PowerWater

Program Business Need Identification

Power and Water Corporation

NMP16

Zone Substation DC Supply Replacement Program

Proposed:

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Date: 24/11/2017

Approved:

Michael Thomson
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Date: 6/2/2018

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Date: 14/11/2017

Refer to email
D2017/519503

Finance Review
Date: / /20

PMO QA
Date: / /20

1 Program Summary

Program Name:	Substation DC System Replacement		
Program No:	NMP16	**SAP Ref:**	
Financial Year Commencement:	2019/20		
Business Unit:	Power Networks		
Program Owner (GM):	Djuna Pollard	**Phone No:**	8985 8421
Contact Officer:	Stuart Eassie	**Phone No:**	8924 5214
Date of Submission:		**File Ref No:**	D2017/377256
Submission Number:		**Priority Score:**	
Primary Driver:	Renewal/ Replacement	**Secondary Driver:**	Compliance
Program Classification:	Capital Program of Works		

2 Recommendation

MAJOR PROJECT >$1M OR PROGRAM

It is recommended that Investment Review Committee (IRC) note the proposed five year Zone Substation DC Supply replacement program for an estimated budget of $1.19M, 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

Zone substation switchgear and protection systems require DC supplies to operate and to ensure operation during loss of network supply. The reliability of these systems is critical to ensure the safety and protection of people and assets is maintained during both normal and abnormal system events. This is a core requirement of the Network Technical Code.

Batteries have a limited lifespan and performance is monitored using condition assessment techniques such as discharge testing and cell impedance testing. Discharge testing has only been introduced to the maintenance regime in 2017 in recognition of the large proportion of systems approaching end-of-life.

Modern lead acid batteries commonly used in the industry due to their low fire risk have various design lives, however life is reduced based on operating temperature. Most substation batteries are located in rooms without air-conditioning to eliminate the risk associated with explosive hydrogen gas generation associated with battery failures. Experience and technical data sheets[1] show that there is a 50% reduction in battery life for every 10C above 20C. The average temperatures in the Northern Territory range between a low of 23C and a high of 32C[2]

The design life of the batteries in PWC's substation DC systems at their expected operating temperature are shown in Table 1. Limited discharge testing performed in non-air conditioned sites recently has not identified a battery bank beyond 12 years of age with adequate remaining capacity. Further discharge testing is planned in 2017/18 to refine expected remaining life for systems approaching end-of-life.

Table 1 - Battery design life

Equipment Type	Asset Life (yrs) (air conditioned)	Asset Life (yrs) (non-air conditioned)
UXL series	15	13
UXH series	10	9
UXF series	10	9
PJ2V series	15	13

Charging systems including battery management and rectifiers also have a limited lifespan and are affected by age and obsolesce. Once technology becomes obsolete the availability of spares is very limited. A network wide replacement of charging systems was carried out between 2001 and 2007. In 2010 the manufacturer of these systems became insolvent and spares have not been available since then. The life of the fleet has been extended through retaining components from substation replacement projects, sourcing spares from 3rd parties including other utilities and telecommunications industry. These sources are now exhausted.

An assessment of when batteries and charging systems will reach end of life has been used to determine the likely replacement volumes of the next regulatory period[3]. The consequence of failure of DC systems is considered unacceptable due to the system security and safety consequences. Figure 1 below shows the age profile of substation DC systems, indicating an emerging peak in systems reaching end of life during the next 5 years.

[1] D2017/375703 – Sonnenschein Gel VRLA Handbook Part 2 – Page 35 of 73

[2] Bureau of Meteorology website: http://www.bom.gov.au/climate/averages/tables/cw_014015.shtml

[3] D2017/358495 Battery Bank and Charger Age Profile Assessment

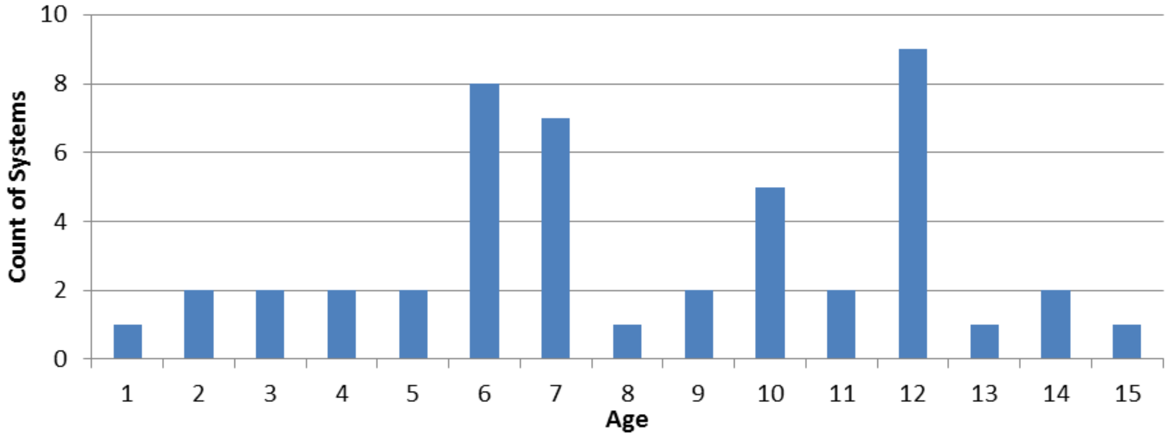

Figure 1 Substation DC System Age Profile

3.1 Project Needs

3.1.1 Safety

Substation DC systems are critical to ensure the safe operation of the electrical network. Functioning and reliable DC systems are required for:

- the correct operation of switchgear operations either as part of daily operations for maintenance of the electrical network or as part of a protection event; and
- the correct operation of protection devices so as to protect people and equipment from power system faults.

3.1.2 Compliance

The Power Networks Technical Code and Planning Criteria Section 2.9 define the requirements placed upon Power and Water Corporation with respect to the provision of Protection Systems. DC systems are a critical component of the overall Protection System.

4 Potential Solution

Substation DC systems are an essential component of network infrastructure. Options considered to deal with end of life include:

Option 1 – Replace on Failure

This option maximises the life of DC systems, taking advantage of redundancy at most substations. However failure of systems is usually only identified during abnormal system conditions when it is critical that DC systems operate as designed. Failure of the DC systems at these times can lead to failure of Protection Systems to operate as designed and/or the capacity to remotely operate switchgear.

Option 2 – Age Based Replacement

This option replaces the systems based on design life and is the lowest risk option to safety and security. It does not maximise the life of modern charging systems which are still supported by various manufacturers.

Option 3 – Condition Based Replacement

This option achieves maximum life where possible through monitoring of condition through to end of life. Where spares are available, charging systems will be retained, even when batteries are replaced. Charging systems will only be replaced when availability of spares compromises the ability to replace failed modules.

4.2 Preferred Option

The preferred option is to replace batteries based on condition which can be directly measured through discharge testing and is part of the Power Networks maintenance strategy for Zone Substation assets. Batteries will be replaced when the condition approaches a stage where the ability of batteries to support DC supplies has deteriorated but not compromised the integrity of substation DC supplies.

Charging systems will be replaced based on the availability of spares and vendor support.

This option is considered the most efficient as it ensures the maximum life is achieved from these systems.

4.3 Non Network alternatives

No viable non-network alternatives have been identified.

4.4 Capex/Opex substitution

Batteries and charging system components are not considered repairable and no Opex substitution options have been considered.

4.5 Contingent Project

This project is not considered to meet the requirements of a contingent project.

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 the infrastructure outlined in this program will contribute to the Corporation achieving the goals defined in the Board's Strategic Directions and SCI Key Result Areas of Health and Safety and Operational Performance.

6 Timing Constraints

To maintain compliance to the Network Technical Code, DC systems require monitoring to safely manage them to end of life. As end of life approaches, planning for replacement must commence to prevent unsafe conditions, particularly due to most systems having batteries banks of identical age.

7 Expected Benefits

Driver	Benefit	Measure
Growth / Demand		
Renewal / Replacement	Network safety	Health and Safety Index
Compliance	Maintain redundancy for critical secondary systems	Compliance to Network Technical Code
Service Improvement	Network reliability maintained	Performance against SAIDI and SAIFI targets
Commercial / Efficiency		
Social / Environmental		

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
	Senior Manager Asset Management
Internal Design Stakeholders	Senior Manager Network Assets
	Manager Substation Services
	Manager Protection
	Manager Test & Protection Services
	General Manager System Control
External – Unions and public	ETU
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 Case's for each individual replacement.

11 Delivery Risk

No delivery risks have been identified for this program. If current standard charging systems become obsolete during the program it is expected enough spares will be sourced to maximise the asset life.

12 Financial Impacts

12.1 Expenditure Forecasting Method

The Expenditure Forecast has been developed based on a Program approach. Replacement volumes have been forecast based on expected end-of-life. Expenditure unit rates are based on a limited number of historical brown field replacement costs and current period contracts for supply of DC systems.

Forecast volumes have been based on the expected design life of the batteries based on the conditions at the locations e.g. air-conditioned or non-air-conditioned. Legacy charging systems installed between 2002 and 2007 without spares will be replaced at the same time as battery banks.

12.2 Historical and Forecast Expenditure

A significant proportion of Substation DC systems have been replaced during the current and previous regulatory period as part of major substation replacement projects. As sites are assessed on a case-by-case basis, historical expenditure is highly variable. Historical, budget and forecast expenditure related to specific DC system replacements is shown below in Figure 2.

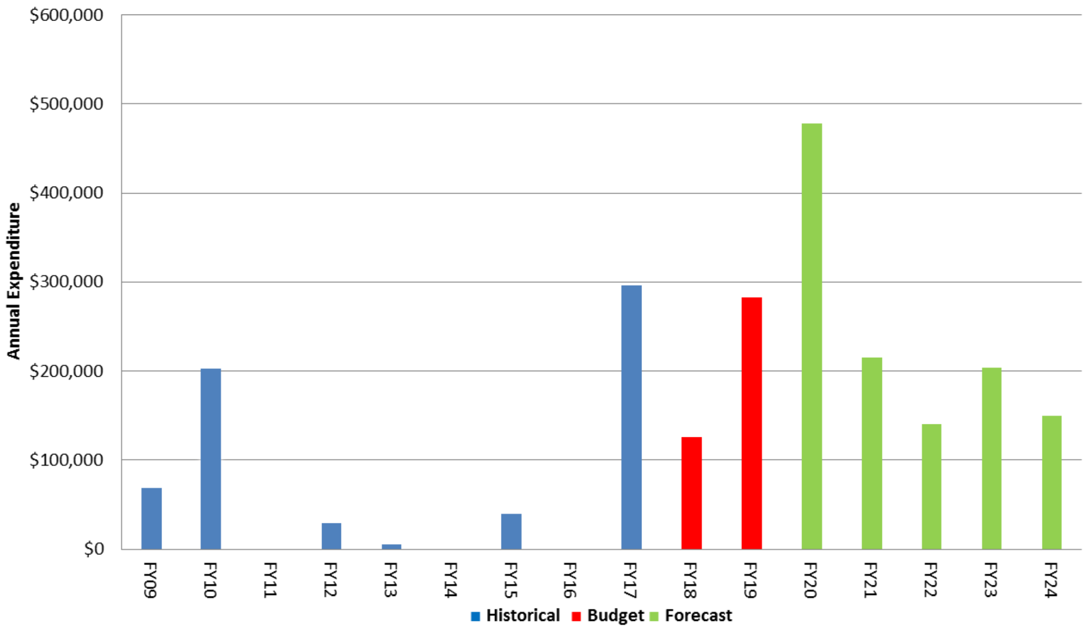

Figure 2 Historical and Forecast Expenditure

12.3 Validation

Where possible the forecast expenditure has been based on current period contract pricing and analysis of previous battery system replacements. Historic replacement costs for brown field replacement scenarios are highly variable and require detailed review of current system configuration as part of the design process. An average cost has been derived from historical replacements performed.

12.4 Capex 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	478	215	140	204	150	**1,187**

Phase	2019-20 ($'000)	2020-21 ($'000)	2021-22 ($'000)	2022-23 ($'000)	2023-24 ($'000)	Total ($'000)
Review						
Total	478	215	140	204	150	**1,187**

12.5 Opex Implications

A reduction in Opex is expected due to the decreasing failure rate of legacy charging systems as they are replaced. As a larger proportion of systems reach end-of-life, corrective maintenance expenditure has increased as shown in Table 2 , mainly due to battery cell and rectifier failures on aged systems. It is expected there will be some reduction in corrective maintenance as systems are replaced, however this will likely be offset by increasing defects on other systems as they age.

Table 2 - Historical Maintenance Expenditure for Substation DC Systems

Fin Year	2012-13 ($,000)	2013-14 ($,000)	2014-15 ($,000)	2015-16 ($,000)	2016-17 ($,000)
Fault Response	0.0	2.4	5.1	1.4	13.2
Corrective Maintenance	3.7	29.5	13.8	50.1	62.5
Preventative Maintenance	19.7	34.6	9.8	22.9	22.4
Total	**23.4**	**66.5**	**28.8**	**74.5**	**98.1**

12.6 Variance

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