Distribution Pillar Replacement

Regulatory Business Case (RBC) 2024-29

PowerWater

Contents

1 Summary

This business case has been prepared to support the 2024-29 Regulatory Proposal. The business case demonstrates that Power and Water has undertaken appropriate analysis of the need for the expenditure and identified credible options that will resolve the need and ensure that Power and Water continues to meet the National Electricity Objectives and maintain the quality, reliability, and security of supply of standard control services and maintain the safety of the distribution system.

The proposed investment identified in this business case will undergo further assessment and scrutiny through Power and Water's normal governance processes prior to implementation and delivery.

This business case addresses the condition issues and risks of distribution pillars.

1.1 Business need

A low voltage distribution pillar ("pillar") is used for distribution of power to the customers such as residences and businesses through the underground distribution network. Low voltage pillars mark the interface between Power and Water's distribution network and the service connection to a customer. A typical pillar can be used to supply between 4 to 8 residential customers depending on the demand load. Therefore, they are located in high pedestrian traffic areas and in close proximity or immediately adjacent to homes and businesses.

Pillars are essential for distributing electricity to customers. Failed or damaged pillars create a health and safety risk for the public and operational crews, and disruption to supplies to affected customers.

The current fleet of Green and Cream pillars is exhibiting end of life issues, predominately caused by the deterioration of the covers, outer enclosures and damage to the base / foundations due to the operating environment. This includes prolonged exposure to heat and UV light, infestation of pests and dirt, subsidence of ground, humid environment created by water sprinklers in garden beds and impact from vehicles. This can lead to a high probability of live internal components/ busbars becoming exposed or easily accessible by the public and result in an elevated risk to public safety.

The risk to public safety is highlighted by the three recent network incidents that have occurred in the past two years. In two instances a cover was removed leaving exposed LV components, while the third incident resulted in a member of the public receiving an electric shock from a pillar.

Our analysis of the inspection data has been used to define the scope of the need and quantify the network risk. Internal Service Request (ISR) and defects work orders have been analysed to identify the current state of the network, the rate of defects being identified and to determine the current network risk. The analysis demonstrates that:

- The age profile shows that approximately 30% (approximately 2,500 pillars) of the asset fleet is expected to be older than the expected serviceable life by the end of the next regulatory period.
- The level of defects requiring repair or replacement are increasing and are expected to further increase as the condition of the asset fleet continues to deteriorate.
- 29% of defective pillars require replacement while 71% could be addressed through maintenance.
- 23% of defective Green or Cream pillars, and 25% across all pillar types being designated as requiring immediate action, as critical to public safety.

1.2 Options analysis

The options considered to resolve this need are shown in Table 1.

Table 1 Summary of credible options

Option No.	Option name	Description	Recommended
1	Replace at failure (counterfactual)	This option will only undertake reactive replacement of pillars upon failure.	No
2	Maintain historical practice	Maintain historical approach to managing assets, expect 20 replacements and 110 repairs p.a.	No
3	Targeted replacement and repair program	Replacement or repair of assets when identified to be defective according to new asset management approach. Expect 56 replacements and 200 repairs p.a.	Yes
4	Targeted replacement (only) program	Replacement of assets when identified to be defective according to new asset management approach. Expect 256 replacements p.a.	No

As part of a holistic assessment, non-network solutions, capex/opex trade-offs and retirement or derating options were also considered, but found that none of these options addressed the underlying network issues.

Power and Water calculated the likely volume of assets requiring replacement based on review of 6 years of Internal Service Requests (ISRs) that are used to identify defects and initiate remedial action, and four years of work orders that are raised when the actions are undertaken. The analysis demonstrates that there are a significant number of pillars that are expected to be at or approaching their end of life with an impact on the network safety profile.

A cost benefit analysis was completed for each of the options where the risk reduction, compared to Option 1, was used as the benefit achieved by the option.

1.3 Recommendation

The recommended option is Option 3 – Target replacement and repair at an estimated cost of $4.2 million (real 2021/22) comprising $2.9 million capex. This option had the highest NPV, addressed the need and was deliverable. It is therefore the recommended option to resolve the identified network issue prudently and efficiently.

Table 2 shows a summary of the expenditure requirements for the 2024-29 regulatory period.

Table 2 Annual capital and operational expenditure ($'000, real FY22)

	FY25	FY26	FY27	FY28	FY29	Total
Capex	586	586	586	586	586	2,931
Opex	260	260	260	260	260	1,300
Total	**846**	**846**	**846**	**846**	**846**	**4,231**

Note: the opex is already part of business as usual activities and does not represent a step change.

This option will treat a total of 1,280 pillars, comprised of 280 replacements and 1000 repairs over the 2024-29 regulatory period.

2 Identified need

This section provides the background and context to this business case, identifies the issues that are posing increasing risks to Power and Water and its customers, describes the current mitigation program and its delivery status, highlights the consequence of asset failure, and provides a risk assessment of the inherent risk if no investment is undertaken.

2.1 Asset profile

A low voltage pillar is used for distribution of power to the customers such as residences and businesses through the underground distribution network. Low voltage pillars mark the interface between Power and Water's distribution network and the service connection to a customer. A typical pillar can be used to supply between 4 to 8 residential customers depending on the demand load. Therefore, they are located in closed proximity or immediately adjacent to, our customers' premises.

Pillars are essential for distributing electricity to customers. Failed or damaged pillars create a reliability as well as a health and safety risk for the public and operational crews.

The asset fleet comprise of different types of pillars namely 'Green Turret' ("Green"), 'Cream Turret' ("Cream") and 'Holec' Pillars as shown in Figure 1. Table 3 shows the total number of pillars in the network by type with photos provided below in Figure 1. A more detailed breakdown is provided in Appendix C.

Table 3 Type and volume of pillar (as at 2022)

Type	Name	Description	Connection type	Volume
Service Pillar / Link Pillar	Green Turret Pillar	Predominately used in urban areas. Used from 1970-2010 and have a green PVC/Fibre glass cover.	Direct connect to busbar	5,118
Fused Pillar	Cream Turret Pillar	Cream domed pillars installed until 2000. Cables connected to the bus using fuse switchgear.	Striple fuse switchgear	350
Fused Pillar	Holec Pillar	The modern standard type used by Power and Water since 2000. Cabinet style opening at the front with cables connected to the bus with fused switchgear.	Striple fuse switchgear	2,770
Total				**8,238**

Green Turret Pillar

Cream Turret Pillar

Holec Pillar

Figure 1 Pillar types

The age profile, as extracted from our asset information system Maximo, is shown in Figure 2.

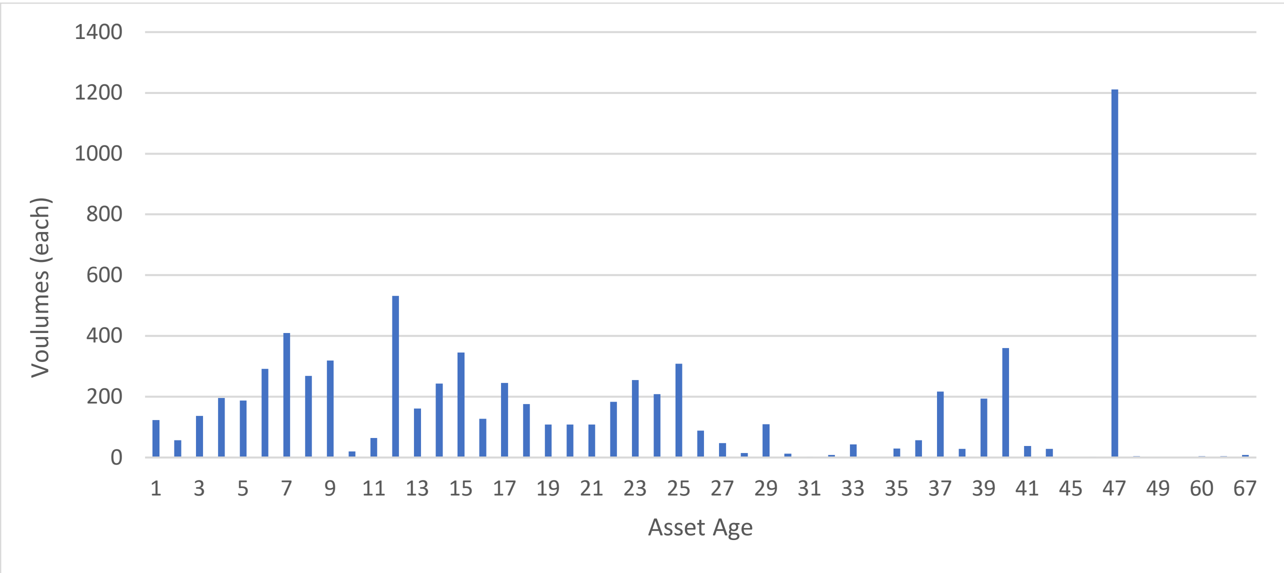

Figure 2 Age Profile (as at 2022)

Pillars have an average expected serviceable life of 35 years, but this can vary depending on the type of material used, operating environment, and external factors.

The network was reconfigured post Cyclone Tracy to supply consumers through an underground network instead of the overhead network. As a result, a significant volume of pillars that were installed in 1975 and the follow years are now approaching 50 years old. It is estimated that approximately 30% of the asset fleet for pillars (or approximately 2,500 pillars) are expected to be older than the expected serviceable life by the end of the next regulatory period.

This business case is focused on the Green and Cream pillar that have been found to be in deteriorated condition and are increasingly posing safety risks. The Holec pillars are typically repaired or replaced due to impact by third parties, and which are not related to age/deterioration.

2.2 Recent network incidents

There have been several incidents on the network during the past couple of years that have highlighted the potential safety risk posed by pillars. Accelerated weathering and deterioration of the pillar material has led to instances where the pillar lid assembly can be easily removed, resulting in exposing live parts to the public and to weather conditions. This has the potential for electric shock, injury or fatality or catastrophic explosion (due to flash-over of live components).

Some of these incidents include:

- In May 2022, a member of public removed the lid of a pillar in the CBD and placed it nearby. This resulted in live cables and busbars inside the pillar to be exposed that resulted in an unsafe condition and risk of electric shock. An incident investigation (INC-213) revealed that the lid had deteriorated due to weathering, exposure to heat and ultra-violet rays and the locking mechanism had failed under pressure. This contributed to the easy removal of the lid.
- In April 2022, a member of the public received an electric shock from a pillar by accessing live parts. An ICAM investigation (INC-154) was conducted, which found that the pillar was in an advanced stage of deterioration and did not provide adequate protection against the lid being removed. The pillar was located in proximity of a public bus stop and was found to be frequently used as a default seat by members of the public while waiting for public transport.
- In December 2020, a member of public removed the lid of a pillar and placed it nearby. This resulted in live cables and busbars inside the pillar to be exposed that resulted in an unsafe condition and risk of electric shock. The cause of the cover being removed is unknown. The incident was recorded in the safety management system (Ref. # I19911) and a safety alert issued to Power and Water staff with recommended actions.

As a result of these incidents, Power and Water has undertaken a review of the condition of the fleet of pillars that are in high risk locations with high levels of interaction with the public, such as at bus stops and schools.

2.3 Historical and current management programs

Power and Water has previously undertaken replacement programs to target specific type issues on for ‘grey’ and ‘pregnant’ pillars, particularly in Nightcliff and Palmerston areas. The targeted programs were completed in July 2019 and since then pillar replacements have only been completed under the volumetric replacement program (program code NMFCR). The NMFCR program targets assets that are found to be at end of life based on condition assessment.

The large volume of assets installed in 1975 is expected to have an influence on the health of the fleet and investment needs in the short to mid term.

As shown in Figure 3, the expenditure on pillars has continually decreased each year as the targeted programs were completed and the focus shifted to condition based replacement. The expenditure each year on condition based replacement has been fairly consistent at around $350,000 per year. However, this has increased at the start of FY23 (not shown on this chart) as a result of two causes:

- The recent network incidents which have highlighted the safety risk, in particular the one that occurred in April in which a member of the public received an electric shock from a pillar, and
- A change in approach to management of the asset that was established towards the end of FY22. The change in asset management was to replace pillars found with a damaged base if the pillar was more than 18 years old. This was due to the cost of civil works required to repair are extensive and the threshold was based on economic analysis.

In light of the recent incidents, the historical condition based approach to replacement is not considered prudent and further risk mitigation is required.

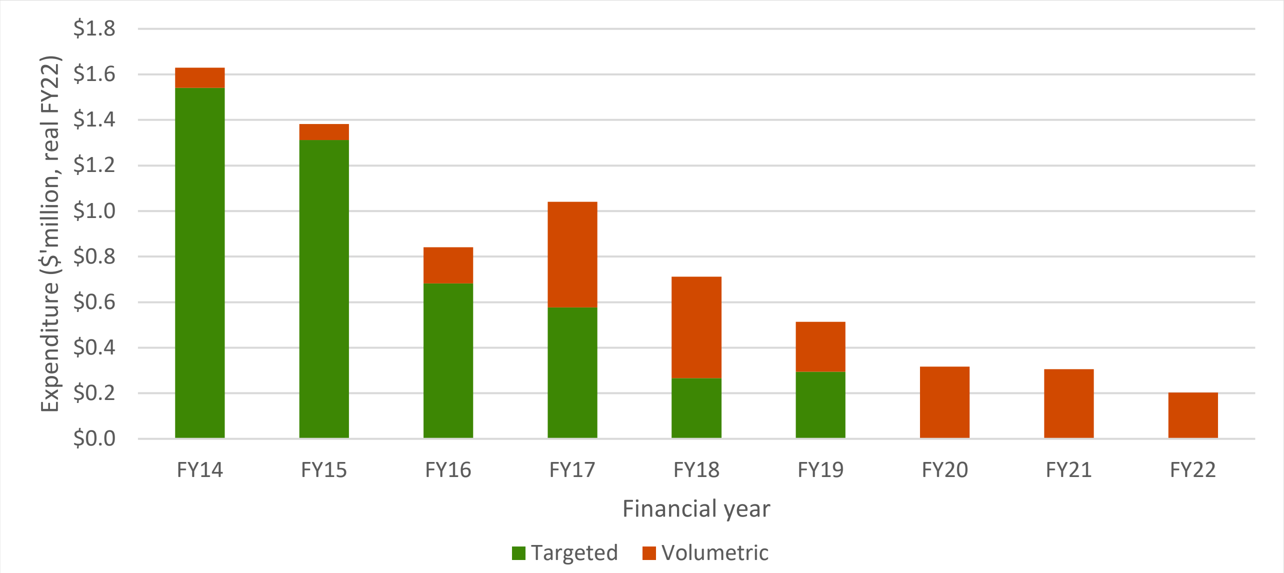

Figure 3 Historical expenditure on Pillars

The Green and Cream pillars that are the focus of this business case total approximately 5,468 assets (being 66% of all installed pillars). With an expected serviceable life of 35 years, an average of 220 assets are expected to reach end of life each year. This would result in an average annual expenditure of approximately $2.2m if all the end of life assets were replaced. However, since the age profile is not constant the annual volumes requiring replacement will vary from year to year. In addition, a high proportion of defects are repaired (opex) rather than replaced (capex), reducing the expenditure to significantly below the expected level.

2.4 Asset condition assessment and emerging issues

The failure of a pillar will generally only cause an outage for the small number of customers, so they have a low criticality from a reliability perspective. However, damage to the pillar can expose cable terminations and other low voltage parts located inside the pillar. The exposure of low voltage parts in locations that are easily accessible by the public make pillars critical for managing and ensuring network safety.

Recent investigations related to asset health of pillars have identified a range of functional and operational issues such as access to isolation points for maintenance and failure modes including damage to the base and nuts that is beyond repair preventing fasteners from securing the cover, termite infestation, and damage to cover due to UV radiation, and external impacts. All these issues may result in safety hazards.

Internal Service Requests (ISRs) are used by field crews to record asset defects when they are found during inspections and to request/initiate appropriate remedial actions. Defects are scored based on severity and must be actioned within a defined timeframe, ranging from within 12 hours for a P1 to the next maintenance interval for a P4 which corresponds with 10 years for pillars. Refer to Appendix D for further detail.

During the period FY16 to FY21 (inclusive) there were 4,969 inspections of pillars that included an estimated 3,281 inspections relating to Green and Cream pillars based on the population and a 10 year inspection cycle. During this time 1,330 ISRs were raised with 993 (75%) attributed to green and cream pillars.

An analysis of the ISRs raised against Green and Cream pillars, grouped by defect type, and the typical remedial actions is described in Table 4.

Table 4 Summary of typical remediation actions

Defect type	Typical action	Safety critical	Volumes
Access issues	Maintain / Repair	No	281
Cable/termination issues	Maintain / Repair	No	173
Cover Broken / damaged / missing / Impact damaged	Replace	Yes	121
Base Broken / damaged	Replace (if older than 18 yrs)	Yes	110
Pest/insect issue	Maintain / Repair	No	108
Ground level changes / erosion	Maintain / Repair	No	85
Age / heat deterioration	Replace	No	43
Pillar number / label / tag issue	Maintain / Repair	No	32
Other	Maintain / Repair	No	23
Switchgear/backboard issue	Replace	No	17
Total			**993**

The types of defects were also categorised into failure modes that pose an immediate safety hazard to the public, referred to as ‘safety critical’. The analysis identified that, on average:

- 29% of defects were identified as replacement being the only action, whereas 71% could be addressed through maintenance (including repair).
- 23% of defects were considered safety critical and required immediate action, all of which require replacement.

To provide a more meaningful analysis of the trend in defects, the data was limited to the Green and Cream pillars in our analysis to show the change in the defective pillars that require replacement as a percentage of all Green and Cream pillars that were found to be defective.

Figure 4 shows that the percentage of Green and Cream pillars that had defects that required replacement has been relatively constant. When including the more recent FY22 year, the trend is slightly increasing.

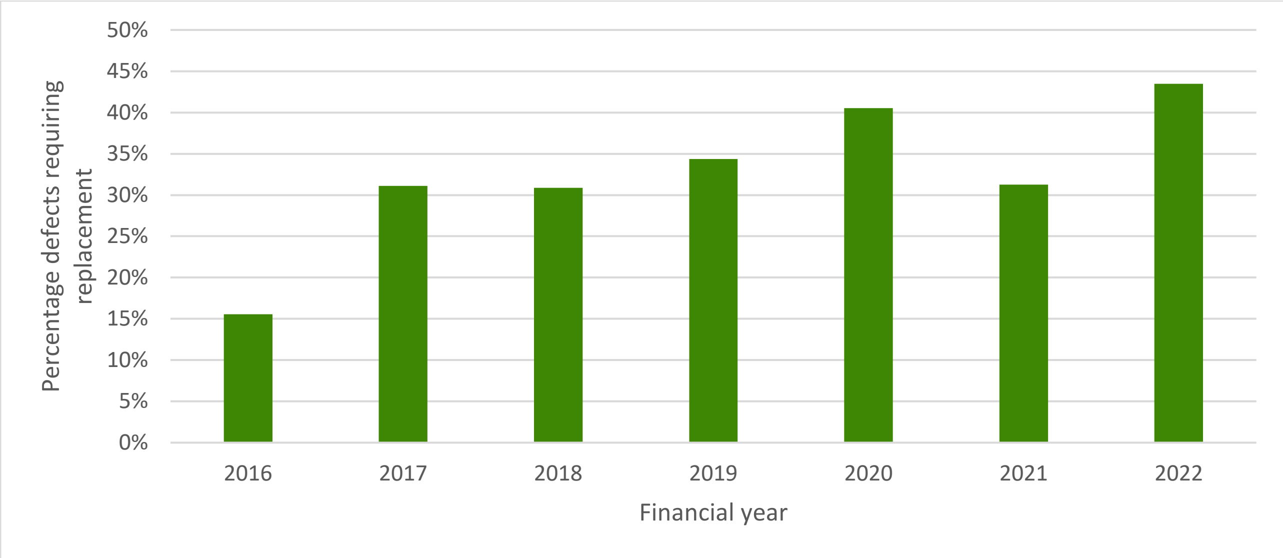

Figure 4 Percentage of defects requiring replacement (Green & Cream Pillars Only)

Analysis was also undertaken on the Repairs & Maintenance (R&M) work orders completed, which is related to the completion of ISRs as R&M work orders.

Figure 5 shows the trend of pillar defects requiring repair and the number of pillar defects requiring replacement of the pillar since FY18 for all pillar types. The FY23 data is based on the first four months of the financial year only, and is already higher than all years other than FY22. When including the FY22 data, the trend in both repair and replacement is increasing. This further supports the need for increased focus on identifying risk treatment options for this asset class.

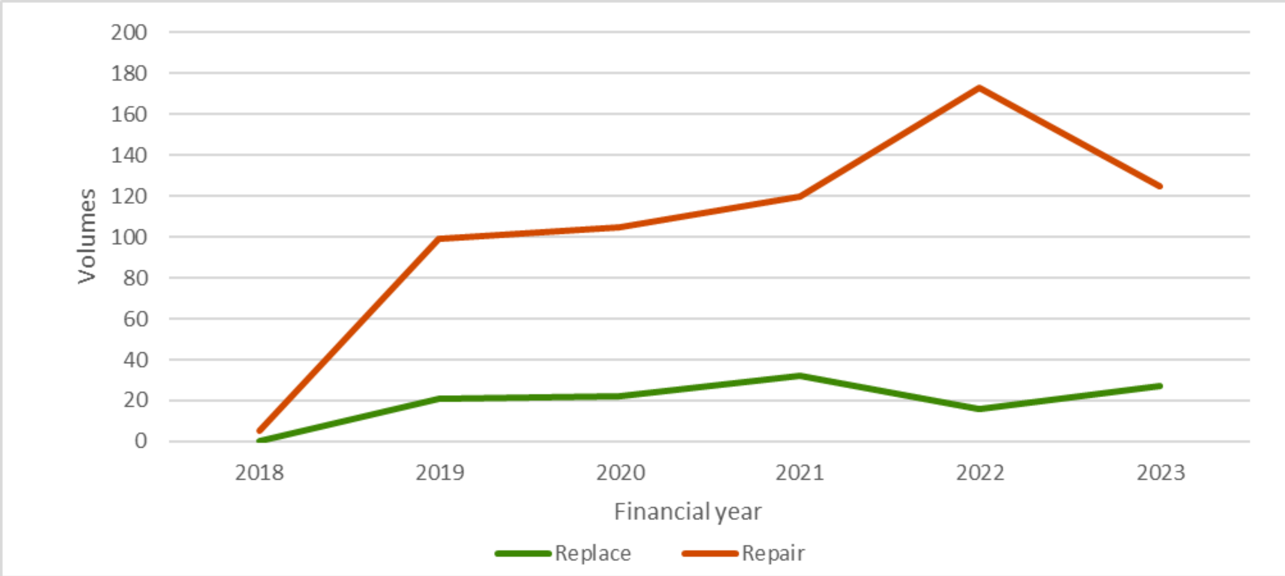

Figure 5 Trend of pillar replacements and repairs based on work orders

2.5 Consequence of failure

All the consequences related to pillar failures fall into two categories aligned to the Risk-Value framework as described below.

2.5.1 Health and Safety

Deterioration of pillars leading to exposed live parts or unauthorised access to the live parts poses a significant health and safety risk for the public. Since pillars are located in very close proximity to pubic accessible areas (at ground level and in or adjacent to residential premises) there is an elevated probability that the public could receive an electric shock as evidenced following review of recent network incidents.

For operational crews, access to isolation points within pillars for maintenance of older assets is difficult. The design of the older pillars requires that crews manually access the links at the base of the pillar in the vicinity of energised cables. Additionally, the older Cream pillars have no touch protection, or covers on live components (which hare included in the modern design). Infestation of distribution pillars with termites and changes to ground level with dirt build up exacerbates the access issue and elevates the risk to the field crew.

As described earlier, a significant proportion of the fleet of pillars that have been assessed, were identified as being safety critical, with other conditions likely to lead to a safety hazard if not addressed.

2.5.2 Reliability/Serviceability

Most pillars supply up to four customers at the adjacent premises, however, there are some that may supply a larger number of customers, such as a scenario where the pillar supplies a block of units. The failure of a pillar will therefore typically result in the disconnection of a small number of customers from the network thus only having a minor impact on reliability.

The two most common failure modes which are associated with this risk are:

- Termite infestation which can lead to damage of cable terminations or a short circuit due to build-up of soil and absorption of moisture.

- External impact damaging the pillar and resulting in loss of supply.

The outage management system is not able to capture all data related to pillars and may assign the outage to an individual customer or the LV cable, hence the reliability impact from pillars is likely to be under reported. However, the data analysis found that between FY17 and FY20, there were a total of 39 unplanned outages associated with pillars, with an average of 4.3 per year.

There was no trend evident in the data available for pillars. Power and Water considers that pillars to have a low criticality with respect to reliability.

2.6 Risk assessment

The risk posed by pillars due to the identified issues above has been quantified by applying Power and Waters Risk-Quantification Procedure[1]. This procedure has been developed taking into account the recent guidelines and determinations made by the AER, the ISO 31000 Risk Management Standard, and other professional publications.

Our analysis of network risk is based on the results of the inspection program, extrapolated across the pillar population.

The assessment of the base case scenario shown in Figure 6 has been undertaken based on the business as usual case, that is, on the basis that Power and Water does not undertake any additional mitigation measures to address the emerging risk and increasing volumes of defects being identified. The analysis demonstrates the increasing level of risk that would be carried by Power and Water in the absences of any new mitigating actions.

The reduction in risk that is achieved by different credible mitigation options, along with the cost of those options and any other direct financial cost savings, is used to identify the preferred option in Section 3.

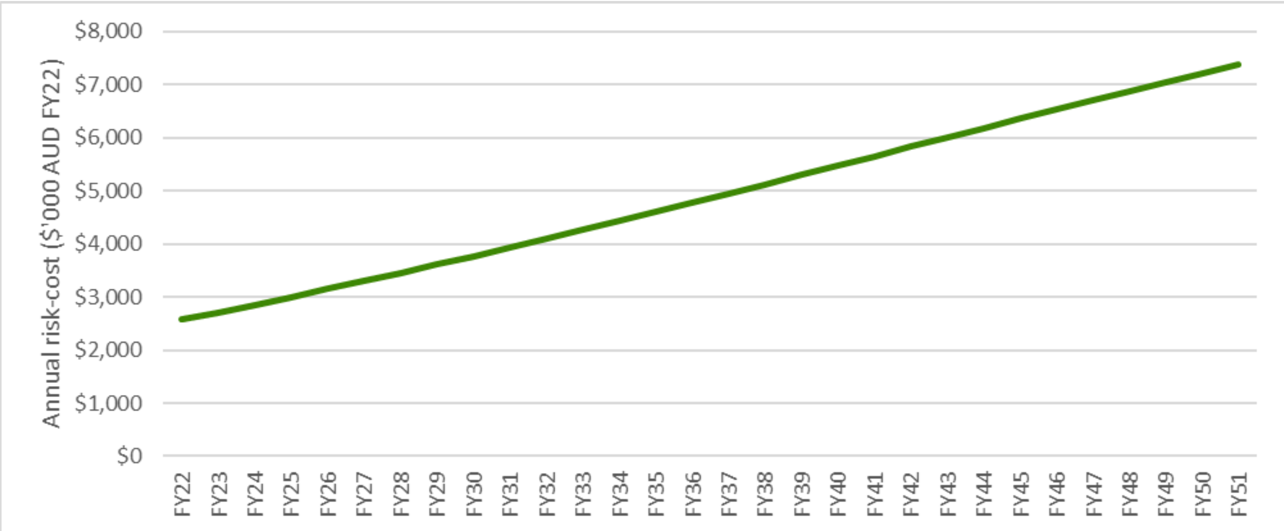

Figure 6 Current risk with base case scenario

[1] CONTROL0932, Risk Quantification Procedure for Investment Decision Making

2.7 Summary

Distribution pillars are a critical part of the low voltage distribution network. They are located in close proximity to residential and commercial properties, often in locations of high public exposure. The pillar is protected by an external housing that is exposed to the natural elements.

The current fleet of Green and Cream pillars are exhibiting end of life issues, predominately caused by the deterioration of the cover due to prolonged exposure to heat and UV light, damage to the base and impact from third parties (primarily vehicles). In these cases, live internal components have the potential to become exposed or easily accessible by the public and result in an elevated risk to public safety.

The risk to public safety is highlighted by the three recent network incidents that have occurred in the past two years. Two incidents involved the removal of the pillar cover which exposed live LV components, while the third incident resulted in a member of the public receiving an electric shock from a pillar. In all three cases, the follow up investigation found that the deteriorated condition of the pillar contributed significantly towards the incident.

Our analysis of the asset data has been used to define the scope of the need and quantify the network risk. ISRs and work orders have been analysed to identify the type of recent defects, the rate of defects being identified and to validate our forecast of the number of defects likely to occur on the network up to the end of FY29. The analysis demonstrates that:

- The age profile shows that approximately 30% of the asset fleet is expected to be older than the expected serviceable life by the end of the next regulatory period.
- The level of defects requiring repair or replacement are increasing and are expected to further increase as the condition of the asset fleet continues to deteriorate.
- 23% of defective Green or Cream pillars, and 25% across all pillar types being designated as requiring immediate action, as critical to public safety.

Section 3 discusses the options that will efficiently manage these risks.

3 Options analysis

This section describes the various options that were analysed to address the increasing risk to identify the recommended option. The options are analysed based on ability to address the identified needs, prudency and efficiency, commercial and technical feasibility, deliverability, benefits and an optimal balance between long term asset risk and short-term asset performance.

3.1 Comparison of credible options

Credible options are identified as options that address the identified need, are technically feasible and can be implemented within the required timeframe. The following options have been identified:

- **Option 1**: Replace on failure (Base case). This option will only undertake reactive replacement of pillars upon failure.
- **Option 2**: Maintain historical practice. Maintain historical approach to managing assets, expect 20 replacements and 110 repairs p.a.
- **Option 3**: Targeted replacement and repair. Replacement or repair of assets when identified to be defective according to new asset management approach. Expect 56 replacements and 200 repairs p.a.
- **Option 4**: Targeted replacement (only). Replacement of assets when identified to be defective according to new asset management approach. Expect 256 replacements p.a.

A comparison of the four identified credible options and the issues they address in the identified need is depicted in Table 5.

These options are described and assessed in detail in the sections below.

Table 5 Summary of options analysis outcomes

Assessment metrics	Option 1	Option 2	Option 3	Option 4
NPV ($'000, real FY22)	-	$11,843	$64,446	$37,618
BCR	-	1.8	2.99	1.66
Capex ($'000, real FY22)[1]	-	$1,049	$2,931	$13,427
Meets customer expectations	○	○	●	●
Aligns with Asset Objectives	○	◑	●	◑
Technical Viability	◑	●	●	◑
Deliverability	◑	●	●	○
Preferred	×	×	✓	×

● Fully addressed the issue ◕ Adequately addressed the issue ◑ Partially addressed the issue ○ Did not address the issue

Note 1: the capex stated is only for the 2024-29 regulatory period

3.1.1 Option 1 – Replace on failure (Counterfactual)

This option proposes to only replace a pillar on failure and accept the increasing level of risk. The replacement of pillars would be completed under the volumetric replacement program (NMFCR) based on defects found during inspection or outages (asset failure).

This option was not costed.

This approach would result in the replacement of approximately 5 pillars per year with no significant maintenance or repair undertaken. As a result the risk on the network is expected to increase as shown in Figure 7. This option was assessed to result in the highest residual risk cost of the credible options, does not adequately address the identified need and therefore is not recommended.

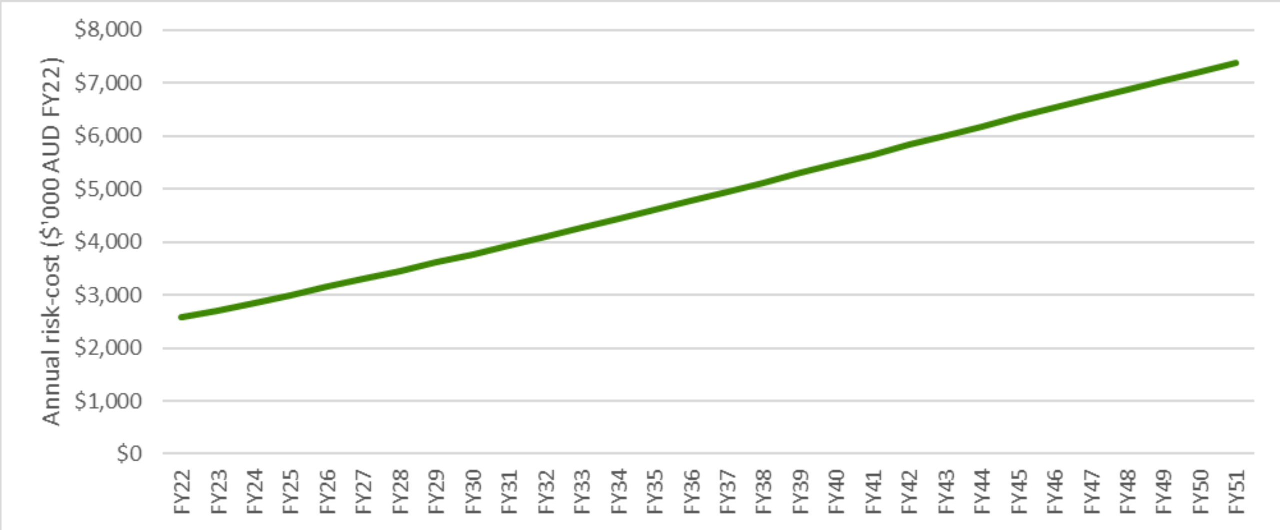

Figure 7 Risk profile achieved through Option 1

3.1.2 Option 2 – Maintain historical practice

This option proposes to continue the historical management practice that included the replacement of approximately 20 pillars per year and the repair of an additional 110 pillars. This was based on a review of historical work order data from FY19 to FY21.

The total capex for this option for the next 2024-29 regulatory period is estimated to be $1.05 million (real 2021/22). While this is the least cost option, it has the highest risk and does not meet Power and Water's requirements. The NPV is $11.8 million and BCR is 1.8 when assessed over a 30 year period, but the risk is still expected to increase.

The residual risk of this option is very high. This approach does not directly address the underlying need which is the large volume of pillars that are known to be in poor condition and exceeding their serviceable life. Therefore, it does not align with the Asset Objectives of maintaining reliability and safety of the network.

This option is found to result in a reduction in risk compared to Option 1, but the risk is still found to be increasing as the number of assets reaching end of life exceeds the number of assets being addressed by the program of works. The risk profile is shown in Figure 8.

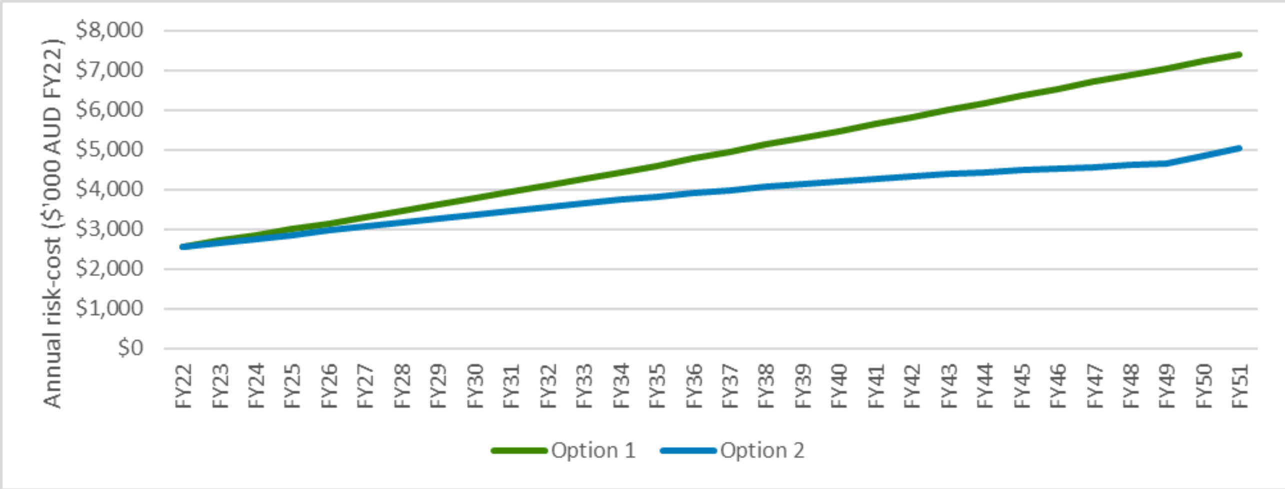

Figure 8 Risk of option 2 compared to option 1

While this option is deliverable and technically feasible, it results in deteriorating condition of the asset fleet and increasing safety risk to the public.

This option is not recommended.

3.1.3 Option 3 – Targeted replacement and repair

This option proposes to implement a new approach to managing the pillars asset class to manage network risk. The key aspects of this option include:

- Establishing a dedicated program to enable effective monitoring of progress.
- Increasing the annual replacement volumes to 56 pillars per year and repairs to 200 per year.
- Prioritise the works to focus on assets that are located in areas with higher interaction with the public, such as high foot traffic / high population density areas or close to critical infrastructure such as schools.

The total requested capex for this option for the next 2024-29 regulatory period is estimated to be $2.94 million (real 2021/22). The NPV is $64.5 million and the BCR is 2.99 when assessed over a 30 year period. This option will result in managing the network risk with the risk cost reducing over time.

It is expected that replacement will continue at a similar rate following the end of the regulatory period. This option is found to result in a reduction to the risk profile over time. The risk profile is shown in Figure 9.

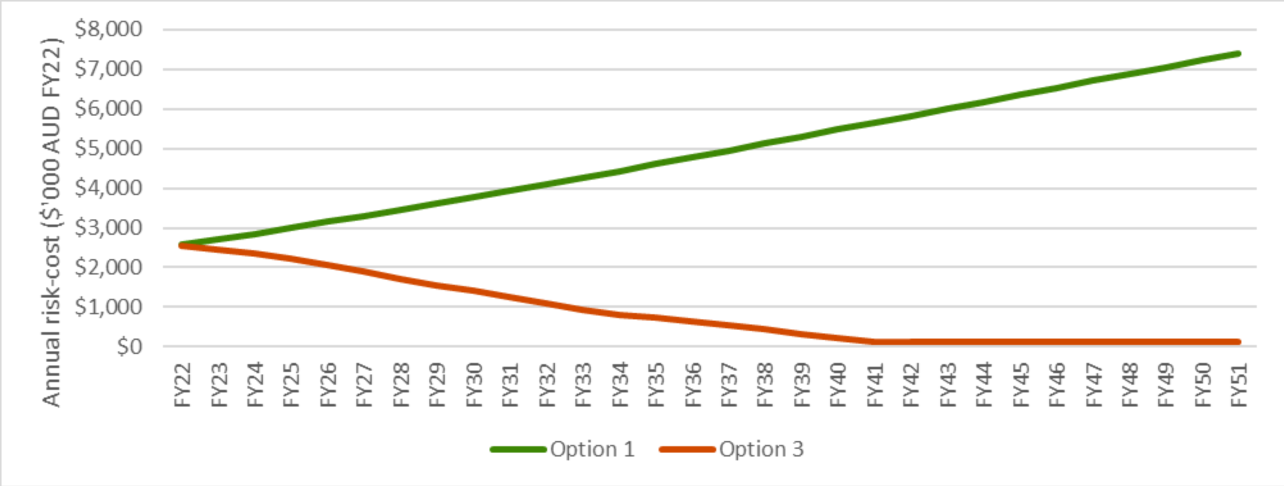

Figure 9 Risk reduction achieved through Option 3

By taking this approach, Power and Water will be able to manage the risk on the network in an efficient manner and manage the fleet as it reaches end of its serviceable life.

Power and Water has assessed the delivery requirements and change compared to the scale of the existing program and considers that it is deliverable based on the elevated level of works completed so far during FY23. Deliverability is also supported by Power and Water's previous targeted programs replacing approximately 80 pillars per year on average, with the highest replacement rate at 141 pillars in one year.

This option is aligned to the low voltage pillars asset strategy and has the following benefits:

- It addresses the underlying need of an increasing volume of pillars being identified as defective and requiring either replacement or maintenance to mitigate safety risks.
- It will contribute towards achieving the Asset Objectives of maintaining reliability and safety of the network.
- It will improve the safety of field crews as the new Holec pillars have improved designs and included covered terminals and overall covers, making them more touch safe for field crews when opening.
- It will reduce cost to customers by undertaking the replacement only when the asset can't be made safe and returned to service through maintenance.
- It will mitigate the risk to public safety.

This option is recommended.

3.1.4 Option 4 – Targeted replacement (only)

This option proposes to undertake replacement of all identified defective pillars, including those that are candidates for repair. The volumes of pillars to be treated under option 2 would also be addressed in

This option includes the replacement of 256 pillars p.a. being the same total volume treated as a part of Option 3. The primary difference between this option and Option 2, is the higher capital cost associated with a higher replacement volume, which is offset by a reduction in opex for repair identified in Option 2. The reduction of opex is estimated to be approximately $1.3 million across the next regulatory period, with a corresponding increase in capex of $10.6 million (real, FY22) relative to Option 2.

The risk profile would be marginally lower due to the new assets rather than repaired assets, however, the difference is not expected to be material.

The NPV has been calculated as $37.6 million and BCR of 1.66, being lower than the recommended option. The capex required to achieve this is $13.4 million during the 2024-29 regulatory period, which is significantly higher (almost 5 times) than Option 3 and (over 10 times) Option 2.

With a materially similar risk profile as Option 2 but inferior economic outcome, this option is not recommended.

3.2 Non-credible options

Our analysis also identified a number of options found to be non-credible. These options are described below and were not taken through to detail analysis for the reasons provided.

3.2.1 Replace all pillars above 35years by end of FY29 – not deliverable or economic

This option proposes a comprehensive and advanced replacement and repair program which would see total risk completely reduced by the end of the 2024-29 regulatory period. Replacement of aging pillars would be concentrated in the short term to address the approximately 2,500 pillars (approx. 32% of assets) that will have exceeded their serviceable life by 2029. This will require 600 pillar replacements conducted for RY2024-29, with an ongoing replacement rate of 200 pillars per year from RY2030 onwards.

Although this option would result in significantly accelerate the risk reduction for pillars compared to Option 2 and 3, this level of replacement is a significant increase from current levels and is not considered to be feasible from a resource perspective, both in terms of labour and capital spend. The capex for this option for the 2024-29 regulatory period is estimated to be $31.8m (real FY22).

This option is not considered prudent and is not recommended.

3.2.2 Retire or de-rate assets to extend life – does not address the need

Total retirement of the assets is not a credible option as the pillar is required for safe and reliable distribution of the electricity network. De-rating the pillar will not have any desired impact as it will directly impact customer’s load or maximum demand supplied through the pillar. However, when a pillar is identified to require full replacement, an assessment will be done to determine if it can be done as part of planned replacement resulting in reduced expenditure for Power and Water.

3.2.3 Non-Network alternatives – does not address the need

Due to the type and function of these assets, there are no non-network alternatives or solutions that can be implemented in place of direct asset replacement with like for like (modern equivalent) assets. When a pillar is identified for replacement, Power and Water undertakes an assessment of whether the size or type can be changed to reduce cost or to meet future demand most efficiently.

3.2.4 Capex/Opex Substitution – does not address the need

In general, it is not feasible to substitute capital expenditure with operating expenditure to resolve the risk across the entire asset fleet. In the cases identified in this business case, the asset has functionally failed and is no longer considered repairable. There are no operating practices that can be sued to mitigate the identified risk other than a capex replacement solution.

4 Recommendation

The recommended option is Option 3 – Targeted replacement and repair at an estimated cost of $4.2 million (real 2021/22) comprising $2.9 million capex for the 2024-29 regulatory period. This option is considered to be the most prudent and cost effective to meet the identified needs.

The proposed program is consistent with the National Electricity Rules Capital Expenditure Objectives as the expenditure is required to maintain the quality, reliability, and security of supply of standard control services and maintain the safety of the distribution system.

4.1 Strategic alignment

The "Power and Water Corporation Strategic Direction" is to meet the changing needs of the business, our customers and is aligned with the market and future economic conditions of the Northern Territory projected out to 2030.

This proposal aligns with Asset Management System Policies, Strategies and Plans that contributes to the D2021/260606 "Power and Water Strategic Direction" as indicated in the table below.

Table 6 Summary of strategic direction focus areas

	Strategic direction focus area	Strategic direction priority
1	Customer and the community at the centre	Improve Public Health and Safety
2	Always Safe	Cost Prudency

4.2 Dependent projects

There are no known projects or other network issues that are dependent on the resolution of this network issue.

4.3 Deliverability

This is a standard program of works that has been implemented historically and it is forecast to continue at volumes consistent with historical practice. No material delivery risks have been identified.

4.4 Customer considerations

As required by the AER's Better Resets Handbook, in developing this program Power and Water has taken into consideration feedback from its customers.

Feedback received through customer consultation undertaken at the time of writing this PBC, has demonstrated strong support amongst the community for appropriate expenditure to enable long term maintenance of the network to ensure continued reliability, maintainability and safety of supply.

4.5 Expenditure profile

Table 7 shows a summary of the expenditure requirements for 2024-29 regulatory period.

Table 7 Capital and operating expenditure by year ($'000, real FY22)

	FY25	FY26	FY27	FY28	FY29	Total
Capex	586	586	586	586	586	2,931
Opex	260	260	260	260	260	1,300
Total	**846**	**846**	**846**	**846**	**846**	**4,231**

Note: the Opex is already part of business as usual activities and does not represent a step change.

In Appendix B, the key assumptions and a summary of the top-down forecasting methods applied to develop the forecast is provided.

4.6 High-level scope

The scope for this project is to replace 280 and maintain/repair 1,000 pillars based on the defect priority and asset condition as shown in Table 8. They will be prioritised based on the defect type and location on the network (proximity to the public).

Table 8 Replacement and repair volumes by year

	FY25	FY26	FY27	FY28	FY29	Total
Volume replaced	56	56	56	56	56	280
Volume maintained	200	200	200	200	200	1,000
Total	**256**	**256**	**256**	**256**	**256**	**1,280**

Appendix A. Cost estimation

Cost estimates have utilised historical average spend to project expected continued costs. Annual replacements since 2017 have resulted in an average cost of $10,490 per asset replacement, as set out in the cost estimation methodology.[2]

[2] TRIM reference D2022/474750

Appendix B. Forecasting assumptions

B.1. Key assumptions

- Historical cost records from 2018-19 to 2020-21 can reasonably be used to estimate projected capex and numbers of projects for the 2024-29 regulatory period.
- The probability of asset at EOL resulting in an outage is set to 2.3% based on historical data on the number of volumes and the number of assets reaching end of life in the first year of the forecast.
- The Energy Not Served (ENS) in MWh is based on review of the historical outage data to determine the average ENS not supplied per outage of pillars and excluding outlier values.
- To determine the survival curve parameters, the Weibull distribution was applied with the characteristic age sourced from the CA RIN and the shape parameter set by reconciling the number of asset reaching end of life to the number of work orders raised in FY22 for pillars. This is a similar approach as taken by the AER for the Repex model and is based on the best data available to Power and Water.
- The planned investment profile time series, which is used to mitigate the risk observed on the network, was calculated in two parts:
  - only 23% of the pillars forecast for repair are included in the profile as the ISR data identified that since only 23% of the defective pillars are considered safety critical
  - All assets forecast for replaced assets are included in the time series.
- The safety critical repairs and replacements were summed together and used in the planned investment profile. The same level of investment has been assumed to continue following the end of the 2024-29 regulatory period.

B.2. Top-down review

To improve the robustness of our forecast the required repairs and replacements were forecast based on three approaches, then averaged the outputs:

- **Method 1:** Calculated a linear regression to estimate the trend of the replaced and repaired pillars using the data from 2019 to 2023[3]. The average value that was forecast for FY25 to FY29 was assumed for a smoothed replacement approach and was found to be 46 pillars to be replaced and 284 to be repaired p.a.
- **Method 2:** Applying a survival curve to the asset age profile (implemented in the base case option using the Risk Quantification Procedure template) and apportioning between repaired and replaced assets based on the average yearly percentage (30%). The age profile excluded Holec pillars but included the Cream and Green pillars and other pre-Holec types. The volume of Holec pillars that are replaced due to external impacts was forecast to be 6 per year and were then added on. The total replacements were calculated to be 61 green and cream pillars and 6 Holec replaced and 203 repaired p.a.
- **Method 3:** Based on the defect rate during the 2016 to 2021 period, and the number of pillars inspected each year, the outcome was 49 replaced, plus an additional 6 Holec type damaged by external impacts, and 115 repaired p.a.

[3] Since FY23 is not yet complete, an adjustment has been made to the current numbers to cover the remainder of the year. 2019 was chosen as the start of the trend as it was the year that the targeted programs were completed.

Table 9 Summary of top-down forecasting methods

Method	Replacements (Green & Cream)	Replacements (Holec)	Replacements Total	Repairs Total
1	46	0	46	284
2	61	6	67	203
3	49	6	55	115
Average (p.a.)			56	200
Average (5-year period)			**280**	**1,000**

On average there will be an average of 256 defects identified per year that will need to be rectified. Of these, it is estimated that 56 will require replacement while 200 will require repair.

The three top-down forecasting approaches largely aligned with our initial assessment.

Appendix C. Pillar types

C.1. Existing Pillar Types

The table below provides a summary of the existing pillar types on the network, including their volumes and characteristics.

Table 10 Summary of existing pillar types

Type of Pillar	No. in service	Description	Connection type
Service pillar	3,291	- Green pillar (aka URD pillar). - Primarily installed in urban areas for connection of domestic premises. - Used extensively from mid-1970’s until 2010.	Direct connect to busbar
Fused pillar	2,770	- Steel cabinet construction (Small numbers in CBD from early undergrounding). - Cream domed pillars until year 2000.	Legacy triple fuse switchgear
		- Holec cabinet fused pillar from 2000 onwards, fitted with the same LV switchgear as Distribution Transformers.	Holec triple fuse switchgear
	350	- Green double headed pillar pilot in Nightcliff only, all now replaced with Holec.	Miniature circuit breaker
Link pillar	1,827	- Used for open points between LV circuits, in addition to connection of consumers. - Generally green pillar up to 2010, and Holec pillar 2011 onwards.	Direct connect to busbar
Integral Pillar	0 Superseded[4]	- Also known as pregnant pillar. Combination service pillar and streetlight. - Program completed to replace with standalone pillars, early phases with green and later phases with Holec.	Direct connect to busbar
Total	**8,238**		

[4] Maximo data indicates 1 x Integral Pillar in service however this is understood to have been replaced with a Green Pillar.

C.2. Power and Water Standard Pillar Type

A new type of pillar design has been implemented by Power and Water to address all access and safety issues related to old type of pillar covered in section 2. The new pillar type has an improved design where operational crews can access isolation points from the front of the pillar cover. This mitigates any access issues for operational crews as the new pillar design offers enhanced safety and visibility related to cable terminations. The materials used are more resistant to UV radiation and heat and the cable entry has been designed to reduce the likelihood of termite infestation.

Figure 10 below shows a new type of pillar where isolation points can be accessed from the front of the pillar which will mitigate any access issues related with old type of pillar.

Figure 10 New pillar design

A detailed design drawing for new type of pillar is shown below.

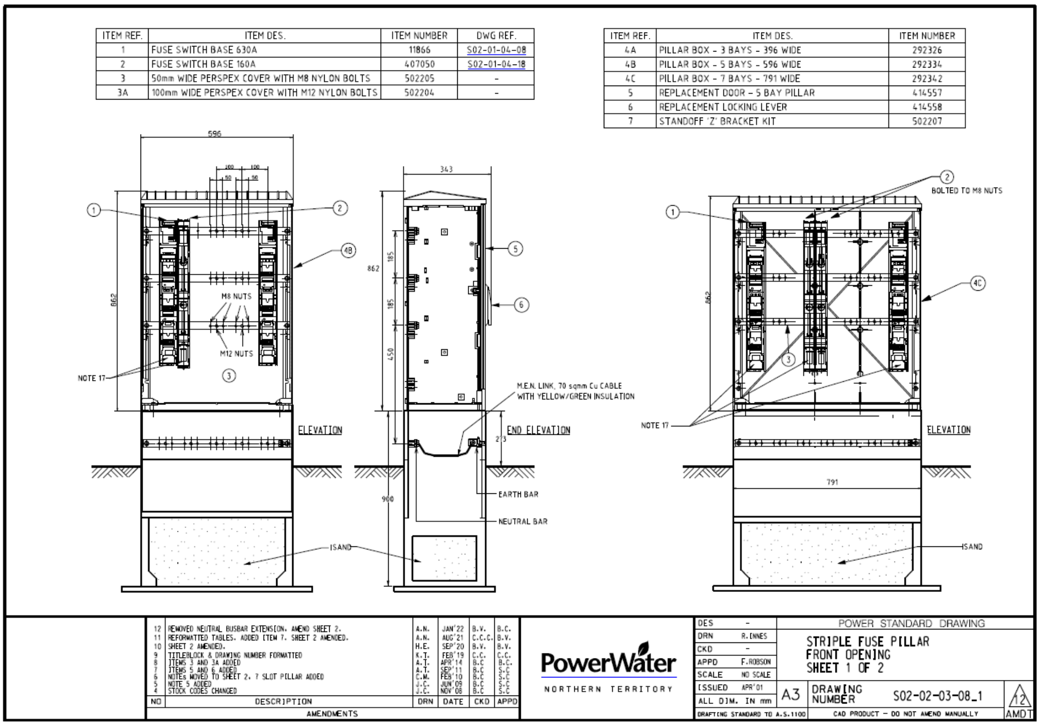

Figure 11 New pillar design – general arrangement drawing

Appendix D. Priority assessment guidelines

Table 11 Summary of priority assessment guidelines

Priority	Defect Description	Action
P1	Exposed or accessible live LV (e.g. pillar lid damaged or missing bolts)	Make safe by de-energising or restricting access and report to resource coordinator
	Audible/visible arcing or discharge	Make safe by de-energising or restricting access and report to resource coordinator
	Any other defect resulting in elevated safety risk	Make safe by de-energising or restricting access and report to resource coordinator
P2	Hot joint (>15 difference between phases)	Tighten on site or raise ISR
	Major mechanical damage with significant deterioration of material strength	Replace cover or raise ISR
	Major insulation damage	Raise ISR
	Broken Bakelite board	Raise ISR
	Calcium Adipate bridging between phases or phase to earth	Repair on site or raise ISR
	Missing or inadequate earthing (do not raise defect if installation is as per design e.g. Palmerston combined earth/neutral)	Raise ISR
	Neutral integrity or phasing	Raise ISR
	Advanced pest/termite infestation	Repair on site or raise ISR
P3	Hot joint (<15 difference between phases)	Repair on site or raise ISR
	Minor mechanical damage	Raise ISR to monitor within P3 date
	Minor insulation damage	Raise ISR to monitor within P3 date
	Cracked/damaged Bakelite board	Raise ISR
	Calcium Adipate build-up	Repair on site or raise ISR

P4	Flash or burn marks	Raise ISR to monitor within P3 date
	Signage missing/incorrect	Repair on site or raise ISR
	Graffiti/vandalism	Repair on site or raise ISR
	Corrosion on busbar/lugs	Repair on site or raise ISR
	Vegetation or other obstruction preventing safe access to pillar	Repair on site or raise ISR
	Vegetation growth likely to cause future obstruction (e.g. small tree)	Repair on site or raise ISR
	Early pest/termite infestation	Remove pests and apply pesticide as appropriate
	Pillar base buried but no access impediment	Raise ISR
	Pillar without easement or enclosed by private fencing	Raise ISR
	Other low priority defects	Raise ISR

Table 12 Summary of priority action timeframes

Priority	Description	Timeframe
P1	Immediate safety issue. Make safe by de-energising or restricting access and report to resource coordinator	< 12 Hours
P2	Major defects impacting functionality. Replace covers. Repair on site or raise ISR.	< 28 Days
P3	Minor defects. Make safe as necessary. Repair on site or raise ISR.	< 39 Weeks
P4	Access issues or superficial defects. Raise ISR.	Next Maintenance Interval

Appendix E. Examples of defect types

The key failure modes being experienced on the network are:

- Cover damage due to prolonged exposure to heat and UV radiation
- Termite infestation
- External impacts

E.1. Cover damage due to UV radiation

In most of the instances, pillars are exposed to Ultraviolet (UV) radiation. As a result, the pillar cover starts to weaken (become brittle). Common effects are cracks on its surface or breaking around the bolt holes that secure the cover to the concrete base. These failure modes are shown in Figure 12. Analysis of inspection results found that 127 (13.8%) of 926 pillars inspected were found to have issues related to cover damage.

Figure 12 Cracks in the pillar cover

E.2. Termite infestation

Another common issue that affects pillars on Power and Water network is termite infestation which is exacerbated by the operating environment. This failure mode is shown in Figure 13 below.

Termite infestation has three main impacts:

- Access by operational staff becomes more difficult and poses risk due to the termites and the termite mound causing difficulty accessing isolation links.
- The termites can damage the cable terminations inside the pillars, ultimately affecting the reliability of supply or increasing safety risk due to additional and unexpected LV assets being exposed.

- The combination of the termite mound matter and absorbed moisture can cause a short circuit between LV terminals which will result in an outage, or other metallic components becoming live and causing a safety hazard.

Analysis of inspection results found that 96 (10%) of 926 inspected pillars were found to be infested with termites.

Figure 13 Examples of termite infestation

E.3. External impact

Due to the locations of a pillars, they have an increased probability of being hit by a third party, particularly residential vehicles. External impacts can damage to the pillar and expose live parts or make them more easily accessible. Figure 14 shows damage to access cover and pillar base caused by vehicles.

There were 54 incidents involving third party failures including external which caused damage to pillar or its associated components. As per ISR analysis, 54 (5.8%) of 926 inspected pillars were found to be damaged as result of external impact.

Figure 14 Examples of damage by vehicles

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