

## **RISK MANAGEMENT VERSUS COST MANAGEMENT**

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**Summary:** This paper describes the necessary trade-off between risk management and cost management in a modern, performance-based maintenance contract. Risk management is achieved by an effective, procedural-based PM system implemented using a scheduling process and observing a previously developed resource plan. Through competitive tendering, the resources available to implement this plan are lean – the primary cost driver in such contracts being the scheduled labour commitments. As a consequence a maintenance strategy needs to be clearly established that sets out the task areas for the work force, and then drives a detailed maintenance plan, which in turn drops cards into the regular schedule. A case study describing this process is included where the bulk of the work is made up of PM tasks with little allowance required for corrective maintenance.

### **1. INTRODUCTION**

A modern maintenance contract requires the delivery of expert work using established business systems for either a tendered lump sum or a cost plus process where profit may be separated from recovery of incurred cost and paid on a performance basis. In providing this service it is understood that the client is relying upon the advice, skill and judgement of the contractor in the planning and performance of the maintenance activities.

To facilitate the delivery of the maintenance strategies required in a maintenance contract, the contractor will tailor a generic strategy for a type of site. This strategy is then provided to a number of facilities that are designated to be of this site type. The sites are differentiated by service requirements, complexity of assets, level of manning and criticality. Remote sites are specifically treated differently from sites close to both operational manning and maintenance hubs, where hubs are defined as contractors' depots or local subcontractor facilities.

In the event that another category of facility needs to be added to this list during the course of a contract, the list will be updated and the maintenance approach suitably modified. Hence the maintenance strategy may well evolve throughout the term of the contract, often in response to client concerns. A successful contractor intends to leverage effort and resources as far as possible from a labour pool wider than the specific contract in order to deliver significant cost savings to the client. Using this modular approach the contractor is able to reduce the workload in maintenance optimisation and thereby ensure that optimisation of planned work, expenditure and numbers of dedicated resources is delivered throughout all facilities in the scope of works.

The intent is to identify specific areas for maintenance savings to the client so that key areas are listed for immediate savings in expenditure and the strategy by which these savings may be achieved is identified.

The strategy can change due to the following:

1. Reduction in the scheduled overhaul work – this can be beneficial where maintenance budgets include a set amount based on an assumption of hours under this item.

2. Elimination of forced work by investigations and consequent, less frequent correction activity.
3. Work place efficiency, which will have the outcome of reduced real costs of maintenance.
4. Reduced infrastructure costs such as water and energy expenditure.
5. Extension to the life of capital assets with consequent financial returns associated with delay in commitments.

In this paper the trade-off between risk management and cost management is specifically explored in terms of the maintenance strategy. The primary costs driver is the resource base deployed to the contract, and competitive tendering will mean that this base is lean. This has a flow-on impact on what may be feasibly achieved in terms of risk management let alone continuous improvement. Promises made at the time of tendering may not be delivered due to resource limitations rather than lack of contractor will.

## **2. MAINTENANCE STRATEGY**

A maintenance contractor is expected to have the necessary knowledge and understanding to implement maintenance improvement techniques. One approach is provided below and covers the range of maintenance strategy concepts referred to in this paper. It should be noted that this approach is not undertaken in isolation from external factors such as OH&S obligations, developments in the information systems and the introduction of technology opportunities to upgrade condition monitoring. As the contract progresses, other external factors will come into play, and the implementation strategy is designed to be sufficiently robust to integrate with these.

It shows five key stages, moving across the page:

1. Plant dictionary – identification of assets to be maintained
2. Identification of equipment types
3. Development of Master Plans for the equipment types (eg RCM process)
4. Allocation of Master Plans to specific items of equipment
5. Development of time schedules for preventative maintenance

It should also be noted that these stages are implicit in the maintenance plan provided elsewhere in this tender. The contractor is required to provide PM schedules for the client's assets in accordance with this process. It is critical that the client can remain confident that commitments on maintenance improvement will be fully met in the project term.

A few key points should be noted:

- The process needs to be mapped to the system capability of the works management system – information trapping for work, reliability, costs, spares and so on is necessary to support improved planning and work management
- The process is based on proven methodology – to achieve detailed implementation in the field, the finer points of training, organisation and business systems need to be addressed
- The process is contractor/out-sourcing tolerant – the location of the maintenance resources is not an issue and this assists with the improvement of sub-contractor quality

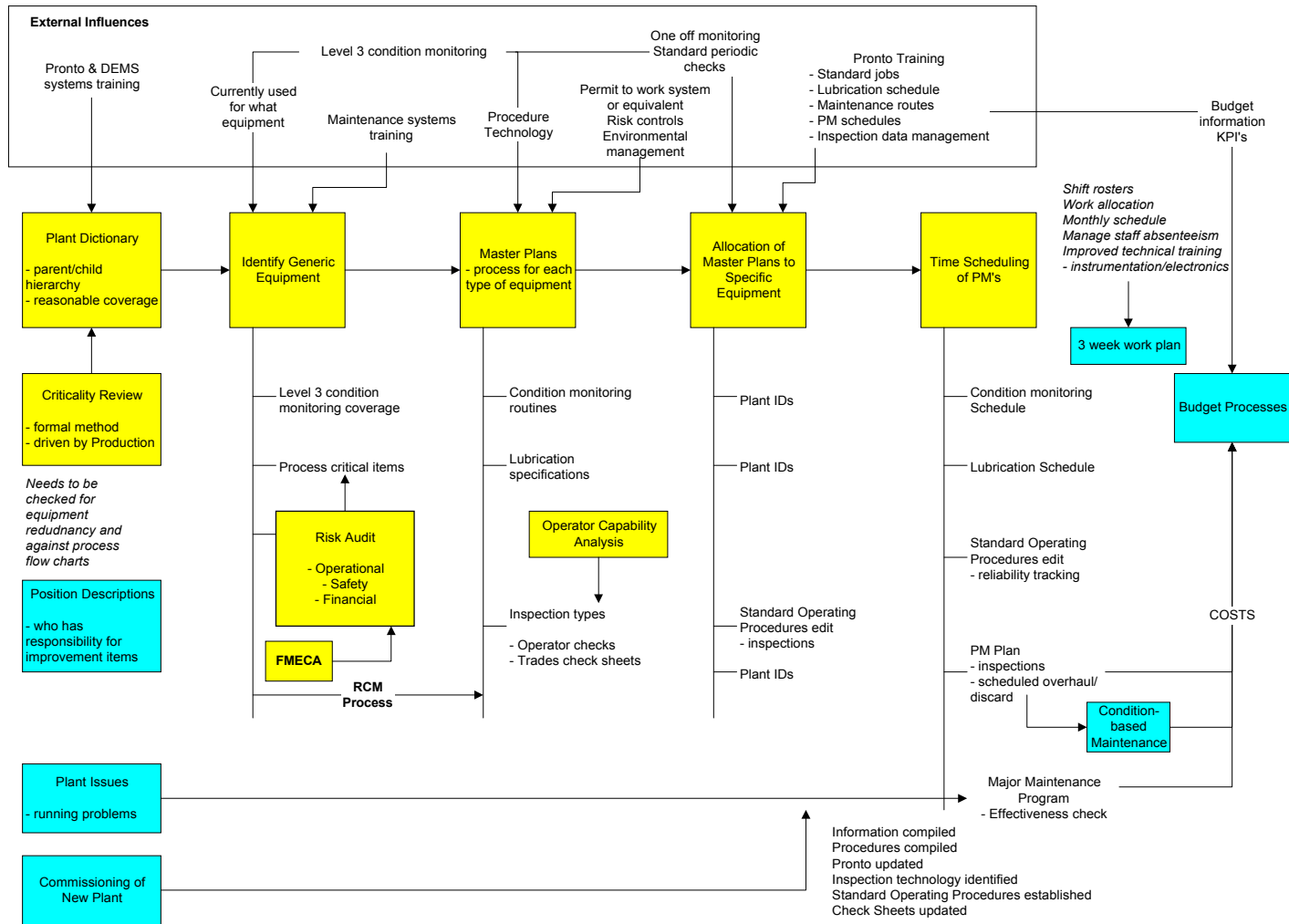


Figure 2.1 Maintenance strategy overview

- The process exploits the use of common types of equipment across many work places, leveraging the contractor's experience from these sites
- The process incorporates external issues such as a Permit to Work System which may be extended to job safety plans attached to procedures, and which are in keeping with the most stringent OH&S requirements

The PM procedures are then attached to work orders issued by the works management system and are responsible for ensuring quality of work completed and a format for data to be collected such as performance measurements and assets condition This process, plus its integration with the works management system is shown on Figure 2.1

Cost savings are sought in the following areas:

1. Reduction of one-off, inefficient corrective maintenance work – reducing shift requirements and moving staff to day work.
2. Reduction of scheduled overhaul/retirement work in major maintenance periods.
3. Reallocation of staff from minor inspection and corrective work to plant improvement work under separate budgets.

Operational savings are sought in the following areas:

1. Avoidance of infrequent, one-off large losses.
2. Avoidance of hidden failure modes, e.g. protection systems, control devices.
3. Capture and solution of minor problems before they become major problems.
4. Improved plant capability through plant improvement work – throughput, control, flexibility, safety, etc.

These factors are the fundamental building blocks of the long-term maintenance strategy in reducing life cycle costs. Cultural improvement, which has intangible benefits, are sought in the following areas:

1. Improved operator communication skills in description of problems encountered during inspections.
2. Information system closing the loop from problem identification to problem closure and feedback.
3. Integrated operator/maintenance problem solving.

Capital reduction may be possible through improved life cycle management, but this is dependant on whether or not functional capability/technology upgrade is the primary driver for expenditure in any case of a capital upgrade. If there are deficiencies in lubrication, smooth running, scheduled replacement of consumable parts and so on, this program will address these issues without having to rely on capital change-outs of worn out equipment or plant.

### **3. RESOURCE PLANNING**

There are three primary sections to the preparation of the Maintenance Plan and establishing the required resources to implement it:

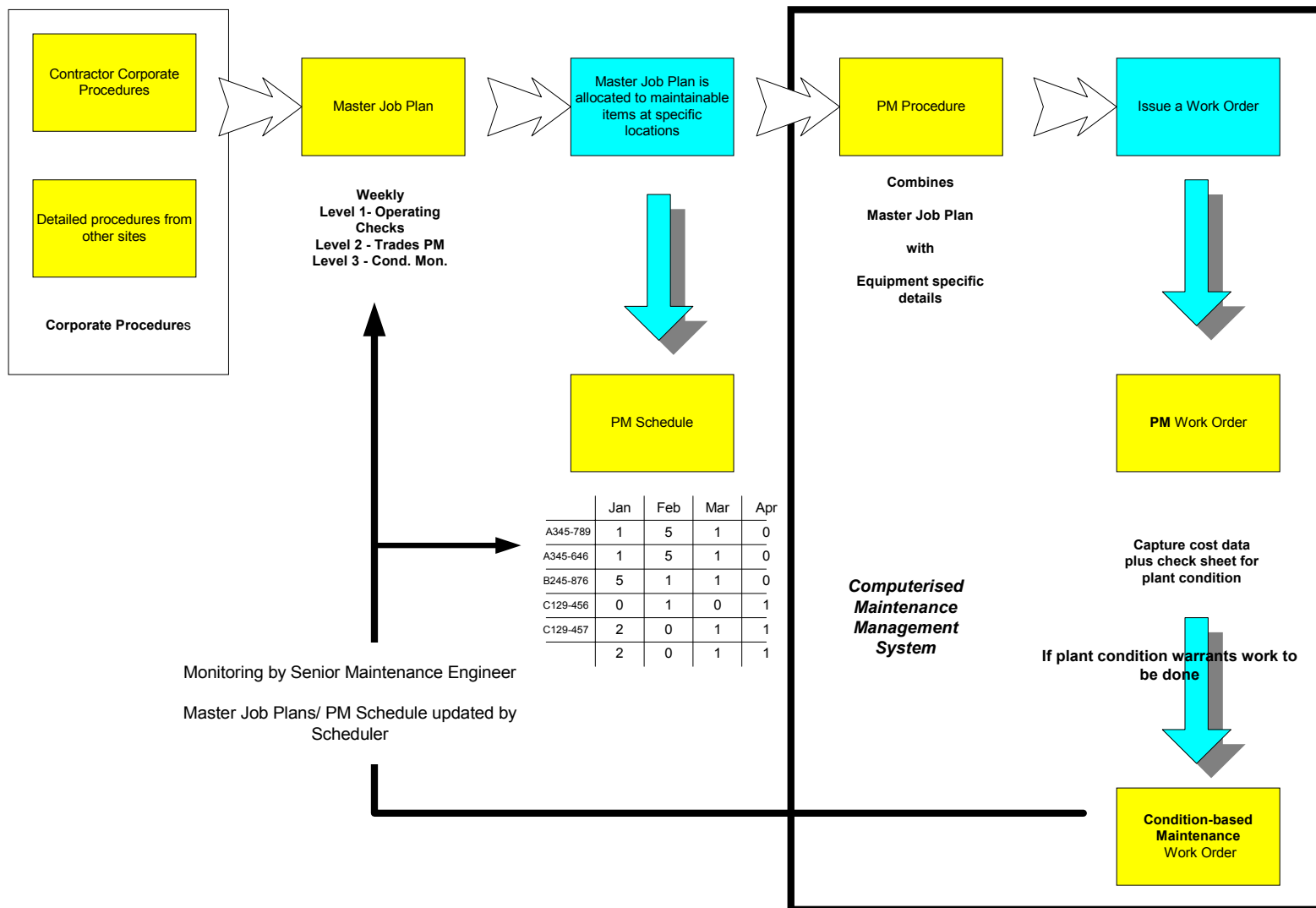


Figure 3.1 Maintenance procedure design

Master Job Plans – the basic procedures employed by trades staff to maintain items. Procedures to be sufficiently well designed that the contractor understands the costs of work and can provide for it in the lump sum portion of the contract. Further, the effectiveness and frequency of each procedure to be sufficient to avoid unforeseen or corrective action, as much as possible.

PM Schedule – a time-based spreadsheet allocating Master Job Plans to specific items of equipment, identifying equipment specific information plus the timing of when the procedures will be scheduled to occur.

PM Procedures – Works management system documents that integrate procedures from Master Job Plans with equipment-specific information, and subsequently can be provided as field data to the trade staff.

### 3.1 Master Job Plans

A contractor should be able to leverage a comprehensive data base of highly refined job procedures, covering the broad range of assets and maintainable items relevant to the client’s site. Each job procedure has a detailed list of tasks, necessary observance of Standards and statutory obligations plus OH&S and criticality information. This process and the use of such Master Job Plans is shown below.

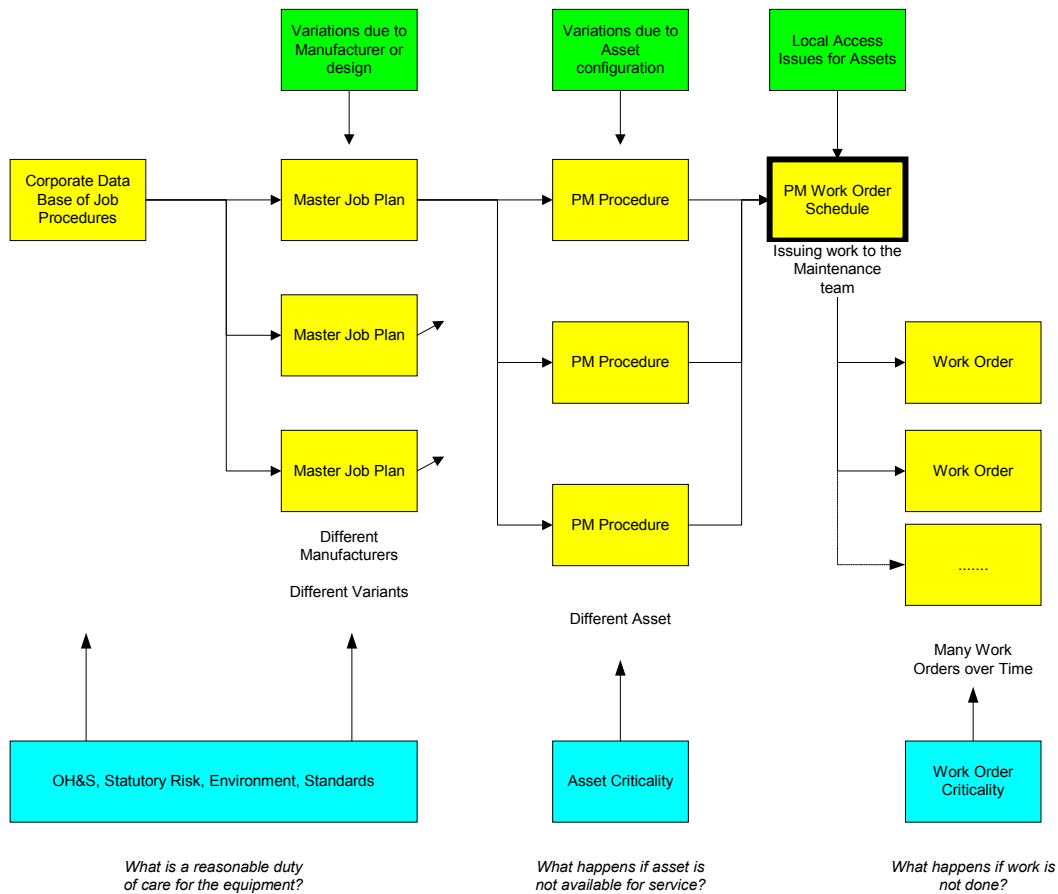


Figure 3.2 Generation of PM Procedures

The figure above highlights the different levels of risk addressed by each stage of generation of procedures, and ultimately down to the work order level. The advantages of this hierarchical generation of PM procedures area follows:

- There is efficiency in the generation of a comprehensive PM plan.
- RCM methodology may be applied at a very high functional level to ensure optimisation of the task list of procedures – this is typically the case of an RCM analysis of Master Job Plans where aspects of design are taken into account.
- Changes in fundamental methodology due to new thinking, experience or the introduction of new condition assessment technology may flow throughout the company, the project and the asset base of a project in an efficient manner.
- The contractor may assure its clients that it has learnt from its extensive contract base and is passing on its learning to all clients in an efficient manner. This represents a fresh approach by the company to improving its service delivery.

#### **4. CASE STUDY**

To demonstrate the approach, the following tables are drawn from actual spreadsheet schedules used in the planned rollout of a maintenance system for widely distributed facilities. This type of maintenance contract may be distinguished for example from maintenance for utilities or manufacturing sites, but the principles translate well into these other applications.

The spreadsheet approach presented here can be used to not only implement the start-up of PM schedules for new sites, but also to manage existing sites' risk profiles by the following:

- Identify potential savings in extending times between services and modifications to scope of works.
- Identify deviations from actual schedules of service by comparison of time sheets and completed PM schedules with the design specification in the spreadsheets.

Supporting the spreadsheets needs to be an extensive database of PM work procedures for a wide variety of plant, to which work associated with each client site will contribute. The reader should scan along the rows across the examples; so that first row of each example table follows on to the first row of the following example table. The first set of tables is drawn from the Master Job Plan sheet.

<b>AreaID</b>	<b>Functional Area</b>
1	Air Conditioning
2	Cold Storage (food)
3	Cold Storage (non-food)
4	Cold Water Retic.
5	Compressed Air
6	Cooling Tower
7	Dishwashers

Functional Area groupings

<b>Job Plan ID</b>	<b>Contractor Procedure No.</b>	<b>Equipment Name</b>	<b>Functional Group</b>
1001		Air Handling Unit	Air Conditioning
1002		Air Handling Unit	Air Conditioning
1003		Chilled Water Valve	Air Conditioning
1004		Compressor	Air Conditioning

Columns 1-4 Master Job Plan Sheet

<b>Manufacturer</b>	<b>Use</b>	<b>Criticality</b>	<b>Performance Requirements</b>	<b>OH&amp;S Requirements</b>
Muller	Climate Control	3	The temperature within the air conditioned environment is required to be 22 degrees +/- 3 degrees C.	Confined space; Guarding of Belts; Electrical Isolation of Motor
Hiflow - Lamina	Climate Control	3	The temperature within the air conditioned environment is required to be 22 degrees +/- 3 degrees C.	Confined space; Guarding of Belts; Electrical Isolation of Motor
Landis & Gyr	Climate Control	3	The temperature within the air conditioned environment is required to be 22 degrees +/- 3 degrees C.	
Carlyle	Climate Control	3	The temperature within the air conditioned environment is required to be 22 degrees +/- 3 degrees C.	Guarding; Electrical Isolation

Columns 5-9 Master Job Sheet



<b>Consumeable Parts</b>	<b>Access</b>
Associated equipment, Filters make: International filter company, model: Pyracube.	Schedule maintenance to be carried out during the facilities normal hours of operation.
	Schedule maintenance to be carried out during the facilities normal hours of operation.
	Schedule maintenance to be carried out during the facilities normal hours of operation.
R12 Refrigerant	Schedule maintenance to be carried out during the facilities normal hours of operation.

Columns 10-11 Master Job Sheet

<b>Time Required</b>	<b>Periodicity</b>					
	<b>Level 1</b>	<b>Level 2</b>	<b>Level 3</b>	<b>Level 1</b>	<b>Level 2</b>	<b>Level 3</b>
(Operational)	(Condition Report)	(PM)	(Performance)	(Condition Report)	(PM)	(Performance)
0	1	4	1	3	12	12
0	1	4	1	3	12	12
0	1	2	1	1	3	12
0	1	2	1	1	3	12

Columns 12-18 Master Job Sheet – Time and Periodicity Allocations

In this work we distinguish between four types or levels of tasks:

Weekly – periodic task that is brief and must be completed every week; typically used for fire equipment checks.

Level 1 – visual and simple inspection; typically conducted on a monthly basis by trades. Some local improvement may lead to Defence personnel conducting these checks.

Level 2 – trades PM; typically conducted on a 6 monthly or annual basis.

Level 3 – comprehensive inspection or condition monitoring check; typically conducted on a 12 month basis.

Level 1 and Level 2 tasks may coincide, in which case the Level 1 task is rolled up into the Level 2 task. The Level 3 task is conducted independently of the other two types of tasks. Procedures are provided for all types of tasks as required.

The data on the Master Job Plan sheet is then automatically picked up in the PM schedule work sheets for a specific site or facility. An extract is shown below.

Equipment ID	Building ID	Condition	Criticality	Item of Equipment	Number of Items
SWHH0054	0382/OH021	3	3	HWS 275 Ltr	1
SWHH0055	0382/OH021	3	3	Circulating Pump H/W	1
SWHH0056	0382/OH021	3	3	Circulating Pump H/W	1
SWHH0057	0382/OH021	3	4	Air Break Tank Registered Non Portable 2000Ltr	1

Columns 1-6 PM Schedule

Functional Area	Master Plan	Manufacturer	Model No.	Serial No.	Location	Site ID
Hot water retic	14006	Rheem	620275N0	572867	PLANT ROOM 1	0382/OH
Hot water retic	17001	Grundfos	UPS-20-60B150	9526DK	PLANT ROOM 1	0382/OH
Hot water retic	17001	Grundfos	UPS-20-60B150	9506DK	PLANT ROOM 1	0382/OH
Retic Serve	31001				PLANT ROOM 1	0382/OH

Columns 7-13 PM Schedule

Hours Required				Months Periodicity			Start Month	Level 3 Start
Weekly	Level 1	Level 2	Level 3	Level 1	Level 2	Level 3		
0	0.5	1	0	3	12	0	1	1
0	0.5	1	0	3	12	0	1	1
0	0.5	1	0	3	12	0	1	1
0	0.5	0.5	0	3	12	0	1	1

Columns 14-22 PM Schedule – Time and periodicity allocations based on Master Job Plans

What the tables above demonstrate is the information requirements in a PM plan. Based on the periodicity and duration of tasks established in the Master Job Plans specifications, plus the start month specified for commencing the PM cycle, it is possible to determine the expected trades hour spent for each item of equipment per month. In the case of facilities maintenance, this is a reasonable estimate of likely man hour requirements, since the duty of the assets is not severe. In more extreme environments such as utilities

or manufacturing multipliers on the PM tasking is required to better anticipate requirements for breakdown and corrective maintenance support.

An extract of the resource plan established in this study is shown below.

All  
Levels

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	2	3	4	5	6	7	8	9	10	11	12
1.5	0	0.5	0	0	0.5	0	0	0.5	0	0	0.5
1.5	0	0.5	0	0	0.5	0	0	0.5	0	0	0.5
1.5	0	0.5	0	0	0.5	0	0	0.5	0	0	0.5
1	0	0.5	0	0	0.5	0	0	0.5	0	0	0.5

Columns 23-35 PM Schedule – Hours per month for all types of work

The hours in the resource plan are sums of time allocated to the various levels of work described earlier in this paper.

The raw numbers in the spreadsheet examples shown above are man-hours. These may be converted into number of trades people required to service the schedule per month through use of the equation:

$$\text{No. of trades people} = \frac{\text{Total man hours of work per month}}{8 \text{ hours/day} \times \text{No. of work days per month} \times \text{Availability}}$$

In this equation it is recognised that some months have less workdays due to public holidays. Moreover, some months have a higher rate of absenteeism due to leave. A further refinement planned for the immediate future is to move from 8 hours per day to a calculated factor that takes into account non-productive time, travel time and other time away from maintenance tasks.

Final results for one notional schedule are shown below. The final results show total numbers of man-hours and total number of trades people required on a monthly basis.

	PM Man Hours				
	Jan	Feb	Mar	Apr	May
Weekly	0	0	0	0	0
Level 1	29.7	20.45	27.95	20.45	20.45
Level 2	52.85	0.5	21.75	0.5	0.5
Level 3	12	0	0	0	0
All Levels	94.55	20.95	49.7	20.95	20.95
	No. of trades staff				

Weekly	0.0	0.0	0.0	0.0	0.0
Level 1	0.2	0.1	0.2	0.2	0.1
Level 2	0.4	0.0	0.1	0.0	0.0
Level 3	0.1	0.0	0.0	0.0	0.0
All Levels	0.7	0.1	0.3	0.2	0.1

Extract from summary report of a PM schedule

#### **4.1 Cost Analysis**

The pricing of the tender is then based on an expected number of resource hours, allowing for the following factors.

1. Direct overheads - leave
2. Statutory overheads – workers compensation, payroll tax
3. Award overheads – superannuation, redundancy

The base rate is established according to the craft type and the numbers of hours per craft may also be extracted from a comprehensive resource plan.

#### **5. SUPPORTING AND REFINING THE MAINTENANCE PLAN**

The contractor is expected to continue their proactive approach by analysing existing data to identify equipment that would benefit from a inspection-based/condition-monitoring program. Perhaps elements of these recommendations will not be taken up straight away, but they will be fed into the maintenance plan review scheduled to occur simultaneously with the identification and addition of new maintainable items to the overall equipment list.

The figure also demonstrates the mobilisation strategy where the continuous improvement process kicks off with risk appraisals and audits of the items, leading to an initial check of the Master Job Plans and PM schedules established within the first period of the contract takeover. This work, driven by the Maintenance Engineer (who may be the Site Manager or some other leading manager) and the Scheduler, will lead to revised equipment plans passed to the client in accordance with the stipulations of the contract.

However this process will not end in the first cycle at the establishment of the contract. It is intended to be a continuous improvement process, with a cycle time of 12 months, leading to an annual review of maintenance performance and financial performance.

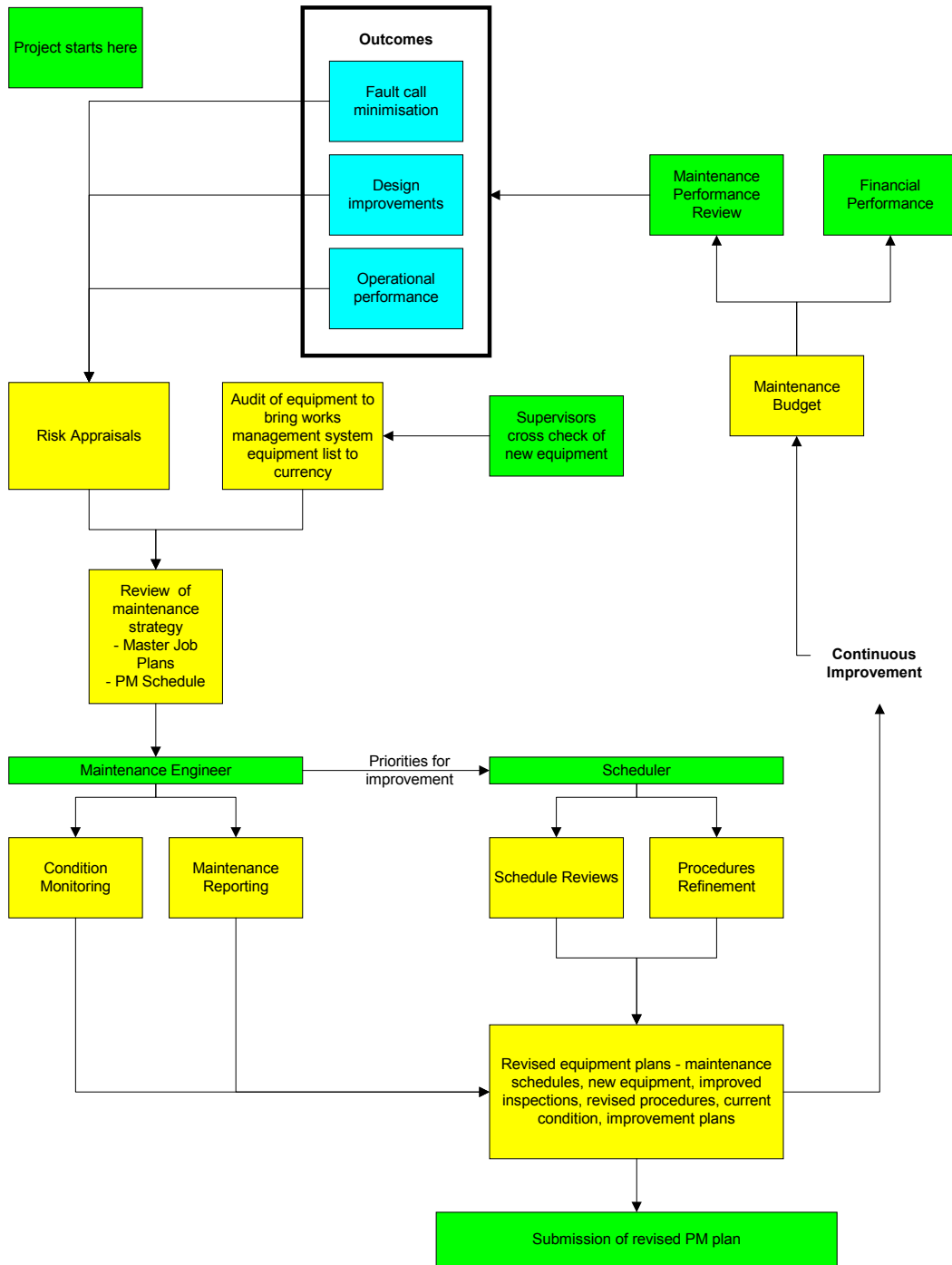


Figure 5.1 Continuous improvement – note the accountabilities

## **6. CONCLUSION**

The PM schedules presented in this paper provide a practical example of the systems and approach a competent contractor employs when developing a PM schedule and associated procedures for a preventative maintenance system. The approach allows for continuous improvement, using the methods described in the paper under a short term and long term maintenance strategy. A short term strategy describes how the contractor will deliver the maintenance plan, and the long term strategy describes how continuous improvement in terms of both risk mitigation and cost down can be achieved.

In order for plant and equipment to continue to operate and maintain the required performance criteria, appropriate statutory, predictive, preventative, reactive and condition monitoring maintenance activities are essential. These tasks can be established within a strategy for specific types of equipment and then procedures applied to instances of these types across the scope of works. This approach can offer substantial efficiencies in maintenance systems design with a proportion of 1 Master Job Plan to up to 100 PM tasks.

Current maintenance strategies, actually independent of whether they be contractor or internal service provider, include:

1. The means to analyse work and expenditure that will identify opportunities for feasible savings and performance enhancement
2. The ability to model projected maintenance costs on the basis of historical performance and the risk profile of the site. This will allow the future costs of providing maintenance to be reduced through applying the most appropriate type of maintenance strategy
3. The ability to improve the planning of maintenance based on knowledge of the condition of assets and measuring the outcomes of the work
4. An improved format for maintenance reporting and monitoring of outcomes
5. Development of the skills of the maintenance and operation team to improve their capability in forecasting future problems, decision-making and corrective action

These elements are contained within a business system as described in Section 2 of this paper and are necessary to create and then maintain the detailed types of schedules described in Sections 3 and 4.

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