Program Business Need Identification

Power and Water Corporation

CONTROLLED DOCUMENT

NMP18 / PRD33438

Darwin Coastal Pole Top Corrosion Replacement Program

Proposed:

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Date: 15/2 /2018

Approved:

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Date: 23/02/2018

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Refer to email
D2018/72353

Finance Review
Date: 06/02/2018

Refer to email
D2018/66619

PMO QA
Date: 13/02/2018

1 Program Summary

Program Name:	Darwin Coastal Pole Top Corrosion Replacement Program		
Program No:	NMP18 / PRD33438	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:	23/02/18	File Ref No:	D2017/463391
Submission Number:		Priority Score:	
Primary Driver:	Renewal/ Replacement	Secondary Driver:	Compliance
Program Classification:	Program of Works		

2 Recommendation

2.1 MAJOR PROJECT >$1M OR PROGRAM

It is recommended that Chief Executive note the proposed coastal pole top replacement program for an estimated budget of $2.4 million, and approve the inclusion of this pole top replacement program into the SCI for this amount, with a corresponding completion date of June 2024.

The current 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 C to be approved by the Executive General Manager Power Networks.

3 Description of Issues

3.1 Asset Portfolio Context

Power Networks owns and maintains a portfolio of 42,899 high voltage (HV) and low voltage (LV) crossarms distributed across the four regions of Alice Springs, Darwin, Katherine and Tennant Creek. The vast majority of the crossarms; 95.7% consist of steel with the remainder a mix of fibre and wood.

Table 1 Crossarm Asset Portfolio

Region	High Voltage (HV)			Low Voltage (LV)			Total cross arms	Total %
	Steel	Wood	Fibre	Steel	Wood	Fibre		
ASP*	3,688	0	0	2,441	0	0	**6,129**	14.3%
DRW	12,934	183	1,165	11,180	5	1	**25,468**	59.4%
KTH	5,120	229	270	2,604	1	1	**8,225**	19.2%
TCK*	2,034	0	0	1,043	0	0	**3,077**	7.2%
Total	**23,776**	**412**	**1,435**	**17,268**	**6**	**2**	**42,899**	**100.0%**
Total %	55.4%	1.0%	3.3%	40.3%	0.01%	0.005%	**100.0%**	

* Crossarm quantities estimated based on pole use, i.e. HV, LV and HV/LV. All crossarms assumed to be steel.

The crossarms were installed over a 67 year period from 1950 and the portfolio has a weighted average age of 34 years. Given a conservative operational life of 53 years based on the typical replacement life of steel 'poles' across the NEM, the age-based remaining life of the PWC crossarm population is around 19 years with more than half (59%) having a remaining life of less than the average, and 3.2% exceeding the expected operational life.

A large number of crossarms were replaced in 1975 following extensive damaged caused by Cyclone Tracy in the December of 1974. It should be noted that asset records from that period are not comprehensive. The asset system indicates that all poles within the cyclone affected areas were replaced; however it is likely that a portion of the existing assets were not damaged and are older than the records indicate.

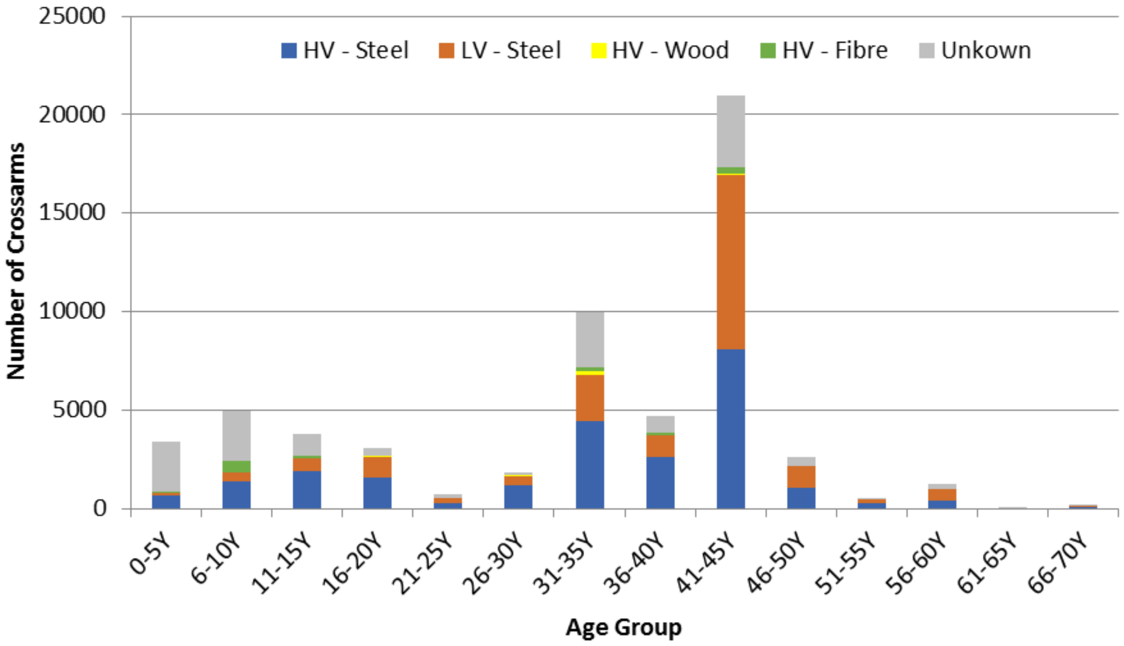

Figure 1 – Crossarm age profile

Industry experience is that steel 'poles' generally achieve an operational life of around 53 years. Experience also indicates that crossarms achieve shorter lives; however insufficient information is currently available to quantify a typical replacement life for steel crossarms across the NEM.

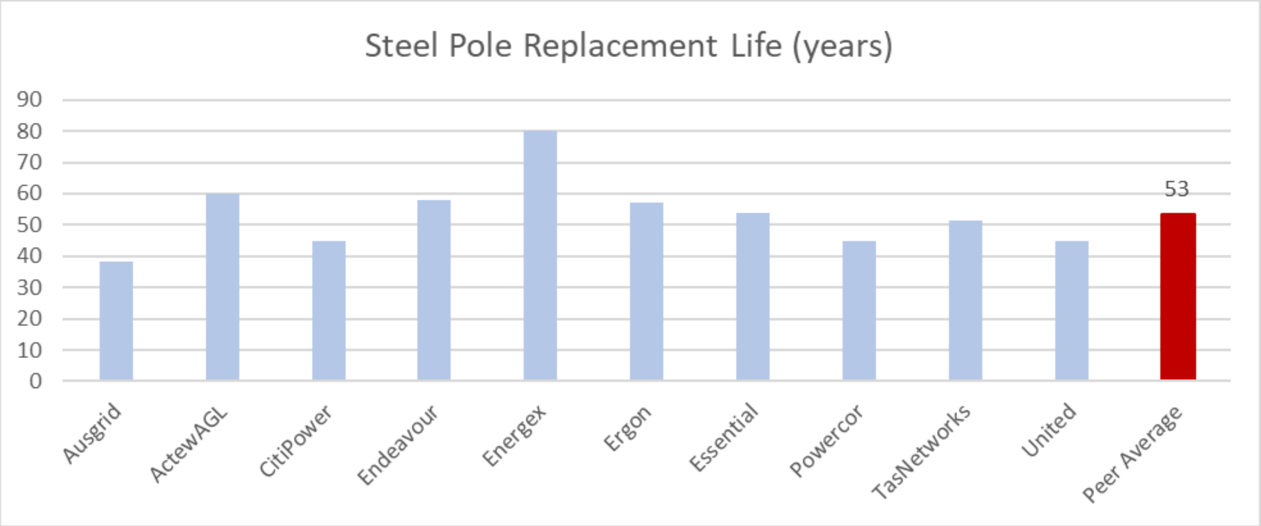

Figure 2 – Typical steel pole replacement lives

3.2 Poletop Condition

To date most of the focus on crossarm condition has been on replacing deteriorated wooden crossarms, and replacement programs have now addressed the bulk of these issues. However in recent years more failed steel crossarms are being found, particularly in the older foreshore suburbs of Darwin.

The full extent of the risks associated with this developing issue are not yet fully understood, as analysis of corrosion rates on poles in the northern region is very limited. A detailed inspection of several of Darwin's oldest coastal suburbs was undertaken in 2017 to help quantify the extent of the issue. The inspection identified that approximately 1% of the 700 poletops inspected had suffered corrosion to such an extent that portions of the crossarm had completely rusted through leaving visible holes. An example of some of these corroded crossarms is shown in Figure 3. Investigation of historical maintenance data identified that a similar number of arms with severe corrosion had been replaced in foreshore suburbs in 2012.

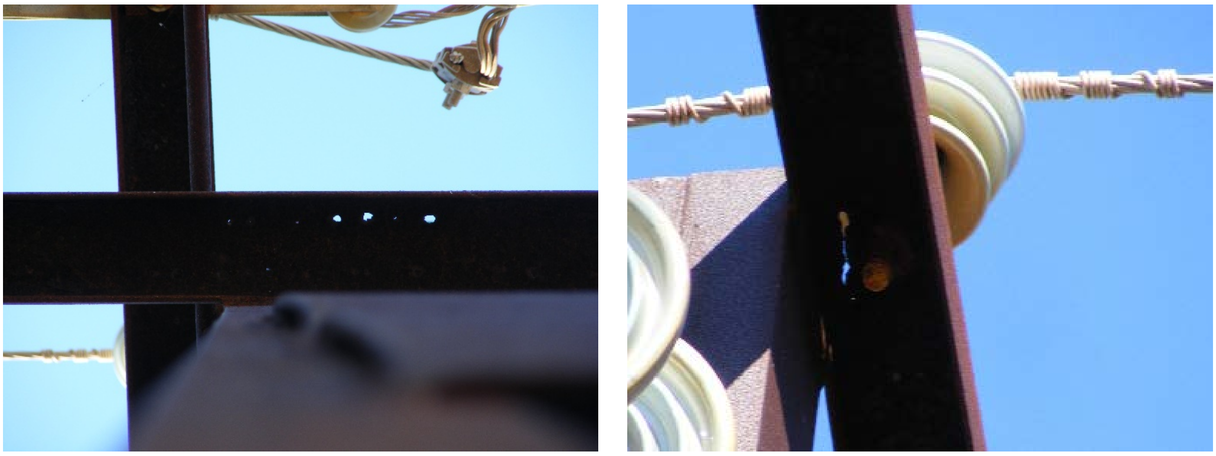

Figure 3 – Examples of crossarm corrosion

AS/NZS 2312:2002 provides guidance on mild steel corrosion rates by corrosion zones. Coastal zones are classified as a medium type corrosive zone with corrosion rates ranging from around 25µm to 50µm per annum. This translates to a typical 4mm mild steel crossarm losing around 35% of its material thickness and associated strength over a period of 28 years to 56 years, characteristic of the PWC experience in the coastal areas of the Darwin region.

Wattyl Industrial Coatings[1] undertook an extensive study of corrosion rates involving 35 sites across Australia, New Zealand and Papa New Guinea. Based on the outcomes of this study an average corrosion rate across the Darwin region of around 18µm with a standard deviation of 57µm has been derived, translating to a conservative 78 year crossarm life. Given a normal distribution of failures around the derived crossarm life, an increase in failures is expected in the coming years. However this study does not effectively evaluate the corrosion where very localised complete loss of section occurs around crossarm welds and insulators. The current standard crossarm design includes reinforcement in these sections.

3.3 Asset Risk

The function of crossarms is to maintain safe conductor-to-conductor, conductor-to-structures, and conductor-to-ground clearances. Mechanical failure of HV and LV crossarms resulting from advanced corrosion poses a risk of physical and electrical harm to PWC employees and the public and affects the continued reliable operation of the assets.

Routine inspections are aimed at the early identification of asset condition issues, however this has been found to be ineffective when assessing corrosion degradation and remaining mechanical strength in poletop structures. In most cases it is only when severe material decay becomes visible that an assessment is made. This advanced stage of deterioration is preceded by a gradual decay in mechanical strength that is not easily identifiable during routine inspections and carries a high risk.

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[1] Wattyl Industry Coatings, GUIDE TO AS/NZS 2312:2002 (amdt no.1 2004)

3.4 Project Drivers

3.4.1 Safety

The HV and LV overhead networks are managed in a manner that ensures PWC's obligations to the safety of its employees, contractors and the public are met. The deterioration in crossarms poses a safety risk to the public as well as PWC employees involved in undertaking works on and in the vicinity of the overhead assets and fittings.

The replacement of corroded HV and LV crossarms addresses the public and worker safety risk. The replaced arms will also provide valuable data on expected corrosion rates and common corrosion points, informing a considered long term forecast for annual replacement volumes to efficiently manage this aging asset class without compromising public and personnel safety.

3.4.2 Compliance

A fundamental business driver for PWC is compliance with the Network Technical Code and Network Planning Criteria objective of providing safe, secure, reliable, high quality power supply at a minimal cost.

Targeted replacement will maintain the effectiveness of the overhead HV and LV networks and reduce employee and public risk associated with asset failure, compliant with the business objective.

The development of procedures for the replacement of welded crossarms using live-line techniques is expected to also produce benefits in terms of ongoing operating costs given the ageing of pole assets, particularly in the context of the high proportion of poles and crossarms that are approaching 50 years service.

3.4.3 Reliability (if not compliance obligation)

The HV and LV overhead networks contribute signficiantly to the reliability performance of the network. The condition and failure mode of HV and LV crossarms are recognised in industry for its operational and deteriorating performance impact over time.

Replacement of aged HV and LV steel crossarms will ensure continued maintenance of system reliability and achievement of PWC's reliability performance objectives.

4 Potential Solutions

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

Option 1 - Run to failure

Run to failure is not an industry approach that is applied to pole top crossarms and insulators. The public and worker safety risk and adverse system performance impacts makes this an unsuitable approach to managing HV and LV crossarm assets.

Option 2 - Inspection and repair

This approach involves the routine inspection of HV and LV pole top structures to determine high-priority repairs and to forecast asset failures. Based on a prioritised forecast, asset repairs or replacements are then scheduled.

PWC applies a 3 yearly ground based visual inspection cycle to assess the health of HV and LV pole top structures. Asset replacements are initiated where deemed necessary. The inspection involves a judgement of condition and risk of failure based on a visual assessment. The approach is not considered effective as it is difficult to assess the level of corrosion degradation and remaining structural strength in crossarms from visual inspections. In most cases it is only when severe material decay becomes visible that an assessment is made. This advanced stage of deterioration is preceded by a gradual decay in mechanical strength that is not easily identifiable during routine inspections and carries a high risk.

PWC has been implementing the inspection and repair/replace approach on the HV and LV poletop structures and have recognised the need for a more effective approach to maintain the safe and reliable operation of the network.

Option 3 - Targeted proactive replacement and refurbishment (Preferred Option)

The targeted proactive replacement of HV and LV crossarms in the coastal region of Darwin 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 crossarms taking into consideration asset health and criticality to inform a replacement program. Using the expected corrosion rates and age to inform health, and an assessment of criticality based on the reliability and safety impact of a crossarm failure, the crossarms evaluated to have the highest risk of failure will be prioritised for replacement. The volume of crossarms are projected using health and criticality as inputs into Probability of Failure (PoF) model. Data gathered from crossarms removed can be used to further refine the PoF model.

4.1 Preferred Option

The risk based approach defined in Option 3 has been used to establish a targeted replacement program. A replacement forecast based on the corrosion rates derived from the Wattyl study has been developed. It is expected to cost \$2.4M over the 5 year period and will result in the replacement of 790 crossarms, which constitutes 3.3% of the known steel crossarm population in the Darwin coastal region or 1.4% of the total population of crossarms in the NT regulated network.

Year	2019-20 Qty	2020-21 Qty	2021-22 Qty	2022-23 Qty	2023-24 Qty	Total Qty
Replacement volumes: LV Crossarms	78	82	86	90	93	429
Replacement volumes: HV Crossarms	65	69	72	76	79	361
Total	144	151	158	165	173	790

The program considers asset criticality, health, and probability of failure to prioritise the crossarms that pose the higher risk. Criticality has been determined based on the voltage level, i.e. high voltage or low voltage with low voltage crossarms allocated a higher risk given typical proximity to people. Asset health has been based on location (coastal or non-coastal) and age, and in particular crossarms located in coastal areas and exceeding the expected operational life have been prioritised.

The probability of failure has been based on expected corrosion rates as derived from the Wattyl study. A weighted average of corrosion rates observed around Australia has been used to derive a conservative corrosion rate of 18µm per year and an allowable section loss of 38%. Additionally, crossarms of unknown material (approximately 26% of the population) were excluded from the modelling. More detailed structural analysis of the impacts of crossarm corrosion is in progress and to date supports the potential for a large volume of arms approaching a concerning level of section loss in the next 5-10 years. However the studies are yet to consider the risk associated with the very localised corrosion observed in coastal areas, particularly around the crossarm to pole welds and insulators as shown in Figure 3.

4.2 Non Network alternatives

No non-network alternatives were identified that would mitigate the need for the replacement of HV and LV crossarms.

4.3 Capex/Opex substitution

The proposed HV and LV crossarm replacement program addresses an asset deterioration issue that cannot be solved through operations and maintenance activities.

4.4 Contingent Project

The expenditure does not meet the criteria for a contingent project as outlined in the Northern Territory National Electricity Rules, section 6.6A.1.

5 Strategic Alignment

PWC's objective is to operate a safe and reliable network. Investing in the replacement of aging HV and LV crossarms is aimed at achieving PWC's objectives as set out in the Strategic Asset Management Plan (SAMP), and the Poletops/Hardware Asset Management Plan (AMP).

6 Timing Constraints

It is essential that this project commence as proposed to manage the continued safe and reliable operation of the network.

The peak in the asset age profile associated with the rebuild of Darwin after Cyclone Tracey is a key consideration in establishing a considered and targeted crossarm replacement program, mitigating the risk of a potential step change in failures associated with a large population of similar aged crossarms corroding at a similar rate.

7 Expected Benefits

Driver	Benefit	Measure
Asset Renewal	Network safety Network reliability	Safety index SAIDI/SAIFI performance
Service Improvement	Network reliability	SAIDI/SAIFI performance
Safety	Mitigate increasing public and personnel risk associated with corroding crossarms.	Safety Index

8 Milestones (mm/yyyy)

Investment Planning	Project Development	Project Commitment	Project Delivery	Review
01/2018	NA	07/2019	06/2024	09/2024

The program is scheduled to run for 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 Contracts and Projects
	Senior Manager Asset Management
	General Manager System Control
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 batch of replacements.

11 Delivery Risk

- Site access for the removal and installation of crossarms may need to be negotiated on a site by site basis. These negotiations could impact on the timely and effective delivery of the program. Early stakeholder notification and consultation would assist in managing the delivery of the program.
- Consequential, site specific costs may result from works being undertaken on existing installations in existing built up environments. The expenditure estimates have been based on similar brown field works undertaken in recent years, albeit a small volume in the context of the proposed program.
- Replacement of welded crossarms is not considered a routine task due to the limited historical volume of replacements. Management of hazards associated with similar corrosion risks on adjacent poles requires the development of robust procedures to ensure the safe replacement of arms while minimising disruption to customers. There is

equal risk that robust procedures will improve the efficiency of replacement in some instances, but conversely increase the costs associated with performing some replacements safely.

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 of the highest 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 crossarm replacement capital expenditure for the 2019/20 to 2023/24 regulatory period is provided below. No material capital expenditure over the previous 5 years has been identified. This is an emerging issue resulting in a step change in expenditure for this asset class. The forecast expenditure is shown in Section 12.4 Capex Profile.

12.3 Validation

The cost estimate has been based on recent crossarm replacement works. The replacement of welded steel crossarms is considered unique and difficult to benchmark with other peer utilities.

12.4 Capex Profile

The capex in the table below is in $2017-18, and is excluding capitalised overheads and cost escalation.

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	$430	$451	$472	$494	$516	$2,363
Review						
Total	**$430**	**$451**	**$472**	**$494**	**$516**	**$2,363**

12.5 Opex Implications

No step change in operating cost is forecast for the next regulatory period as result of investing in the replacement of HV and LV crossarms in the coastal region of Darwin.

12.6 Variance

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.