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Powerlink Queensland 2013 - 2017 Revenue Proposal

Review of the Effectiveness of the Reliability Centred Maintenance Initiative for

Powerlink

November 2010

The Asset Partnership

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1 Definitions

For the purpose of clarification of terms used in this report the following definitions apply:

Asset	In this context refers to a physical asset or piece of equipment
Failure mode	Any errors or defects in a piece of equipment that will prevent the equipment from achieving its intended function
Failure Finding Interval (FFI)	Also known as fault finding interval, describes the time between functional checks of protective devices
Failure finding task	Also referred to as functional check or fault finding task. It is a maintenance task with the purpose to determine whether a piece of equipment is in an acceptable functional state
Failure Mode and Effect Analysis (FMEA)	A procedure in product development and operations management for analysis of potential failure modes within a system for classification by the severity and likelihood of the failures
Object type	A level in the asset hierarchy that groups like equipment for the purpose of accounting and reporting
Plant section	Category of asset type
Planned Maintenance	Planned Maintenance tasks are often referred to as Preventive Maintenance. These are typically maintenance tasks developed from RCM and carried out at predetermined intervals or corresponding to prescribed criteria, and are intended to reduce the probability of failure or minimise performance degradation of an item. Planned maintenance includes routine/scheduled actions, such as regular patrols or visits for the purpose of inspections or examinations, routine substation maintenance and line patrols. Planned maintenance also includes condition based actions and fault finding tasks carried out at predetermined intervals (for example, time-based or after a certain number of operations), and this includes protection testing, circuit breaker service and oil sampling.
Protective devices	Devices of which failure on their own will not become evident to the operations under normal operating circumstances. Typical protective devices include emergency stop buttons, emergency bunding, standby plant

Reliability Centred Maintenance (RCM)	A formal methodology used to analyse equipment to develop optimised maintenance strategies. Typically used for high criticality equipment.
Unplanned Maintenance	Unplanned Maintenance tasks are often referred to as Corrective Maintenance. These are typically maintenance tasks carried out after a failure or unacceptable condition has occurred or has been identified, and effort is required to restore an item to a state in which it can perform its required function. This includes: • Emergency – must be done immediately to prevent danger to personnel, equipment, or system performance • Deferred – must be done, but may be programmed for later action

2 Background

Reliability Centred Maintenance (RCM) is by far the most rigorous maintenance strategy development tool developed in the aviation industry by Stan Nowlan and Howard Heap in 1978. It is a structured process that utilises the experience of people who manage, operate and maintain equipment to determine the most appropriate maintenance tasks for equipment under a specific operating context.

In 2003, Powerlink implemented RCM as the system to optimise the performance of its transmission network. Powerlink's embracing of this best practice maintenance strategy development methodology was intended to result in improved plant reliability and improved management of safety and environmental risks.

An RCM analysis is conducted by a facilitator with an in-depth knowledge of the process. The facilitator asks questions of an analysis team consisting of people experienced in maintaining and operating the equipment as well as people with technical expertise in the design and failure of the equipment.

Powerlink's RCM programme involves the use of Reliability Centred Maintenance 2 (RCM2) which is an industrial derivative of Nowlan and Heap's RCM. Powerlink adopted the RCM2 methodology developed by the late John Moubray in association with Stan Nolan as it is better suited to the management of an electrical network. The program commenced with the training (consisting of a three-day introduction to RCM2 course developed by John Moubray) of a core group of analysis team members in the RCM methodology who then participate in the analyses. While initial analyses in 2003 were facilitated by an external consultant, one of Powerlink's employees has undertook facilitator level training (a ten day course also developed by John Moubray) for the purpose of facilitating subsequent analyses. The outcome of these initial analyses resulted in maintenance strategies being implemented by the end of 2004.

To-date 87% of Powerlink's total equipment count has been analysed. With improvements in performance, Powerlink are currently seeking an independent and expert review of their application of the RCM process and recommendations on the value of reviewing the remaining 13% of equipment items.

This report presents The Asset Partnership's findings of the review into Powerlink's implementation of RCM, a quantification of the benefits RCM has provided to-date, and recommendations based on predicted benefits of undertaking further analyses.

3 Review

The approach The Asset Partnership applied to this review is illustrated in Figure 1.

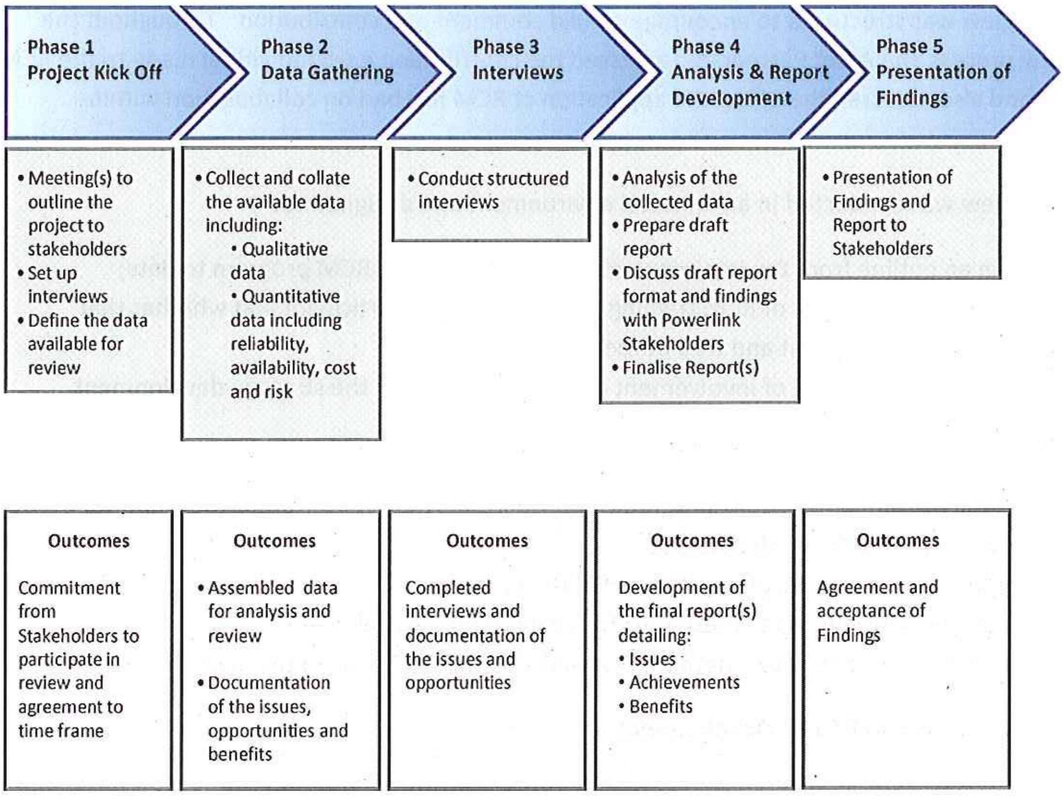

Figure 1: The Asset Partnership's Review Approach

Phase 1 – Kick Off

Prior to the commencement of the review a meeting was held with key stakeholders to outline the review methodology and to agree the timing and the information to be assembled.

Phase 2 – Data Gathering

The validity of the review hinged upon the quantitative and qualitative information available. Data gathered for the quantitative assessment included:

- Asset hierarchy from SAP;
- A copy of the RCM database;
- Examples of completed maintenance tasks derived from an RCM analysis;
- Maintenance costs for assets for the period 2004 to Year To Date (YTD);
- Data of element failures in the period 2004 to YTD;
- Examples of Root Cause Analysis (RCA) of failures in the period 2004 to YTD which are pertinent to the failure of equipment subject to an RCM analysis; and
- Examples of relevant reports on safety or environmental incidents since 2004.

Phase 3 – Interviews

The validation of the data and the gathering of qualitative information were mainly achieved through one-on-one interviews. These interviews were undertaken on the 29 and 30 June 2010. Each interview was structured to encourage candid comment and contribution. Throughout the interview process The Asset Partnership assessed the contribution each individual made to the RCM analysis and also assessed the effect the application of RCM has had on collaboration within Powerlink.

Each interview was conducted in an informal environment and designed to:

a. Gain an outline from the interviewee's perspective of the RCM program to date;
b. Understand the level of RCM training provided to each participant and whether that training was sufficient and well utilised;
c. Understand the level of involvement of the interviewee in the strategy development program;
d. Appreciate how assets were selected and prioritised for review using RCM;
e. Assess the outcomes of the program;
f. Assess the benefits of the program;
g. Appreciate the impact of any failures of the program;
h. Develop an insight as to whether further gains were possible; and
i. Develop an insight as to whether Powerlink obtained value from the investment.

Phase 4 – Analysis and Report Development

This phase was the most substantive component of the review and assessed the technical integrity of Powerlink's application of RCM and whether the approach complies with SAE JA 1011 (the international standard for the application of RCM) and specifically:

- The Functions and Functional Failures for completeness to determine if the RCM process has been applied with sufficient rigor. Specifically we assessed if the functions and the failed states of the assets have been well defined;
- The completeness of the Failure Modes and Effects Analysis to determine whether all likely and credible failure modes are documented and the effects of the failures appropriately recorded;
- Consequence selection, in particular safety and environment consequences;
- Proactive and default task with interval selection;
- The accuracy of converting RCM maintenance tasks to maintenance instructions;
- The overall RCM approach (cultural understanding and implementation); and
- The coverage of the analysis to gauge whether further analysis will generate any significant benefit.

The quality of the RCM database data and of the file structure was also assessed.

Phase 5 – Presentation of Findings

The final phase of the review is the presentation of findings to relevant stakeholders in the form of this report.

4 Powerlink's RCM Methodology

4.1 The RCM Process

RCM has its origins in the aircraft industry in the late 1950s and early 1960s. It was realised that the traditional maintenance philosophy was based on a flawed belief that the majority of failures were age related and could be prevented by scheduled overhauls. Extensive research revealed that only 11% of aircraft components suffered from age related failure (i.e. bath tub, rapid increase and steady increase in probability of failure as illustrated in Figure 2), and a staggering 68% were most likely to fail immediately after maintenance (i.e. infant mortality as illustrated in Figure 2). That discovery necessitated an entirely new approach to determining aircraft maintenance requirements, commencing with MSG-1 in 1968, which was applied to the Boeing 747, and the generic MSG-2 in 1970.

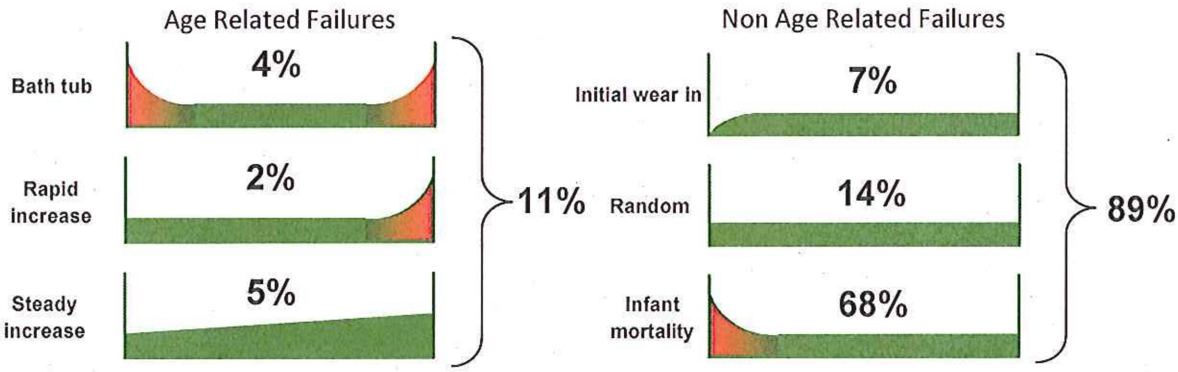

Figure 2: Probability of Failure Over Time

The landmark development in the history of RCM was Stan Nowlan and Howard Heap's 1978 report ("Reliability-Centred Maintenance", report number AD-A066579, United States Department of Defense), which remains the basis of RCM. RCM was rapidly taken up by other industries, including transport, petro-chemical, mining, steel making, manufacturing, and utilities. Powerlink recognised that this seminal work by Nolan and Heap was very relevant to the management of their network assets.

The RCM process, when it is applied in accordance with SAE JA 1011, asks seven questions for each asset or system in its operating context.

The seven questions about the asset or system under review are as follows:

1. *what are the functions and associated performance standards of the asset in its present operating context?*
2. *in what ways can it fail to fulfil its functions?*
3. *what causes each functional failure?*
4. *what happens when each failure occurs?*

5. *in what ways does each failure matter?*
6. *what can be done to predict or prevent each failure?*
7. *what should be done if a suitable proactive task cannot be found?*

The first four of seven questions are answered on the RCM Information sheet (or FMEA) and provide the foundation upon which defensible asset management decisions are made.

The fifth of the seven questions asks how each failure matters, since it is a basic tenet of RCM that what we are trying to avoid is the consequences of each failure, rather than the failure itself. For any task to be worth doing, it must be able to deal successfully with the consequences of failure. The Failure Consequences are grouped into four categories:

- **Hidden Failures:** Hidden failures are functional failures which will not be evident in normal circumstances, and usually concern protective devices which are not fail safe. A large number of the Powerlink systems fall into this category
- **Safety or Environmental:** Failures could hurt or kill someone, or lead to the breach of an environmental standard.
- **Operational:** Where the functional failure will have some adverse effect on operational capability.
- **Non Operational:** Where the only cost is the cost of repair.

The sixth and seventh questions are to establish the most appropriate failure management strategies through either the prevention of the failure or the management of the failed state, or both. The RCM process asks what can be done to predict or prevent failure, or if not, what can then be done. RCM provides strict criteria for assessing if a task is "technically feasible" in addressing the failure mode. The pro-active and default tasks (in order of preference) are:

- **On Condition Tasks:** where items are checked (or inspected) and left in service if they are performing satisfactorily.
- **Scheduled Restoration and Discard Tasks:** where items are either overhauled or replaced at a specified frequency regardless of their condition.
- **Failure Finding Tasks:** where Hidden Functions are checked to determine if they are still working.
- **No Scheduled Maintenance:** where no action is taken to prevent failure.
- **Redesign:** where items or processes are redesigned.

The answers to the fifth, sixth and seventh questions along with the resulting proactive tasks or default actions are entered into the RCM Decision Worksheet.

Tasks are selected only if they are both technically feasible and worth doing. This ensures that tasks that either have little or no effect in reducing failure rates, or are of no benefit, are eliminated from scheduled maintenance routines.

4.2 Powerlink's RCM process

4.2.1 Selection of Assets for Analysis

Starting in 2003 an equipment criticality analysis was used to select the initial group of assets to apply RCM analysis. The purpose of the analysis was to rate criticality of equipment in terms of the following criteria to enable prioritisation of equipment for analysis:

- Affect that the loss of function of the equipment has on the network, safety and the environment;
- Acquisition and maintenance costs; and
- Known problems with the equipment.

Due to the complexity of multiple examples of the same asset type used in various operating contexts, the worst case example was used to determine criticality and hence selection for analysis, i.e. the highest criticality equipment was targeted for the application of RCM over lower criticality equipment.

4.2.2 The RCM Process

Powerlink has chosen RCM2 as their preferred version of RCM as it is the version most closely aligned with the original Nolan and Heap concept. RCM2 was developed by the late John Moubray in association with Stan Nolan and is fully compliant with and aligned with the international standard SAE JA 1011 Evaluation Criteria For Reliability-Centred Maintenance (RCM) Processes. RCM2 is recognised around the world as the industrial version of Nolan and Heap's aviation orientated RCM methodology. A process map for the application and implementation of Powerlink RCM process is shown in Figure 3.

New assets to the network are reviewed following asset commissioning to ensure the asset management strategies are appropriate to the operating context. Since the initiation of the original programme of RCM analyses, existing assets which have not been analysed may be selected for analysis if it has been identified that they have been performing unsatisfactorily.

Due to the nature of Powerlink's assets, a generic analysis is conducted for the object type level. An object type represents a group of like assets such as circuit breakers. The outputs of an object type analysis are applied across the multiple uses of the object type; i.e. for each asset of its kind in the network. While there are slight differences in operating context for each asset of the same object type, these differences are considered to have negligible affect on the outcomes of the analysis.

Following the intense strategy development activity which occurred at Powerlink in early 2003, the application of RCM is now primarily used as a process for review of previous analyses. This review process confirms that failure modes which are experienced are appropriately documented in the analysis and that the assumptions leading to the asset management strategies are appropriate. It is also used for developing maintenance strategies for new assets as shown in Figure 3.

Figure 3: Powerlink RCM2 Analysis and Implementation Process

4.2.3 Review of RCM Outputs

As part of a continuous improvement effort, 22 object types are currently selected for annual review of performance as per Figure 4. Specific to the RCM process, this performance analysis is aimed at:

- Verifying assumptions used to calculate failure finding intervals for hidden failures i.e. mean time between failures and acceptable levels of availability of equipment (process step 9 and step 15); and
- Documenting new failure modes that were not identified at the time of the original RCM analysis or the previous review of the RCM analysis (process step 13).

[redacted]

As previously mentioned, RCM analysis of equipment outside of these select 22 object types will undergo review if the equipment is significantly impacting the business in terms of cost or reliability.

4.3 Powerlink's Asset Hierarchy

4.4 Powerlink's RCM Database

RCM analysis information is managed in a separate database called RCM Toolkit. The RCM Toolkit is a computer application used to assist the documentation of the inputs and outputs of an RCM analysis and is compliant with SAE JA1011. At Powerlink the database is maintained by one person only who has been trained to facilitator level and is experienced with its use.

Linking the RCM analyses to their associated object types it was revealed that 93 out of a total of 151 currently used object types have been analysed to-date. This was then translated into the total number of equipment in the network by multiplying the object types by the number of equipment in each object type. This revealed that 53,902 equipment out of Powerlink's total of 61,811 equipment, i.e. 87% of equipment, have strategies developed using RCM.

The Powerlink RCM data base contains 89 unique analyses, 60 of which were facilitated by The Asset Partnership in 2003. The remaining 29 analyses have been facilitated by Powerlink in the period since 2003.

5 Findings

5.1 RCM Process

5.1.1 Selection of Assets for Analysis

The British Standards Institution "PAS 55:2008 Specification for the optimized management of physical assets", specifies a risk based approach for managing assets. These requirements include identifying asset criticality for the purpose of developing asset management plans, developing contingency plans and monitoring performance.

Powerlink's process for assessing criticality of equipment is undertaken by people experienced in the power transmission industry and with the assets Powerlink manage. This criticality (of low, medium and high) has been used to prioritise equipment for analysis with the RCM process based on overall business risk. This intent is in alignment with the requirements of PAS 55.

The nature of the assets within the Powerlink portfolio is such that the vast majority will fall within the High Criticality ranking.

Powerlink's internal engineering acumen provided an assessment of the criticality of the remaining 13% of assets which have not been analysed. Figure 6 provides a summary of the criticality of this list of object types.

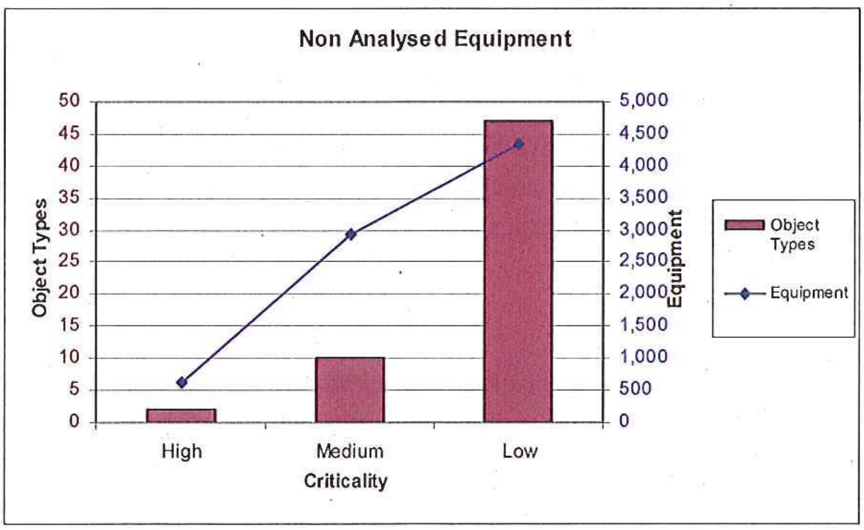

Figure 6: Number of Non Analysed Equipment

Figure 6 shows that there are 2 high criticality object types, 10 medium criticality object types, and 47 low criticality object types which have not had RCM applied to them. Translating this into the number of equipment in each criticality group, there are 624 equipment of high criticality, 2,932 equipment of medium criticality and 4,353 equipment of low criticality. This is compared to the 53,902 that have been analysed to-date. The benefit in further RCM analysis is dependent on the

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criticality of the equipment that remains to be analysed. This presents a strong argument that the benefits of continued analysis are insignificant compared to what has been achieved to-date.

Given this, The Asset Partnership believes the Powerlink decision to not apply RCM2 to the remaining 13% of the Powerlink assets is largely well founded.

Quantification of these potential benefits is discussed further in section 5.7.

5.1.2 The RCM Process

Poor application of the RCM process can fail to produce any or no significant improvement/change in reliability. As can be seen in the data analysis in the following sections reliability has significantly improved during a period of expanding network infrastructure. The Asset Partnership believe this to be a very credible outcome for Powerlink.

A review of a sample of RCM analyses facilitated by Powerlink since 2003 revealed them to be of good quality. During this high level review of the analyses, The Asset Partnership did not detect any significant errors of process which would encourage a more rigorous and detailed review. Without intensively reviewing each analysis with Powerlink's analysis team members it is impossible to assess the technical completeness of either the RCM analysis functions or failure modes but The Asset Partnership see no reason to doubt the coverage of each of the analyses or the competence of the facilitator.

5.1.3 Review of RCM Outputs

Powerlink undertake a review of maintenance strategies through annual performance analysis of a limited number of (currently 22) of selected higher risk object types. As a result of this performance analysis, reliability and cost performance are reviewed and assumptions made during RCM analyses are challenged. This approach encourages continuous improvement to the management of failure consequence of equipment that has the most significant impact of the business.

5.2 Reliability

Powerlink's primary reason for implementing RCM was to improve the reliability of the network components and therefore the performance of the network as whole. As with any implementation of RCM, this improvement is expected to be realised as a step change following the implementation of the recommended maintenance strategies. Powerlink managed to implement the vast majority of RCM derived maintenance strategies by the end of 2004.

Whilst Powerlink undertook a number of improvement initiatives during this time (such as live line and substation techniques) it is The Asset Partnership's assessment that RCM contributed to the reliability improvements made.

As part of the regulatory reporting process, Powerlink is required to report network performance at an 'Element' level. Powerlink's network hierarchy, illustrated in Figure 7, is aligned with this requirement and forms the basis for internal measurement and decision making.

The following analysis of improvements in reliability performance reflects the link between the levels of the network hierarchy. It is recognised that any improvements in reliability of equipment should lead to improvements in the reliability of its corresponding element. Similarly improvements in the reliability of an element should lead to improvements in the reliability of the network.

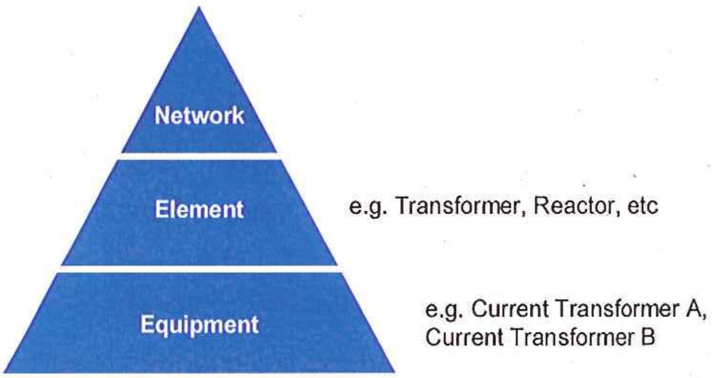

Figure 7: Powerlink's Network Hierarchy

5.2.1 Equipment Reliability

Current transformers are an example of equipment analysed using the RCM process that has since demonstrated significant improvements in reliability. As illustrated in Figure 8 there is a remarkable improvement in reliability of Current Transformers between 2004 and 2006 which has been sustained over subsequent years.

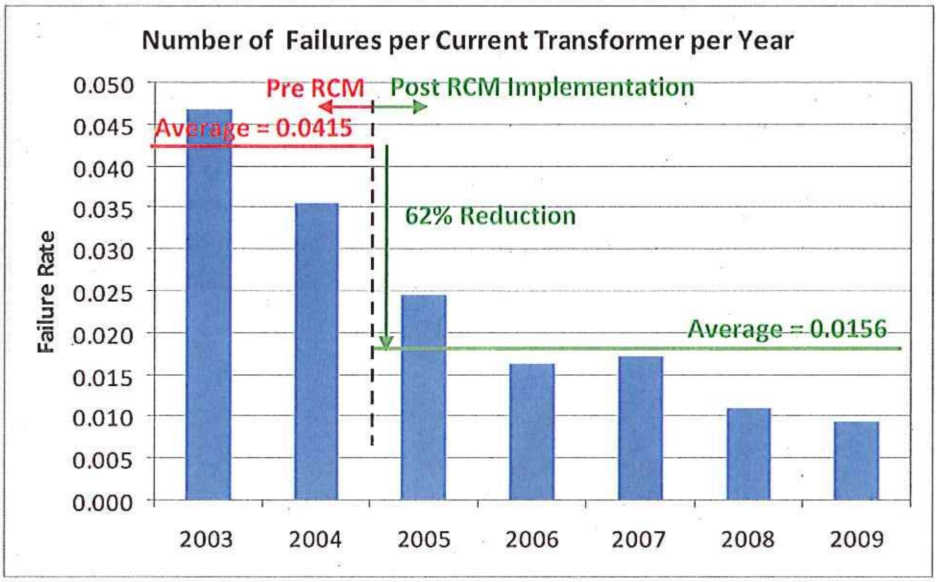

Figure 8: Current Transformer Failures Normalised per Element

The timing for all averages calculated for the purpose of comparison pre and post RCM are based on the assumption that the outcomes from the RCM analyses have been implemented by the end of 2004. Since the increased focus on reliability, failure data recording at the equipment level has improved but unfortunately reliability records at the equipment level prior to 2003 are considered to be incomplete and are discarded from this analysis.

The calculation of the failure rate is a simple division of the total number of failures per year by the maximum number of current transformers in operation for that year.

Based on the data presented in Figure 8 the average annual failure rate of current transformers has reduced from 0.0415 in the period between 2003 and 2004, to 0.0156 from the period between 2005 and 2009. This represents a significant 62% reduction in failure rate between these two periods.

5.2.2 Element Reliability

The reliability improvements realised at the equipment level are also reflected in the improvements at the element level. Figure 9 illustrates the significant step change and sustained reduction in failure rates of Power Transformers.

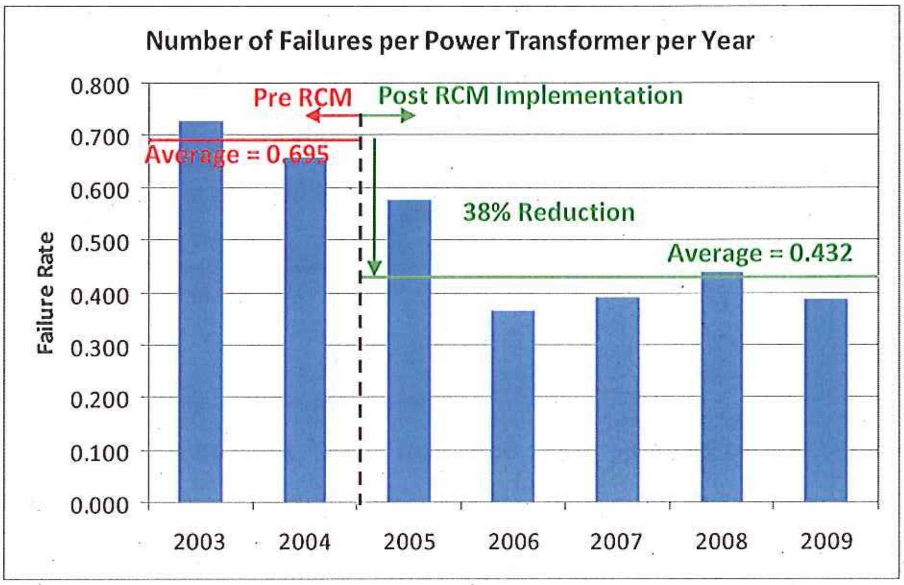

Figure 9: Power Transformer Failures Normalised per Element

Based on the data presented in Figure 9 the average annual failure rate of power transformers was reduced from 0.695 in the period between 2003 and 2004, to 0.432 from the period between 2005 and 2009. This represents a significant 38% reduction in failure rate between these two periods.

5.2.3 Network Reliability

In the period from 2001 to 2009, the reliability of the network has been observed to demonstrate a similar level of step change improvement. This improvement, illustrated in Figure 10, has been achieved despite the network growing in size and complexity. Some improvement has been achieved through other interventions such as the application of modern digital technologies. However, through the application of RCM, it is typical to expect an improvement in equipment reliability as a result of a reduction in intrusive maintenance and the application of more appropriate maintenance tasks.

Based on the data presented in Figure 10 the normalised annual total of forced outages was reduced from 0.586 in the period between 2001 and 2004, to 0.372 from the period between 2005 and 2009. This represents a significant 37% reduction in total forced outages between these two periods.

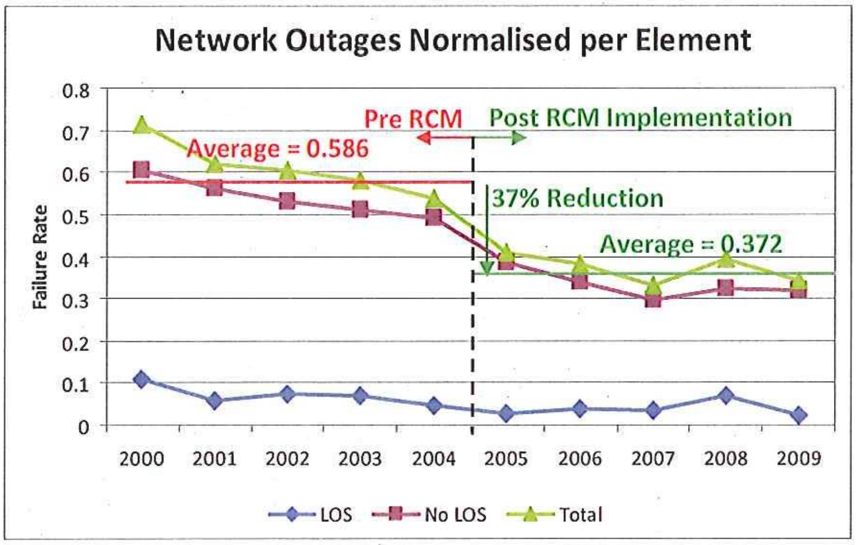

Figure 10: Network Outages Normalised per Element

5.3 Data Analysis and Maintenance Strategy Optimisation

The current detail analysis of a group of 22 object types – which accounts for 19,624 unique equipment items or 32% of the network – provides a means of optimising maintenance strategies at the equipment level. This time intensive, annual task analyses failures down to the equipment level and allows feedback to maintenance strategies based on different behaviours of like equipment from different manufacturers and in different operating contexts. Typical updates to maintenance strategies include the modification of failure finding intervals and other scheduled tasks intervals. Recommendations for future procurement of replacement equipment are also based on conclusions made about various manufacturers of like equipment.

All modifications to maintenance strategies are performed in SAP, the database from which maintenance is planned. The Asset Partnership consider this approach sensible, practical and appropriate given Powerlink's asset base.

5.4 Costs

5.5 Risk (Including Safety and Environmental)

Throughout our interviews and discussions we were made very aware of the importance of risk management to Powerlink and in particular, the performance of the organisation in the management of safety and environmental risk. The RCM2 process deliberately brings safety and environmental performance in the mainstream of maintenance decision making and risk mitigating actions and our review of the RCM database found no evidence that the intent of RCM2 had been compromised.

5.6 Culture

Throughout the interview process we observed a culture which develops and applies asset management strategies to improve longer term reliability and availability.

It is our experience that many (power and water) utilities focus on the immediate and pressing performance issues without a view to the longer term impacts of the immediate actions. The observed culture, driven by Powerlink's asset management practices, not only addresses the immediate performance problems but attempts to maintain a longer term view.

An example of such behaviour is the use of helicopters for general maintenance activities as well as emergency line patrols. Powerlink have found that the use of helicopters provides a cost effective increase in the speed at which inspection activities can be undertaken, particularly in the challenging terrain and environment of North Queensland. The initiative provides a very significant reduction in the need to enter private property or inconvenience landowners as well as releasing ground based resources for other maintenance works.

The Asset Partnership believe Powerlink's culture of looking for innovative 'work smarter' solutions reflects the RCM initiative and the willingness to develop and adopt new processes and technologies rather than rely on traditional approaches.

5.7 Predicted Benefits of Undertaking Further Analysis

The calculation of benefits of undertaking further RCM analysis is not an exact science. However, based on the benefits to-date and the criticality and number of the remaining object types to be analysed, The Asset Partnership feels comfortable in making a reasonable estimate.

The Asset Partnership has assumed that the benefit of analysing one item of equipment that has not been analysed will yield the equivalent benefit of one item of equipment that has been analysed. A rate of improvement in total outage rate based on the equipment analysed can be calculated as follows:

$$\text{Rate of Improvement per Equipment} = \frac{\text{Reduction in Network Outages}}{\text{Equipment Analyses with RCM}}$$

Equipment Analysed with RCM = 87%

Reduction in Network Outages = 37% (as per Section 5.2.3)

Therefore, Rate of Improvement per Equipment = 37/87 = 0.42

Applying this rate of improvement to the total equipment would yield a total improvement of:

100% x 0.42 = 42% reduction

This reduction applied to the pre RCM implementation outage rate of 0.586 (as illustrated in Figure 10) would result in a theoretical total outage rate of:

0.586 x (1-0.42) = 0.340

This theoretical calculation reveals an improvement on the current total outage rate of 0.372, and represents an 8.6% reduction on the average annual outage rate for the last 5 years.

As already explored, the benefit of an RCM analysis is relative to the criticality of the remaining object types. As shown previously in Figure 6, assuming that a uniform benefit can be applied across all assets is significantly flawed. A very small percentage of the remaining assets are critical to the network suggesting there will very little to gain by analysing the low criticality object types - the majority of the remaining object types. The most significant gains through the application of RCM are likely to come from the high criticality object types, which makes up a very small percentage of the remaining object types.

It was determined through interviews that the majority of the remaining object types are to be decommissioned in the near future. Based on experience The Asset Partnership estimate the rate of improvement as a result of applying RCM to the remaining object types to be at best less than one tenth of the rate of improvement seen to-date i.e. 0.42/10 or 0.042. Using this estimate it is calculated the expected annual outage rate is as follows:

0.372 (current outage rate as per section 5.2.3) –

[0.586 (Pre RCM outage rate) x 0.042 (Remaining improvement rate) x 13% (remaining percentage of equipment to be analysed)]

*= 0.372 – 0.003 = **0.369***

Therefore, the reduction of the current total outage rate of 0.372 to 0.369 through the application of RCM to the remaining equipment represents a possible reduction in the current rate. It is considered that this rate of improvement is statistically insignificant.

It is particularly important to recognise that this improvement is based on the total outage rate as opposed to a loss of supply (LOS) events. As the majority of outages do not lead to LOS events, it would be incorrect to assume that this will translate to a 1% reduction in LOS events. However it may decrease the likelihood of a LOS event occurring.

6 Conclusion

Powerlink embarked on a programme in 2003 to apply state of the art reliability strategy development methodology to review the maintenance of network assets. This vision enabled Powerlink to affect a remarkable step change improvement in the reliability of the network during a period of expanding network infrastructure.

At the time of this review, Reliability Centred Maintenance has been applied to 87% of Powerlink's total equipment count to develop the most appropriate maintenance strategies. Analyses have been conducted at the object type level based on Powerlink's criticality assessment process initially targeting high criticality object types. Of the 13% equipment remaining to be analysed, there is only 1 high criticality object types which equates to 0.5% of Powerlink's total equipment count.

Based on a review of analyses conducted by Powerlink, The Asset Partnership believes the RCM process has been diligently applied. The level of training provided to the analysis team members was appropriate to the level of analysis and the process was facilitated in a rigorous manner and in accordance with SAE JA1011 by trained and competent facilitators. The outputs of each RCM analysis have been converted to appropriate field instructions which are generally well written and include an appropriate level of detail for a skilled tradesperson.

Optimisation of the maintenance strategies originally developed between 2003 and 2004 is primarily undertaken through a process of data analysis to a select group of 22 object types. Modifications to failure finding intervals and other scheduled tasks are made in SAP at the equipment level to take into account variations in different equipment manufacturers as well as different operating contexts.

Since the intense initial Reliability Centred Maintenance implementation, the total forced network outages have decreased by 37%. This has been a step change in performance that has been measured as an average since 2005.

During the interview process it was apparent that the organisation considers it gained excellent value from the investment in the RCM process and that the RCM 'way of thinking' is now embedded within the culture of Powerlink. The Asset Partnership has no doubt the RCM initiative played a very significant role in this improvement.

Further application of RCM and other maintenance strategy development derivatives to the remaining 13% of equipment is estimated to produce an extremely small reduction to the current level of total forced outages. The probability that this improvement will translate to any improvement in LOS events due to the inherent redundancy in the network is very small.

RESUME:

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DATE OF BIRTH:	1 July 1953	
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ACADEMIC	1981	Monash University (Gippsland Institute of Advanced Education) Victoria
QUALIFICATIONS:		Bachelor of Engineering Electro Mechanical
	1983	Monash University
		Post Graduate Diploma Asset/Maintenance Management
OTHER RELEVANT QUALIFICATIONS:	1993	Trained and Certified as RCM2 practitioner by John Moubray
MEMBERSHIPS OF	Member of Institution of Engineers, Australia	
PROFESSIONAL BODIES:	Member of the Maintenance Engineering Society Australia (MESA)	
	Chartered Professional Engineer	

OVERVIEW:

Stephen Young is a founding Director of The Asset Partnership and is one of Australia's leading practitioners of Strategic Asset Management and Reliability-centred Maintenance 2.

Over 20 years consulting experience preceded by 15 years industrial experience including senior management roles. Practical experience has been gained in a wide range of industries including mining, railways, water utilities, power generation, transmission and distribution, food and beverage, heavy manufacturing, pharmaceuticals and defence.

Mr Young is one of Australia's leading practitioners in the application of Reliability-centred Maintenance and the use of the process to develop asset management strategies and optimise maintenance, engineering inventory and the strategic management of assets.

POSITIONS HELD

1999 to Current:	Director, The Asset Partnership
1996 to 1999	CEO Favelle Favco
1994 to 1996	Principal Consultant, Price Waterhouse Urwick / PwC
1989 to 1994	Senior Consultant, Price Waterhouse Urwick
1982 to 1989	Professional Engineer (Angove's Distillers and Vignerons, Berrivale Orchards).

RESUME

NAME:	David J Wiley
TITLE:	Associate Director
ADDRESS:	The Asset Partnership Pty Ltd Suite 1, 2 Culdees Road BURWOOD NSW 2136
DATE OF BIRTH:	7 July 1973
NATIONALITY:	Australian
ACADEMIC QUALIFICATIONS:	1995 University of New South Wales Bachelor of Engineering (Manufacturing Management) 2001 University of Technology Sydney Graduate Certificate in Business Administration
OTHER RELEVANT QUALIFICATIONS:	2003 Reliability Centred Maintenance 2 (RCM2) Facilitator Training
MEMBERSHIPS OF PROFESSIONAL BODIES:	Institute of Asset Management UK

OVERVIEW:

David Wiley is a valued member of The Asset Partnership team and a leading practitioner in the development of asset management strategies in complex industrial and operational environments.

With over 15 years of industrial experience in a wide range of industries, including senior strategic roles, David brings and wealth of experience and lateral thinking to the issues of managing critical assets.

David has developed practical experience in a wide range of industries including mining, manufacturing, water utilities, power generation, transmission and distribution, and transport.

David is one of Australia's most capable practitioners in the application of Reliability-centred Maintenance and the use of the process to develop asset management strategies.

POSITIONS HELD

2004 to Current:	Associate Director, The Asset Partnership
2003 - 2004	Team Manager, AMCOR Fibre Packaging
1998 – 2003	Logistics Manager, Site Process Improvement Engineer, Production Supervisor, McPherson's Printing Group
1996 – 1997	Manufacturing Engineer, TRW Steering & Suspension
1993 – 1996	Industrial Engineer, EMAIL Element and Tube Division