Program Business Need Identification

Power and Water Corporation

NMP17

Single Phase Substation Replacement/Refurbishment

Proposed:	Approved:
Stuart Eassie Manager Asset Strategic Engineering Power Networks Date: 5 December 2017	Michael Thomson Chief Executive Power and Water Corporation Date: 6/2/2018

	D2018/42761	
Djuna Pollard Executive General Manager Power Networks Date: 5 December 2017	Finance Review Date:05/12/2017	PMO QA Date: / /20

1 Program Summary

Program Name:	Single Phase Substation Replacement/Refurbishment		
Program No:	NMP17	SAP Ref:	
Financial Year Commencement:	2019/20		
Business Unit:	Power Networks		
Program Owner (GM):	Djuna Pollard	Phone No:	08 8985 8431
Contact Officer:	Stuart Eassie	Phone No:	08 8924 5214
Date of Submission:		File Ref No:	D2017/366928
Submission Number:		Priority Score:	
Primary Driver:	Renewal/ Replacement	Secondary Driver:	Social/ Environmental
Program Classification:	Capital Program of Works		

2 Recommendation

MINOR PROJECTS UP TO $1M NOT COVERED BY AN EXISTING BNI

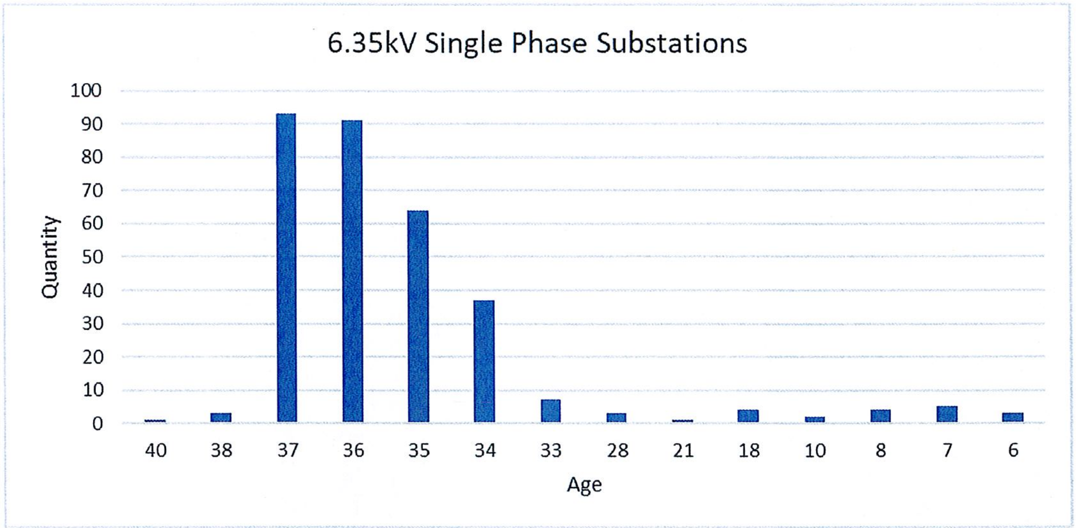
It is recommended that the Chief Executive note the proposed five year single phase substation replacement/refurbishment program for an estimated budget of $2.1 million, and approve the inclusion of this program into the SCI for this amount, with a corresponding completion date of June 2024.

The forecast for this program of work extends beyond the current SCI period. The first two years of this program aligns with the last two years of the 2017-18 SCI. This program will be included in the 2019-24 Regulatory Proposal to the Australian Energy Regulator (AER).

Note that individual projects within the program will be documented in Business Case Category Cs to be approved by the Executive General Manager Power Networks.

3 Description of Issues

Power Networks owns and maintains a High Voltage (HV) underground distribution network, including 318, 6.35 kV, Single Phase Underground Distribution Substations (SPUDs) in Darwin's urban area. The portfolio mainly consists of 50 kVA substations and a small number of 75 kVA substations. The majority of the substations were installed over a 4 year period from 1980 to 1983 and the portfolio has a weighted average age of 34 years. Given a typical operational life of 47 years, the average remaining life of the single phase substation population is approximately 13 years. Life extension or replacement action is required to avoid a significant cliff of investment in replacement of SPUDs.



Corrosion of the bottom of transformer tanks is the most common failure mode and age indicator of the level of corrosion. The SPUDS are mostly located in the front yards of residential properties and subject to watering and build-up of dirt, leaves, etc. Maintenance to remove build-up is ineffective in most locations as debris and soil builds up in a short timeframe due to high vegetation growth rates and wet season erosion. Examples shown in Figure 1 below. Darwin's tropical climate is also conducive to corrosion.

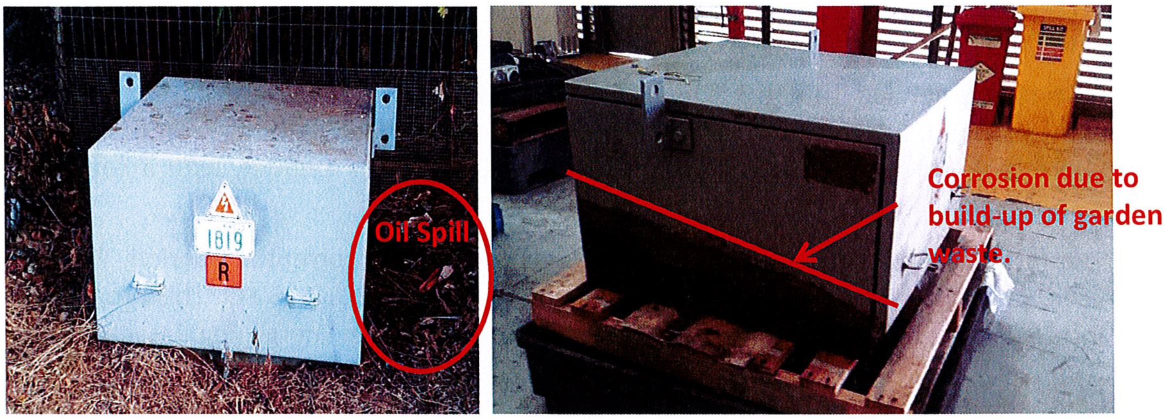


Figure 1 - Common SPUD Installation Condition and Impacts

The installation and environmental conditions maintain moisture beneath the tank and accelerates the corrosion of the base of the substation. As the corrosion is not visible, oil leaks develop over time, contaminating soil around the substation. If undetected the loss of oil causes internal flashovers, and many of the older units do not have oil sight glasses. If found through inspections, the electrical failure can be prevented, however it is often not economical to repair at that stage due to advanced corrosion.

Electrical failure due to loss of insulating oil places people in proximity to the substation at risk. Containment of fault energy cannot be guaranteed and being a residential area, the likelihood of people being present during a failure event is elevated.

Operationally, any maintenance and fault conditions result in excessive performance and cost impacts. There is no ability to transfer loads between substations in the SPUDS network, therefore generators are required in all cases to maintain customer supply in the event of a failure or maintenance. SPUDS contributed around 2% to Darwin's annual system fault events.

The single phase underground network is unique and HV switching is performed using Load-Break Elbows. These allow switching to be performed live however internal components designed to extinguish arcs during live switching operations deteriorate over time. Many units maintained and refurbished have been found with damage to these components including plugs, bushing seals, bails and attachment rings.

A summary of recent trends of failures in repairs is shown in below.

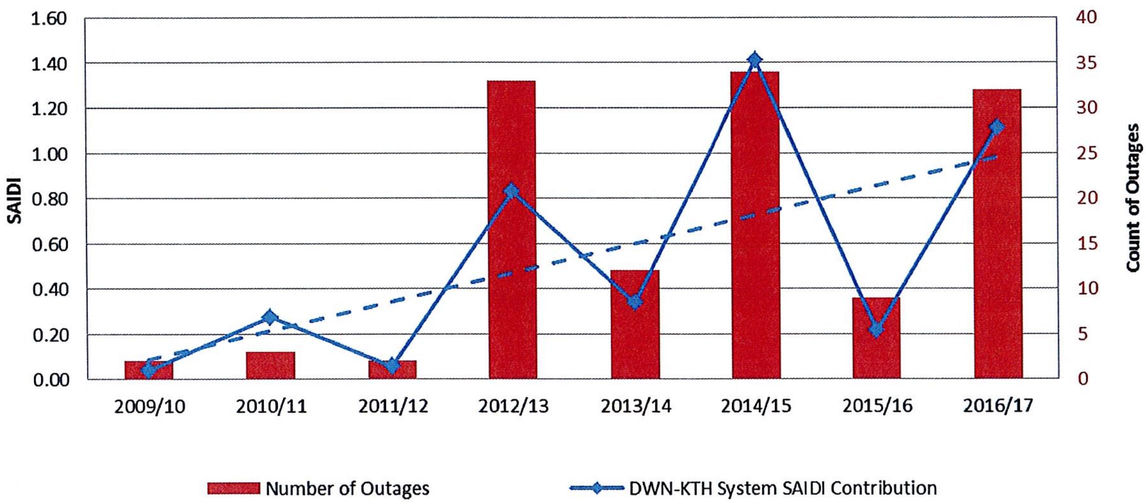


Figure 2 - SPUD Failure and Repair Trends

3.1 Project Needs

a. Safety
The unpredictable issues related to the tank corrosion of the SPUDs poses a safety risk to the public as well as PWC employees involved in undertaking works in the vicinity of the assets and fittings. Targeted replacement and refurbishment of the SPUDS addresses the worker and public safety risk caused by the deterioration of the structure compromising electrical network safety.

b. Compliance

A fundamental business driver for PWC is compliance with the relevant Health and Safety Legislation, the Network Technical Code and Network Planning Criteria objective of providing safe, secure, reliable, high quality power supply at a minimal cost. A detailed outline of compliance requirements is described in the Power Networks Strategic Asset Management Plan.

Targeted replacement and refurbishment will extend and augment the working life of SPUDS and reduce employee and public risk associated with component failure compliant with the business objective.

c. Reliability (if not compliance obligation)

The SPUDS contributes to the reliability performance of the power network. Degredation of the ground mounted substations as a result of corrosion is a common issue in Darwin due to the tropical climate and proximity to the coast. This failure mode has been observed in the PWC network and in particular in the SPUDS, with an increase in the number of SPUDS fault events recorded. Replacement of the SPUDS will contribute to the maintenance of system reliability and achievement of PWC's reliability performance objectives.

4 Potential Solution

Opportunities to maintain the safe and reliable operation of the network have been considered. These include:

Option 1 – Run to failure

Run to failure involves the reactive maintenance and repair of assets. It is characterised by increasing operations and maintenance costs, adverse system performance impacts, unacceptable public and worker safety risk, and increasing environmental risk associated with the continued degradation of the assets.

This approach is not aligned with PWC's business objective for operating a safe and reliable network. The increasing replacement volumes recorded in recent years has urged the need for a focused investment to proactively address the SPUDS degradation issue.

Option 2 – Inspection and repair

This approach involves the routine inspection of SPUDS to determine high-priority repairs. Identifying critical asset issues is however difficult as most of the structural corrosion takes place under the base of the substation and is not accessible for inspection. In many instances the repair and replacement work becomes reactive.

PWC has been implementing an inspection and repair approach on the SPUDS population and have recognised the need for a more effective approach to maintain the safe and reliable operation of the single phase underground network.

Option 3 – Targeted proactive replacement and refurbishment

The targeted proactive replacement of the SPUDS is a concerted approach directed at maintaining system safety and reliability in a prudent and cost efficient manner. It relies on a risk based prioritisation of SPUDS taking into consideration asset health and criticality to inform a replacement and refurbishment program. Current refurbishment practices have been developed to address the common failure modes and achieve a minimum of 10 year life extension without further corrective maintenance.

4.2 Preferred Option

A risk based approach has been used to establish a targeted replacement and refurbishment program as the preferred option. The program will replace 9 SPUDS and refurbish a further 149 in the next regulatory period, 2019/20 to 2023/24 focused on the highest reliability, safety, and environmental risk assets. It is expected to cost $1.5 m over the 5 year period. This strategy will result in the refurbishment of the total SPUDS population over a twenty-year period.

The program considers asset criticality, health, and probability of failure to prioritise the SPUDs that poses the higher risk. Criticality has been determined by the number of faults recorded per SPUD over the last 4 years, and the age provides an indication of asset health. The probability of failure has been based on recent failure rates which are increasing. Ultimately a downturn in failure rates over the regulatory period is expected as result of the prioritised replacements.

Year	2019-20	2020-21	2021-22	2022-23	2023-24	Total
	Qty	Qty	Qty	Qty	Qty	Qty
Replacement volumes	1	2	2	2	2	9
Refurbishment volumes	18	33	47	53	47	198
Total	**19**	**35**	**49**	**55**	**49**	**207**

The SPUDS identified for replacement and refurbishment in the next regulatory period makes up around 48% of the total population. Replacement will be targeted at substations with high utilisation at or above rating as the single phase network does not allow loads to be transferred between substations. The replacement substation for these locations will be rated for 75kVA based on the level of overloading measured historically[1].

[1] D2009/311881 NPR0918 Loading of Single Phase Substations

4.3 Non Network alternatives

No non-network alternatives were identified that would mitigate the need for the replacement and refurbishment of the SPUDS. The life extension of these substations is the most prudent option as their unique design and small volume results in a high cost of manufacture for new units.

4.4 Capex/Opex substitution

The proposed SPUDS replacement and refurbishment program addresses an asset degradation issue that cannot be solved through operations and maintenance activities.

4.5 Contingent Project

The expenditure does not meet the criteria for a contingent project - National Electricity Rules, section 6.6A.1(b)(2).

5 Strategic Alignment

This program aligns with the Asset Objectives defined in the Strategic Asset Management Plan (SAMP) and Asset (Class) Management Plans (AMP). The capital investment into distribution substations outlined in this program will contribute to the Corporation achieving the goals defined in the boards Strategic Directions and SCI Key Result Areas of Health and Safety and Operational Performance.

6 Timing Constraints

It is essential that this project commence as early as possible to manage the continued safe and reliable operation of the network. If refurbishment action is not undertaken, corrosion is likely to reach a stage where it is no longer repairable, forcing replacement of a higher volume of substations as a result of failures. Increasing failures will also increase the risk to personnel and the public, and result in potential negative media attention if oil spills increase in residential areas.

7 Expected Benefits

Driver	Benefit	Measure
Growth / Demand		
Renewal / Replacement	Network safety	Health and Safety Index
Compliance		
Service Improvement	Network reliability maintained	Performance against SAIDI and SAIFI targets

Driver	Benefit	Measure
Commercial / Efficiency		
Social / Environmental	Avoid uncontrolled oil spills	Environment incidents. Customer complaints and negative media.

8 Milestones (mm/yyyy)

Investment Planning	Project Development	Project Commitment	Project Delivery	Review
01/2018	NA	01/2019	06/2024	09/2024

The program delivery is scheduled to run over 5 years from July 2019 to June 2024. A program review will be held at the end of the 5 year program as well as interim reviews at the end of each Financial Year.

9 Key Stakeholders

Stakeholder	Responsibility
Internal governance stakeholders	Executive General Manager Power Networks
	Group Manager Service Delivery
	Chief Engineer
Internal design stakeholders	Senior Manager Network Assets
	Manager Test & Protection Services
	Senior Manager Field Services
External – Unions and public	Local Residents
	ETU
	Ministers
External regulators	Utilities Commission
	Australian Energy Regulator

10 Resource Requirements

Not applicable. Resourcing requirements for this program are considered Business as Usual and will be incorporated into the development of Category C Business Cases for each individual replacement.

11 Delivery Risk

Site access for the removal, installation and refurbishment activities may need to be negotiated on a site by site basis. Easements do not exist for the majority of SPUDs.

Reputational risk needs to be considered when disturbing established residential gardens and council parks. Customer complaints have occurred during previous replacements. Early stakeholder notification and consultation is required to prevent delays to the delivery of the program and costs associated with resolving stakeholder issues.

12 Financial Impacts

12.1 Expenditure Forecasting Method

The expenditure forecast has been based on a programmed approach. The forecast volumes have been determined using a risk based prioritisation of assets focusing on the replacement and refurbishment of the highest safety and reliability risk installations.

The asset replacement investment program is internally driven and no customer contributions are expected.

12.2 Historical and Forecast Expenditure

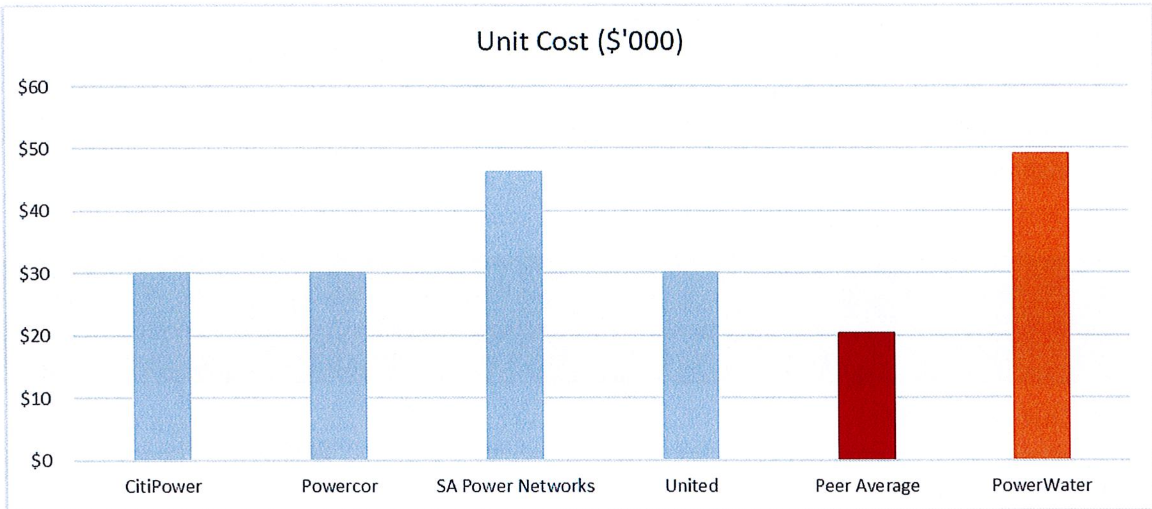
The annual forecast SPUDS replacement and refurbishment capital expenditure for the 2019/20 to 2023/24 regulatory period is provided below.

Year	2019-20 ($'000)	2020-21 ($'000)	2021-22 ($'000)	2022-23 ($'000)	2023-24 ($'000)	Total ($'000)
Replacement expenditure forecast	49	98	98	98	98	441
Refurbishment expenditure forecast	152	279	397	448	397	1,672
Total	**201**	**377**	**495**	**546**	**495**	**2,113**

12.3 Validation

The cost estimate has been based on recent, 2016/17, replacement and refurbishment works undertaken by PWC. A benchmark of the cost against similar works undertaken by peer utilities indicates that the unit cost is reasonable. In comparison with peer utilities PWC's unit cost compares with the upper range and is reflective of a unique network, unique climate conditions, and unique work environment.

Works undertaken in the Northern Territory are characterised by higher costs than other areas in Australia. This can partly be attributed to the remoteness of the network attracting additional transport and logistic costs, as well as the harsh weather conditions set apart by extended wet periods that impedes the effective execution of works, and a tropical climate that impacts on the productivity that can be achieved during normal work hours.



The comparison has been based on publicly available data sourced from the Australian Energy Regulator's (AER's) Repex modelling and utility Regulatory Information Notice (RIN) submissions. There are a number of internal and external operational, asset type, and environmental factors that influence the benchmark costs and provide a challenge in respect of the ability to undertake accurate comparisons. Normalisation for these factors has not been undertaken and the benchmark comparisons provided are an indicative measure of reasonableness only.

12.4Capex Profile

Phase	2019-20 ($'000)	2020-21 ($'000)	2021-22 ($'000)	2022-23 ($'000)	2023-24 ($'000)	Total ($'000)
Investment Planning						
Project Development						
Project Commitment						
Project Delivery	201	377	495	546	495	2,113
Review						

Phase	2019-20 ($'000)	2020-21 ($'000)	2021-22 ($'000)	2022-23 ($'000)	2023-24 ($'000)	Total ($'000)
Total	**201**	**377**	**495**	**546**	**495**	**2,113**

12.5Opex Implications

The SPUDS maintenance expenditure centres around the routine inspection and repair of assets. Reductions in the operational costs associated with SPUDs could be expected to decrease in the later years of the program due to a decreasing failure rate. However those units not targeted will likely increase in failure rate. Therefore no step change in operating cost is forecast for the next regulatory period as a result of investing in the replacement and refurbishment of the SPUDS.

Historical Average Annual Opex	Emergency Response ($'000)	Non-Routine Maintenance ($'000)	Routine Maintenance ($'000)	Annual Opex ($'000)
Unit Cost (2016/17)	1.65	3.75	Part of 3 yearly feeder inspections.	-
Volume maintained	6.5	32.3		-
Totals	**10.7**	**121.1**		**131.8**

12.6Variance

The forecast for this program of work extends beyond the current SCI period. The first two years of this program aligns with the last two years of the 2017-18 SCI.

APPENDIX A

1 Forecast Expenditure by Expenditure Category

The forecast is in today's dollars ($2017-18).

RAB Category	Regulatory Year (A$M, $2017-18, Jul to Jun years)				
	2019-20	2020-21	2021-22	2022-23	2023-24
Total	$0.20	$0.38	$0.49	$0.55	$0.49
Labour	$0.11	$0.20	$0.26	$0.29	$0.26
Materials	$0.10	$0.18	$0.23	$0.26	$0.23
Contractors	$-	$-	$-	$-	$-
Other	$-	$-	$-	$-	$-

Definitions

Labour – The cost of direct Labour for the project. No overheads.

Materials – the cost of materials used in the project. No overheads.

Contractors – the cost of work performed by Contractors in the project, whether Labour or Materials. No overheads.

Other – expenditure that is not Labour, Materials or Contractors. No overheads.

2 Forecast Expenditure by RAB Category

The forecast is in today's dollars ($2017-18).

RAB Category	Regulatory Year (A$M, $2017-18, Jul to Jun years)				
	2019-20	2020-21	2021-22	2022-23	2023-24
Total	**$0.20**	**$0.38**	**$0.49**	**$0.55**	**$0.49**
System Capex					
Substations					
Distribution Lines					
Transmission Lines					
LV Services					
Distribution Substations	$0.20	$0.38	$0.49	$0.55	$0.49
Distribution Switchgear					
Protection					
SCADA					
Communications					
Non-system Capex					
Land and Easements					
Property					
IT and Communications					
Motor Vehicles					
Plant and Equipment					

3 Forecast Expenditure by CA RIN Category

The forecast is in today's dollars ($2017-18).

RAB Category	Regulatory Year (A$M, $2017-18, Jul to Jun years)				
	2019-20	2020-21	2021-22	2022-23	2023-24
Total	$0.20	$0.38	$0.49	$0.55	$0.49
Repex	$0.20	$0.38	$0.49	$0.55	$0.49
Augex					
Connections					
Non-network: IT					
Non-network: Vehicles					
Non-network: Buildings and property					
Non-network SCADA & network control					
Non-network: Other					