-18	Jun-18
RTU Replaced											1	
HMI Replaced		1			1							

Figure 18: Control System Failures for 2017-18 Year (Northern & Southern Regions)

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 SFAIRP to eliminate safety related risks, and where it is not possible to eliminate these risks, to mitigate them SFAIRP[1].

Figure 19 provides a threat-barrier diagram for EQL control system assets. Many threats are unable to be controlled (e.g. third party damage), although EQL undertakes a number of actions to mitigate them so far as is reasonably practicable. Failure of a control system asset risks public and staff safety in several ways, most notably:

- Failure to regulate substation voltage, risking public safety and residences connected to the network
- Mal-operation of equipment, risking public and staff safety
- Loss of supply to customer premises.

EQL's safety duty results in most inspection, maintenance, refurbishment and replacement works and expenditure related to this asset class being entirely focused upon preventing and mitigating failures.

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.

[1] Queensland Electrical Safety Act 2002 s10 and s29

Due to varying influences on the asset class as a whole, due to operating in different environments, the following threat barrier diagrams have been developed. Figure 19 below illustrates the primary threats to the control system assets that can be found within substations, barriers implemented to minimise the threats and the resulting outcomes of asset failures.

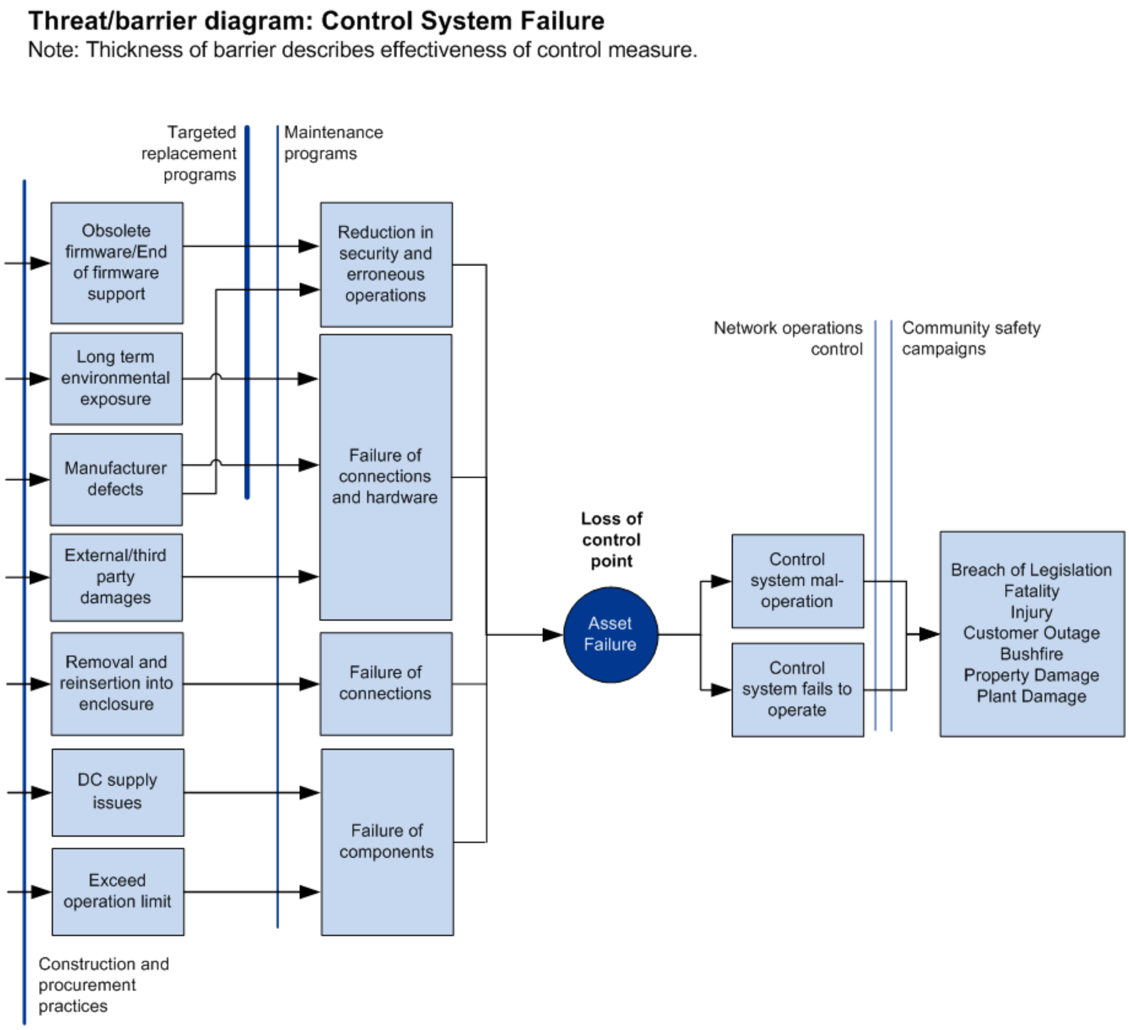


Figure 19: Substation Based Asset Failure Threat/Barrier Diagram

Figure 20 illustrates the threats to control system assets out on the lines in the distribution network, barriers in place to minimise the threats and the resulting outcomes after a failure occurs. The control board, DSS radio, radio repeater and modem assets have been grouped together under the SCADA for field based switch equipment group for the purposes of the threat/barrier diagram below.

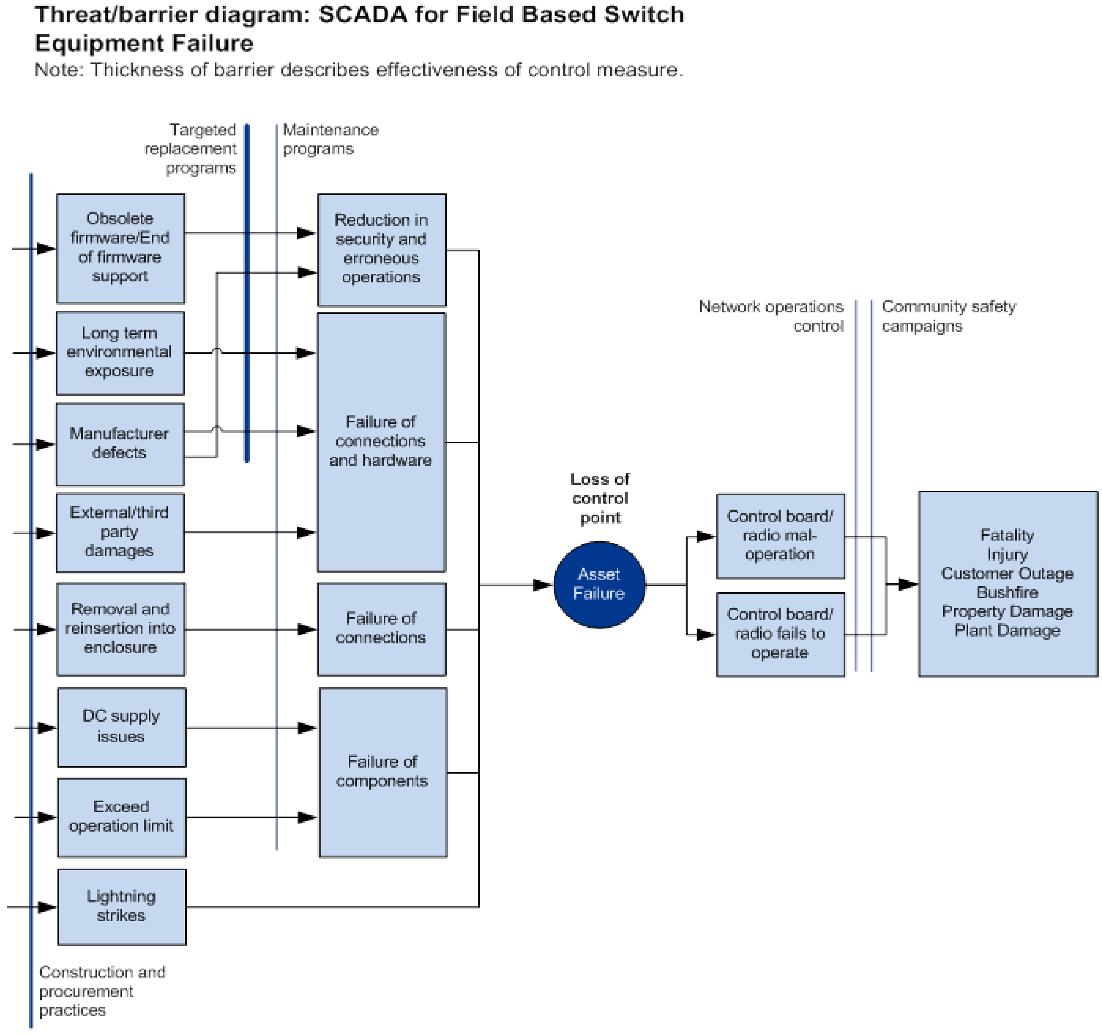


Figure 20: Distribution Asset Failure Threat/Barrier Diagram

5 Health, Safety & Environment

Health, safety, and environment (HSE) are a focus for EQL as a business and how it operates the network across all regions. Therefore, maintaining the serviceability of the control system asset class is vital for the safety of the community, staff, environment and the network. This is due to the important functions performed by the control system asset class in addressing the risks of an overvoltage event, monitoring of alarms and faults and reducing other risks.

5.1 Northern and Southern Regions

Presently the control system asset class faces the issue of meeting Restriction of Hazardous Substances (RoHS) compliance. RoHS is also known as Directive 2002/95/EC and restricts the use of specific hazardous materials found in electrical and electronic products. This is being managed by moving to new standardised equipment that complies with RoHS and carefully disposing of equipment not in compliance with RoHS. The disposal management of these assets, to minimize environmental hazards, are discussed later in this AMP.

5.2 South East Region

For the 2020-2025 period, the control board for field-based switch equipment asset type is of most concern. Older model control boards from Noja Power and formerly Tavrida are problematic and are a high risk of mal-operation leading to unsolicited closes or opens. This is a safety concern for staff and the community, so these risks will be managed and mitigated SFAIRP through asset management strategies discussed within this AMP.

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. These issues are currently being eliminated or mitigated SFAIRP.

6.1 Quality of Asset Records

Presently the quality of Ergon Energy and Energex asset records with regards to control system assets is insufficient to accurately assess the condition, performance, or population to determine asset lifecycle trends.

Some key issues regarding control system data include:

- Accuracy and availability of asset installation dates.
- Availability of asset failures, faults and defects.
- Availability of current levels of service.
- Availability of asset class type.

Currently some actions have been taken to attempt to correct and manage asset records, in particular, the introduction of Maintenance Strategy Support Systems (MSSS) in all regions, and the Network Asset Information Quality (NAIQ) program in the Northern and Southern Regions.

The implementation of MSSS code recording of investigated failures for assets began in late 2016. Due to the recent introduction of the MSSS, failure information is not yet mature enough for accurate analysis. Therefore, in the forthcoming regulatory period more recorded data will be necessary for improved future lifecycle assessments of the control system asset class.

Finally, the Network Asset Information Quality (NAIQ) program was established after recognising Ergon Energy's network data has ongoing data quality issues including missing, inaccurate, and incomplete information. This program aims to address these data quality issues by:

- Populating all network information
- Populating priority asset nameplate data
- Alignment of data between systems and databases including defined governance
- Process and reporting enabling management
- Continued maintenance of asset data.

The realisation of these initiatives throughout the forthcoming regulatory period will provide a foundation for improved future lifecycle assessment of the control system asset class and will provide EQL with better visibility of asset related condition, performance and risks. However, it is expected that these initiatives will require a significant amount of time for development, and also require a significant number of substations to be reviewed before valuable and accurate information can be analysed.

6.2 Alignment of Asset Management Standards

The control system asset class is also experiencing the consolidation process of asset management standards across all the regions. The alignment of Ergon Energy and Energex asset management approaches and standards for control systems will be vital in maintaining the safe operation of the electric network, whilst also striving to reduce associated costs.

As part of this process, it is currently proposed that the field-based switch equipment asset class be managed as separate components and incorporated into different Asset Management Plans, as per the following:

- Main processor module (MPM), under the Control Systems asset class.
- DSS Radio, radio repeater and modems, under the control systems asset class.
- Recloser Switch (Tank), under the circuit breaker and recloser asset class.
- Sectionaliser, load break switch, and load transfer switch, under the switch asset class.

The reasoning for this distinction is due to the recloser tank component having a far greater service life than the MPM, which can be replaced individually and allow for an extension of the overall asset lifespan. This will align management of reclosers and switches within Northern and Southern Regions to the current standards in the South East Region by the following period.

Action 6.2-1: Continued alignment of asset management standards for control boards across all EQL regions.

6.3 Procurement

In the South East Region, the procurement of the following control systems equipment is no longer possible due to manufacturers declaring the equipment end-of-life:

- RTU CPU Card.
- RTU Serial Card.
- IED Microprocessor.

In anticipation of procurement limitations for the above equipment, pre-emptive purchase of large quantities of these items was carried out to reduce the risk of spares issues for the forthcoming regulatory period and foreseeable future. However, if within the next regulatory period the availability of spares is low and the business is at risk of extended SCADA outages due to replacements, then a new standard contract for suitable replacement equipment will need to be created, and a proactive replacement program put in place to maintain the operational fleet. Furthermore, both Ergon Energy and Energex are currently standardising commercial off the shelf (COTS) RTUs for procurement to move away from customised solutions.

In the Northern and Southern Regions, the same strategy was used and large pre-emptive purchases of now end-of-sale RTU hardware was made to support minor network augmentation works and to be held as spares. Hardware purchased includes:

- RTU CPU/OptoNet/Power Supply/Ethernet (COPE) Cards.
- RTU Chassis.
- RTU Input/Output Cards.

7 Emerging Issues

Within the 2020-2025 regulatory period the controls system asset class will face a variety of challenges. Outlined in the following sections are emerging issues that may compromise or influence the safety objectives of EQL and will require appropriate actions taken to mitigate risks.

7.1 Inventory and Spares

Within the South East Region, there is a large population of obsolete control boards manufactured by Noja Power and previously Tavrida. These devices are no longer possible to procure and have diminishing spares availability. Furthermore, due to high failure rates, spares availability of these control boards is becoming an important emerging issue. The risk of mal-operation of obsolete Noja or Tavrida control boards, and the potential associated harm to staff and community is high, therefore additional urgency is required to address this issue.

Schneider model control boards that served as spares for Nulec model control boards were recently declared end-of-sale as of July 2018. Therefore, spares availability is also of concern primarily for the control boards manufactured by Nulec across all EQL regions.

7.2 P5 Energex RTU with Analogue Input Jitter

In the South East Region, there has been an increase in observed issues with some plant interfacing equipment, specifically statistical metering boards and P5 Energex RTU models. Due to noise on inputs to the equipment, via the wiring, alarms for voltage regulation are being generated from the RTU.

This is a risk to the safe operation of the network due to false alarms indicating overvoltage to network controllers. Furthermore, while the noise does not impact overall voltage regulation, due to the alarm generated this may prevent VVR5 from operating normally.

Currently, this issue has only been observed at six sites across the network out of a total of 40 sites with the combination of a P5 Energex RTUs and statistical metering boards for transformers. While further investigation of the issue is required, the proposed solution to address the affected sites is replacement of the statistical metering boards with current standard IED equipment through the cost efficient opportunistic bundling of works.

Action 7.2-1: Continue to monitor the impact of P5 Energex RTUs with analogue input jitter on the network.

7.3 Asset Condition

Currently, in the Northern and Southern Regions, there are a number of older RTU models that have been identified as posing a heightened risk to the business and customers. Older equipment does not support the current standards utilised within the network and some specific equipment cannot be further expanded to accommodate the increased sensing and control used when existing primary network assets are replaced.

Many ageing RTUs are experiencing increasing issues and failures, suggesting that they have moved beyond their reliable service life. For some of the equipment that has long ago moved beyond support arrangements with suppliers, Ergon's ability to repair the equipment using spares is hampered by a loss of expertise as personnel leave the business, inability to keep obsolete equipment management tools running on old computing equipment, and risk associated with corruption of saved configuration information, all of which can impact restoration times. These units need to be replaced with current standard units to manage risk associated with extended SCADA outages to ALARP.

7.4 Communications Protocols

In the Northern and Southern Regions, communication protocols and standards have recently been updated to Distributed Network Protocol Version 3 (DNP3), with all legacy standard protocols to be phased out throughout both regions by 2025. This change in standard impacts several RTU asset models that cannot cater for the latest communication standard, making them obsolete, with no manufacturer support available. These models include older model RTUs that currently utilise an obsolete communications protocol, Conitel.

Therefore, it is not feasible to keep this small number of assets in-service in the fleet due to the cost of managing multiple protocols. Furthermore, as Ergon Energy moves towards a smart grid, the limitations of these technologies will hinder progress and therefore do not align with business strategies for future network needs.

7.5 End-Of-Life Enterprise Configuration Tool

In the Northern and Southern regions, the enterprise configuration tool for substation RTUs (called the Sub Station Data Base (SSDB)) is at end-of-life, and a replacement to support the configuration and deployment of new substation RTUs is required. Currently, the South East region utilises the SCADA base system for the configuration management, diagnostics, and reporting of SCADA infrastructure. This system will not be expanded to accommodate future COTS RTUs and a replacement also required.

Therefore, as both businesses begin to align SCADA standards across all regions it is expected that a new SCADA engineering tool will be developed for both Ergon Energy and Energex. This new SCADA engineering tool will accommodate future implementation of COTS RTUs and align with a future unified DMS.

Action 7.5-1: Development of new SCADA engineering tool to align SCADA standards across all EQL regions.

7.6 Operational Security

For the entire EQL network, there is an emerging need to address the security of the operating systems of RTUs within substations. As Ergon Energy and Energex both move towards a “Smart Grid” these assets will need to be robust in their ability to face up to increasing cyber security threats.

The potential threats to these operating systems can include:

- Unauthorised operation,
- Unauthorised interference, and
- Denial of service.

At present, the Ergon Energy document SGNW0020, Operational Network Security Strategy outlines a 10-year plan for securing the Operational Communications Network (OCN). While there are resources in place to investigate the security of the OCN there is still a real need for a clearly defined security standard across EQL. In lieu of an Energex standard, the adoption of current Ergon standards will be beneficial.

Due to the lack of available manufacturer and vendor options for managing external and internal threats for these assets the EQL network has the potential to be exploited. Therefore, throughout the 2020 – 2025 regulatory period a solution for the future security of RTUs and the electric network is required for RTU assets throughout all EQL regions.

Action 7.6-1: Continue to maintain operational security of the network and control system assets.

8 Improvements and Innovation

Energex has a history of in-house development of Energex RTU technology that has provided many benefits to the organisation over time. However, the innovative history of these units also presents significant challenges in the South East region.

The primary role served by RTUs continues to evolve and shift away from traditional SCADA RTU with plant interface, towards that of a combined data concentrator, protocol converter, and automation application platform. The roles played by RTUs in substations will continue to increase in complexity as customer needs continue evolving and EQL approaches a Smart Grid. Therefore, improvement and innovation are both key drivers for the control system asset class, specifically RTUs, across all EQL regions.

With technological improvements, manufacturers of COTS RTUs are meeting the challenges with increasing sophistication and power. Both Energex and Ergon Energy are therefore investigating COTS RTUs and their ability to meet current and future needs for substation SCADA and automation in an economically sustainably manner.

Based on the available solutions and business requirements, all EQL regions may adopt COTS RTUs as the new and improved standard equipment for procurement and future network augmentation.

Action 8-1: Continue to investigate feasibility of available COTS RTU solutions to meet business requirements.

9 Lifecycle strategies

EQL considers a variety of asset lifecycle management strategies to maintain the operations of the control system asset class and mitigate risks to the community, staff, environment, and the network. 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.

9.1 Philosophy of approach

Due to the key functions performed by the control system asset class, the serviceability of these assets is integral in maintaining the safe operation of the electric network across the state.

Both Energex and Ergon Energy actively manage the control system asset class using the following strategic approaches:

- Inspection of assets to monitor the condition, primarily for assets in the distribution network outside of substations;
- Monitoring the performance of equipment through maintaining records of asset defects, faults, and failures;
- Preventative maintenance to maximise the service life of assets, including refurbishment of board level components on IEDs;
- Reactive maintenance to address defects and faults, and return assets to service;
- Reactive replacements of failed equipment, to maintain operational control and SCADA systems, where suitable replacements and spares are available with tolerable downtime;
- Proactive replacement, determined by risk evaluation analysis based on risk factors that influence the asset; and
- Opportunistic bundling of works at substations to maximise cost efficiencies of network augmentation or replacement work.

9.2 Supporting Data Requirements

As mentioned in Section 6.1, both Ergon Energy and Energex are currently embarking on various data quality initiatives that when realised will improve lifecycle management strategies and continue to support current strategies.

Furthermore, improvements to job completion processes within Ellipse would also see improvements in identifying lifecycle trends and lead to better engineering outcomes for the business. More details captured in job completion comments from field crews, when investigating and determining asset failures would be highly beneficial.

9.3 Acquisition and procurement

Currently, within the Northern and Southern regions, control system assets are procured through direct purchases from vendors through the main warehouses in the regions. The assets are procured on an as needed basis for programs of work and no periodical contracts are currently in place for standard equipment.

Although there are no current periodical contracts, there are reviews of standard equipment and new standards released periodically. These new standards are driven by vendor support and manufacturers declaring equipment end-of-sale or end-of-life.

In the South East region throughout the next regulatory period, control system assets will be obtained through currently open contracts with suppliers as defined within technical instructions outlining standard SCADA and Automation equipment. Further information can be found in Energex Technical Instruction Document TSD0123B.

However, based upon future network requirement and the feasibility of COTS options for RTUs there may be a change in how standard control system equipment is procured across the regions.

9.4 Operation and Maintenance

Currently, the control system asset class is not subject to any operational processes. Once commissioned the assets are left to operate without any manual intervention until a failure occurs and manual intervention through maintenance is required.

9.4.1 Preventive maintenance

Within the Northern and Southern regions, there are some preventive maintenance programs for the control system asset class outlined in STNW0717, Standard for Preventative Maintenance Programs for 2017-18. However, as both Ergon Energy and Energex continue with the alignment of standards, there is a future need for joint standards for preventative maintenance programs.

STNW0717 outlines the desirable preventative maintenance, including inspection of field-based switch equipment that is also applicable to the SCADA for FBSE assets:

Section 6.11 Oil Filled Automatic Circuit Reclosers and Sectionaliser

This section of the standard only applies to remaining equipment in substations.

- (ISCA) In-Service Condition Assessment every 18 months.

Section 6.11 SF6/Vacuum Automatic Circuit Reclosers and Sectionaliser

This section of the standard outlines the routine maintenance for gas and vacuum reclosers in substation as follows:

- (ISCA) In-Service Condition Assessment every 18 months.
- (SS) Specialist Survey – Battery Replacement every 3 years.
- (OSM) Condition Based Maintenance.

Section 8.3 Control and Equipment Room - Maintenance Program

This section of the standard outlines the routine maintenance in the Control Rooms and associated Equipment Rooms. This includes the following:

- Inspection every 6 months.
- The cleaning and vacuuming of all control room work stations, air intakes and cabinet enclosures.
- The cleaning and vacuuming of all equipment room cabinet enclosures, and air intakes.

Section 8.4 PCU Equipment Room – Maintenance Program

This section of the standard outlines the routine maintenance in the PCU equipment rooms and is to be carried out as follows:

- Inspection every 6 months.
- Clean and vacuum all work stations, air intakes and cabinet enclosures.

In the South East region, preventative measures are taken through maintenance to address potential risks to the service life and legislative requirements of assets. For the RTU asset class, regular upgrades of RTU software are carried out wherever possible and in accordance with the opportunistic bundling of work.

Standards for preventative maintenance, routine maintenance, requirements, and acceptance criteria are outlined in STD00945, Maintenance Standard for Control Systems. This includes the routine inspection and maintenance as follows:

1. Physical condition is periodically assessed.
2. Condition of control system shall be monitored automatically where reasonably practicable.

Finally, in the South East region, radio repeater assets would also benefit from preventative maintenance programs to replace weather seals on the units to prevent moisture ingress and prolong the life of the devices.

Action 9.4-1: Recommended preventative maintenance to be carried out for Radio Repeaters assets, including regular interval replacement of weather seals to prolong asset life.

9.4.2 Corrective maintenance

Presently EQL reacts to corrective and forced maintenance issues, as they arise and are identified. These issues are usually addressed by an immediate replacement sourced from spares holdings, or through other corrective maintenance.

Typically issues for the control system asset class are resolved through “like-for-like” replacements of hardware. In cases where this is not possible due to inability to source the equipment or high risks with utilising the same type of equipment, then an equivalent model is sourced through current procurement practices in the respective regions. Other forms of corrective maintenance may include:

- Repair of hardware,
- Repair of input/output connections, and
- Re-installation of firmware.

In the Northern and Southern regions, corrective and forced maintenance is based on STNW1160, Standard for Maintenance Acceptance Criteria. This standard is used to evaluate the degree of deterioration in condition and performance of network plant and equipment, as well as setting safety criteria to determine if the equipment is fit to remain in service.

Action 9.4-2: Recommended capture of corrective maintenance works through MSSS across all EQL regions.

9.4.3 Spares

In the Northern and Southern regions, strategic spares are kept within specific stores. Pre-emptive purchases of now end-of-life RTU model equipment have been made. These units will be kept to meet replacement needs and minor augmentation works where acceptable. Spares of control boards are also available in stores in the Northern and Southern regions, however, these are of an unknown quantity. As per previous lifecycle strategies in the region, spares of entire field-based switches are also available to be utilised if the need arises.

In the South East region, strategic spares are also kept in warehouses in the region and pre-emptive purchases have also been made of some RTU hardware components, such as CPU cards and serial cards. For IED assets, purchases of microprocessors were made to hold as spares. Presently, Energex is procuring a number of final Schneider control board units to replace Nulec control board units to generate spares for the Nulec fleet, whilst also retaining a limited number as spares for the Schneider fleet.

As control system equipment is taken out of service and proactively replaced, the accepted practice in all EQL regions is to store these units as strategic spares for the remaining equipment in the fleet. This is done to minimise the impact of an in-service failure to the network, such as with control boards for FBSE.

Action 9.4-3: Update and maintain accurate spares holding records throughout all EQL regions for all control system assets.

9.5 Refurbishment and replacement

Refurbishment and replacement activities vary throughout the regions and are dependent on a variety of factors. Current refurbishment and replacement strategies used by both Energex and Ergon Energy are not expected to change in the forthcoming period unless driven by risk factors for the assets.

9.5.1 Refurbishment

In the South East Region, refurbishment activities are carried out on IED assets when suitable, to extend the service life of the asset. This can include refurbishment of board level components on microprocessors.

Within the Northern and Southern Regions, no current refurbishment activities or programs are in place as IEDs have not been widely rolled out across the network. However, it is expected that similar refurbishment practices will be adopted as in the South East Region, in the future.

9.5.2 Replacement

Two primary replacement strategies are used throughout the EQL regions for control system assets: proactive replacement and reactive replacement.

9.5.3 Proactive Replacement

Proactive replacement of equipment in all EQL regions is determined by risk evaluation analysis based on risk factors for individual assets. These risk factors are based around life limiting factors, asset performance, manufacturer support, business strategies, standards and future network needs. This can include asset age, technological age limitations, obsolescence in the marketplace, failure rate (problematic units), spares availability, and internal business knowledge of the assets.

Therefore, equipment will be replaced when the risk of in-service failure of equipment poses too much of a risk to the safe operation of the network and to the business. Hence, proactive replacements will be carried out across all EQL regions due to the risks of in-service failure of RTUs and control boards, as outlined in Section 0.

Action 9.5-1: Proactive replacement program of RTUs in the Northern and Southern Regions and South East Region, through risk evaluation analysis based on risk factors.

Action 9.5-2: Proactive replacement program of HMIs in the Northern and Southern Regions and South East Region, based on the tight integration of RTU and HMI assets and maximising cost effectiveness.

Action 9.5-3: Proactive replacement program of control boards in the South East Region, through risk evaluation analysis based on risk factors.

9.5.4 Reactive Replacement

Across all regions, EQL carries out reactive replacements as the need arises and in-service failures are identified. This strategy allows for the assets to reach their maximum life and is accepted where SCADA outages and consequences of failed in-service equipment are tolerable.

9.6 Disposal

EQL considers the safety of the community, staff, and the environment when disposing of decommissioned assets. In all EQL regions, due to the components used to build control system assets, there are few environmental hazards associated with the disposal of decommissioned assets. However, in the Northern and Southern Regions, some older RTU units fail to meet RoHS compliance. This is the primary concern for control system assets.

RoHS restricts the use of specific hazardous materials found in electronic products such as lead, materials containing polychlorinated biphenyls (PCBs) and mercury. The risks of assets not complying with RoHS include environmental hazards, pollution of landfills, and danger in the case of occupational exposure during recycling.

Ergon Energy complies with the Environmental Protection Regulation 2008 legislation in the safe disposal of these substances that have been identified as regulated or trackable waste. The defined processes for safe disposal of these substances are outlined within Ergon Energy work instruction ES000904W101, Management of Disposal of Regulated Waste. The identified appropriate actions to be taken by Ergon Energy for the safe disposal of trackable and regulated waste are illustrated below in Figure 21.

WORK FLOW DIAGRAM

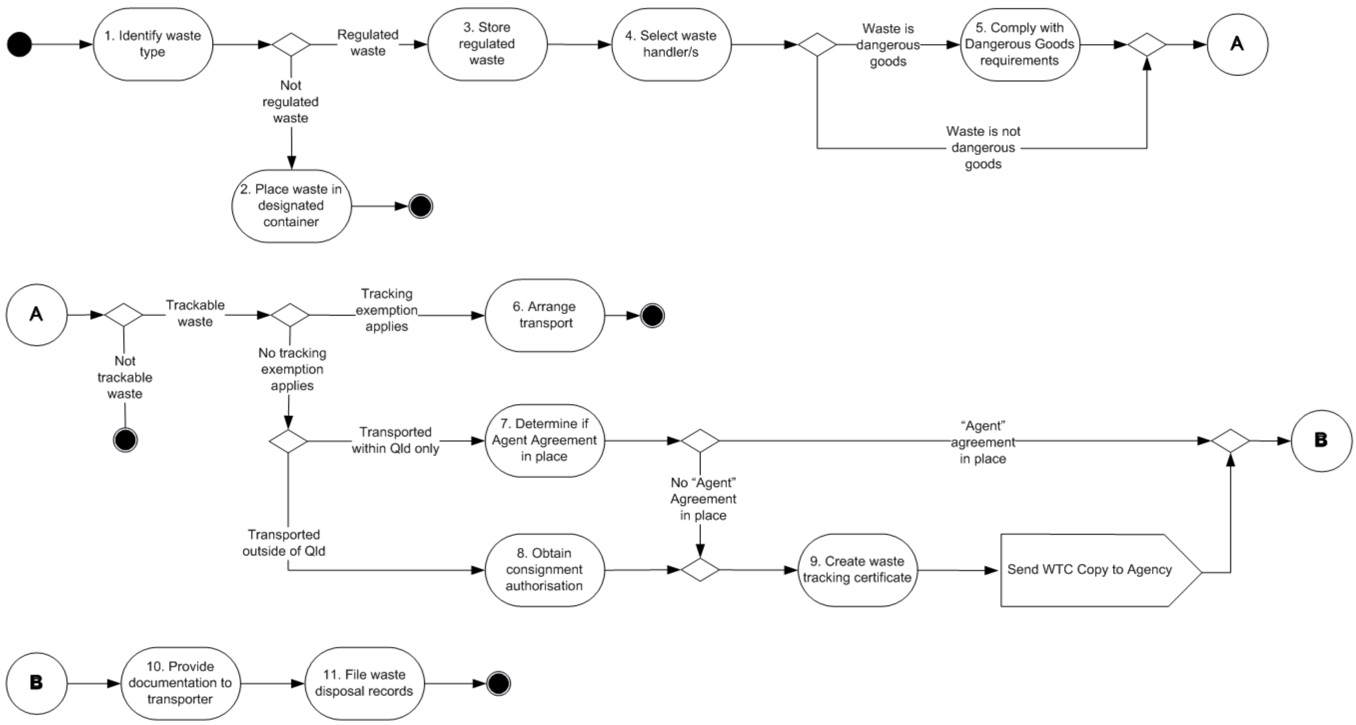


Figure 21: Work Flow of Disposal of Regulated/Trackable Waste

For the control system asset class, there is also the concern of secure disposal of assets that collect sensitive data, such as RTUs and HMIs in all EQL regions. With the increase in potential risks to the network from cybersecurity threats there is a need for secure disposal of the assets to ensure that no sensitive information is disclosed to unauthorised parties after an asset is removed from service.

Action 9.6-1: Provide secure disposal of assets that may contain sensitive information, such as RTUs and HMIs, across all EQL regions and in compliance with disposal legislation.

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 monthly 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 9.6-1: Continued alignment of asset management standards for control boards across all EQL regions.

Action 9.6-2: Continue to monitor the impact of P5 Energex RTUs with analogue input jitter on the network.

Action 9.6-3: Development of new SCADA engineering tool to align SCADA standards across all EQL regions.

Action 9.6-4: Continue to maintain operational security of the network and control system assets.

Action 11-5: Continue to investigate feasibility of available COTS RTU solutions to meet business requirements.

Action 9.6-6: Recommended preventative maintenance to be carried out for radio repeaters assets, including regular interval replacement of weather seals to prolong asset life.

Action 9.6-7: Recommended capture of corrective maintenance works through MSSS across all EQL regions.

Action 9.6-8: Update and maintain accurate spares holding records throughout all EQL regions for all control system assets.

Action 9.6-9: Proactive replacement program of RTUs in the Northern and Southern Regions and South East Region, through risk evaluation analysis based on risk factors.

Action 9.6-10: Proactive replacement program of HMIs in the Northern and Southern Regions and South East Region, based on the tight integration of RTU and HMI assets and maximising cost effectiveness.

Action 9.6-11: Proactive replacement program of control boards in the South East Region, through risk evaluation analysis based on risk factors.

Action 9.6-12: Provide secure disposal of assets that may contain sensitive information, such as RTUs and HMIs, across all EQL regions and in compliance with disposal legislation.

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	NI000401R121	Substation Design Manual	Standard
Energex & Ergon Energy	STNW1160	Standard for Maintenance Acceptance Criteria	Standard
Ergon Energy	STNW0717	Standard for Preventative Maintenance Programs for 2017-18	Standard
Energex & Ergon Energy	STMP001	Standard for Network Performance	Standard
Ergon Energy	SGNW0016	10 Year 2015-2025 Master Station SCADA Strategy	Strategy
Ergon Energy	SGNW0020	Operational Network Security Strategy	Strategy
Ergon Energy	MP001206R101	Collection and Disposal of Scrap Metals Guideline	Reference
Ergon Energy	ES000904W101	Implement Control – Management of Disposal of Regulated Waste	Work Instruction
Ergon Energy	SGNW0006	Switch Equipment Application Strategy	Strategy
Ergon Energy	SGNW0025	ACR Remote Communication Strategy	Strategy
Energex	TSD0123B	Standard SCADA and Automation Equipment	Technical Instruction
Energex	STD00945	Maintenance Standard for Control Systems	Standard

Appendix 2. Definitions

Term	Definition
Condition Based Risk Management	A formal methodology used to define current condition of assets in terms of health indices and to model future condition of assets, network performance, and risk based on different maintenance, asset refurbishment, or asset replacement strategies.
Conitel	Conitel is a half-duplex (master/slave) bit-stream protocol developed by Leeds & Northrup. It is in wide use internationally, providing communication with RTU devices.
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 Program of Work against the appropriate category and resource type.
Distribution	LV and up to 22kV (and some 33kV) networks, all SWER networks
DNP3	Distributed Network Protocol, version 3 (DNP3) is an open SCADA communications protocol supported by the DNP User Group. Used for IED-Energex RTU and DSS communications.
Ellipse	Ellipse is the ERP (Enterprise Resource Planning) software system that manages critical business information. E.g. Finance, Works Management, Purchasing and Process Billing.
Firmware	Permanent software programmed into a read-only memor.y
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 Program of Work against the appropriate category and resource type.
PCB	Polychlorinated Biphenyls are synthetic chemicals manufactured from 1929 to 1977 and was banned for use in 1979 in transformers, voltage regulators and switches.
Preventative 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
SCADA	SCADA is an acronym for "supervisory control and data acquisition" and is a system operating with coded signals over communication channels so as to provide control and status information of remote equipment.

Appendix 3. Acronyms and Abbreviations

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

Abbreviation or acronym	Definition
ac	Alternating current
ACR	Automatic Circuit Recloser
AIDM	Asset Inspection & Defect Management system
ALARP	As Low As Reasonably Practicable
AMP	Asset Management Plan
Augex	Augmentation Expenditure
CBRM	Condition Based Risk Management
CB	Circuit Breaker
COPE	CPU/OptoNet/Power Supply/Ethernet
COTS	Commercial Off The Shelf
CPU	Central Processing Unit
CT	Current Transformer
CVT	Capacitor Voltage Transformer
dc	Direct Current
DEE	Dangerous Electrical Event
DGA	Dissolved Gas Analysis
DLA	Dielectric Loss Angle
DSS	Distributed System SCADA
EQL	Energy Queensland Limited
ESCOP	Electricity Safety Code of Practice
ESR	Queensland Electrical Safety Regulation (2013)
FBSE	Field Based Switch Equipment
GSL	Guaranteed Service Level
HMI	Human Machine Interface
HV	High Voltage
IED	Intelligent Electronic Device
I/O	Input / Output
IoT	Internet of Things
ISCA	In-Service Condition Assessment
LCF	Local Control Facility
LDCM	Lines Defect Classification Manual
LV	Low Voltage
LVR	Low voltage regulator
MDC	Master Data Concentrator
MPM	Main Processing Module
MSS	Minimum Service Standard
MSSS	Maintenance Strategy Support System

Abbreviation or acronym	Definition
MU	Metering Unit
MVAr	Mega-VAr, unit of reactive power
NAIQ	Network Asset Information Quality
NER	National Electricity Rules
NEX	Neutral Earthing Reactor
OCN	Operational Communications Network
OLTC	On-load tap -changers
OTI	Oil Temperature Indicators
PCB	Polychlorinated Biphenyls
PD	Partial Discharge
POC	Point of Connection (between EQL assets and customer assets)
POEL	Privately owned Electric Line
PRD	Pressure Relief Device
QEIC	Queensland Electricity Industry Code
QLD	Queensland
RDC	Remote Data Concentrator
REPEX	Renewal Expenditure
RIN	Regulatory Information Notice
RMU	Ring Main Unit
RoHS	Restriction of Hazardous Substances
RTU	Remote Terminal Unit
SCADA	Supervisory Control And Data Acquisition
SCAMS	Substation Contingency Asset Management System
SCI	Statement of Corporate Intent
SDCM	Substation Defect Classification Manual
SFAIRP	So Far As Is Reasonably Practicable
SHI	Security and Hazard Inspection
SVC	Static VAR Compensator
THD	Total Harmonic Distortion
VT	Voltage Transformer
VVR	Voltage Variance Regulation
WCP	Water Content of Paper
WTI	Winding Temperature Indicators
WTP	Wet Transformer Profile

Appendix 4. Energy Queensland regions

<table>
<tr><th></th><th colspan="2">Energy Queensland (EQL)</th><th colspan="2">Ergon Energy (Legacy)</th><th colspan="2">Energex (Legacy)</th></tr>
<tr><th></th><th colspan="2">Acronym & Description</th><th colspan="2">Acronym & Description</th><th colspan="2">Acronym & Description</th></tr>
<tr><td rowspan="7">Regions</td><td rowspan="3">North</td><td rowspan="3">North Queensland</td><td>FN</td><td>Far North
Including the district of Far North incorporating - Thursday Is, Bamaga, Cooktown, Mossman, Mareeba, Atherton, Ravenshoe, Normanton, Georgetown</td><td colspan="2" rowspan="6"></td></tr>
<tr><td>NQ</td><td>North Queensland
Including districts of Tropical Coast and Herbert</td></tr>
<tr><td>MK</td><td>Mackay
Including districts of Flinders and Pioneer</td></tr>
<tr><td rowspan="3">South</td><td rowspan="3">Southern Queensland</td><td>CA</td><td>Capricornia
Including districts of Capricornia and Central West</td></tr>
<tr><td>SW</td><td>South West
Including districts of South West and Darling Downs</td></tr>
<tr><td>WB</td><td>Wide Bay
Including districts of Bundaberg Burnett, Fraser Burnett</td></tr>
<tr><td>South East</td><td>South East Queensland</td><td colspan="2"></td><td>SE</td><td>South East Queensland
Including districts of Sunshine Coast, Brisbane, Ipswich Lockyer, Gold Coast</td></tr>
</table>