Maintenance Myths, Mindsets & Mistakes
Part 1 – Establishing Maintenance Task Intervals

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1. Abstract

This paper sets out some of the most common myths, mindsets and mistakes[1] that are made when establishing maintenance task intervals.

There are four basic types of maintenance that can be applied to equipment. The task intervals for the three 'routine' types of maintenance are dependent on different factors – these factors are often poorly understood. This lack of understanding is a common cause of poor operational reliability and availability.

Successful reliability growth and performance improvement is all about 'doing the *right* maintenance' on the equipment. Determining the '*right* maintenance' takes time and resources.

Experience has shown that the only way to make real, lasting improvement in the maintenance arena is by:

- Changing the way in which people think (ie dispelling all the myths, mindsets and mistakes that have been ingrained in maintainers' thinking over their working life)
- Providing an approach (such as RCM[2]) that encompasses a structure whereby the changed thinking can be brought to fruition.

The most common myths, mindsets and mistakes that are made when establishing maintenance task intervals are summarised in the following paragraphs; a full explanation is given in the subsequent sections of this paper.

There are four basic types of maintenance that can be applied to equipment. The task intervals for the different types of maintenance are dependent on different factors – these factors are often poorly understood. This lack of understanding is a common cause of poor operational reliability and availability.

A common statement that maintainers make is "*We need to check our critical equipment more often than our non-critical equipment*". This sounds like good 'common sense' but is, in fact, wrong for On-condition maintenance.

A common statement that maintainers make is "*It doesn't fail so often, therefore, I don't need to check it so often*". This sounds like good 'common sense' but is wrong for On-condition maintenance.

A common statement is "*We monitor our equipment MTBFs carefully so that we can determine how often we should overhaul/replace equipment*". In fact the task interval (ie the fixed interval at which the scheduled restoration or discard task is carried out) is determined by the "life" of the equipment. Crucially, "life" and MTBF are different.

Many maintainers think that there are just three types of maintenance: *predictive, preventive and corrective* – ie they mistakenly think that *On-condition* tasks (ie predictive maintenance) and *Failure-finding* tasks (ie detective maintenance) are one and the same; they are completely different

The belief that collecting failure rate data leads to better maintenance is, in most instances, a myth. The data we need is rarely available and so key decisions about maintenance have to be made in the absence of hard data.

Organisations that rely heavily on protective systems frequently reduce the maintenance carried out on them in order to reduce overall spend; they assume that the protective systems will operate when required. These systems can and do fail; organisations may be vulnerable to serious consequences if the protected function subsequently fails. Maintenance spend must be directed to where it will do the most good.

[1] See also Maintenance Myths, Mindsets and Mistakes Parts 2&3, *Improving Operational Reliability & Availability* and *The Maintenance Arena* respectively

[2] RCM – Reliability-centred Maintenance. Short-form definition: *"A process used to determine the maintenance requirements of plant and equipment in its operating context"*

2. Introduction

The last 20-30 years have been characterised by massive technological change and most industries have responded by investing heavily in automation and technology to reduce headcount, improve product quality, reduce unit price and improve safety and environmental integrity etc. The net result is that organisations are increasingly reliant on their assets to perform when required.

In some organisations, equipment failure is becoming increasingly intolerable and the consequences of failure can seriously affect safety and the environment or be expensive in terms of lost production or customer service. Some failures are sufficient to threaten the financial stability of the organisation or even force it out of business.

In other organisations equipment failure is much less severe but can still adversely affect profitability or customer service.

Regardless of the industry sector, organisations are striving to increase cost effectiveness – in most organisations improving equipment reliability is the key to overall performance improvement and cost effectiveness. Successful reliability growth and performance improvement is all about 'doing the right maintenance' on the equipment.

Many regard maintenance as 'applied common sense[3]' – in many respects this is true but only if the proponent of the 'common sense' actually understands what he or she is doing. This paper sets out some of the most common maintenance errors that many make when establishing maintenance task intervals.

The maintenance arena is littered with an assortment of myths, mindsets and mistakes which often mean that the resulting equipment maintenance does not achieve the desired outcome, is frequently flawed (sometimes fatally!) and is sometimes plain wrong.

Current management styles demand 'instant results' preferably via a 'quick fix'. Frankly, it is a myth to think that quick-fixes work in the maintenance arena. Achieving reliability growth or performance improvement is neither quick nor easy; if it was, you would have done it by now!

Reliability-centred Maintenance [RCM] is an approach for determining the right maintenance for plant and equipment in its operating context. RCM is not a 'quick fix' but applied correctly, it can transform an organisation's approach to maintenance and hence lead to substantial improvements in equipment reliability, overall performance and cost effectiveness.

There are four basic types of maintenance that can be applied to equipment:

RCM Task Type	***Description***	***Common Synonyms***
On-condition	Check to see if equipment is failing	'Predictive Maintenance', 'Condition-based Maintenance' or 'Condition Monitoring'
Scheduled Restoration & Scheduled Discard	Overhaul or replace equipment before it fails	'Preventive Maintenance' or 'Scheduled Overhauls/Replacements'
Failure-finding	Check to see if equipment has failed	'Functional Checks' or 'Detective Maintenance'
Corrective	Corrective action following discovery of failure or potential failure	'No scheduled Maintenance' or 'Run-to-failure'. Also includes work carried out following other types of maintenance

The task intervals for the three types of 'routine' maintenance are dependent on different factors; these factors are often poorly understood by maintenance technicians and engineers. This is an area rife with maintenance

[3] A dictionary definition of 'common sense' is: *sound practical judgment that is independent of specialised knowledge, training, or the like; normal native intelligence*.

myths, mindsets and mistakes.

Experience has shown that the only way to make real, lasting improvement is by changing the way in which people think (ie dispelling all the myths, mindsets and mistakes that have been ingrained in maintainers thinking over their working life) and providing them with an approach (such as RCM) that encompasses a structure whereby their changed thinking can be brought to fruition.

Part of the RCM process is to confirm that each maintenance task is technically feasible before it can be selected – the technical feasibility criteria ensure that task intervals are selected appropriately and establish the 'common sense' that is frequently lacking when maintenance tasks are determined in the absence of RCM.

Applying RCM correctly takes both time and resources. However, for an organisation with high value assets, the investment required to get the maintenance *right* is often a drop in the ocean compared with cost of getting it *wrong*. Sadly, few maintainers are praised for getting maintenance *right* – many, however, are lambasted for getting it *wrong.*

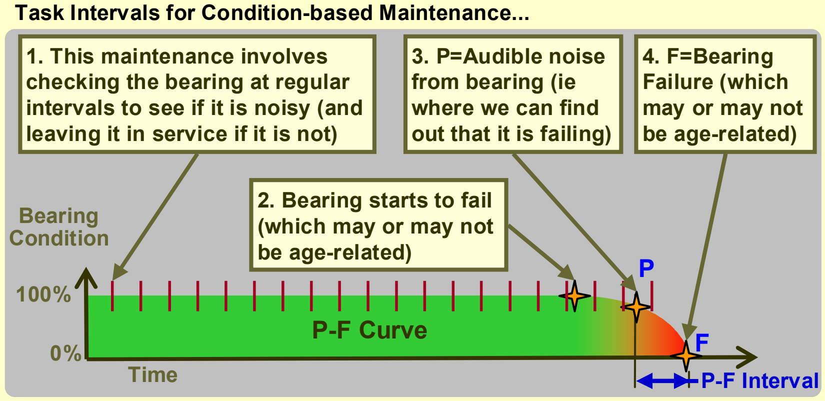
3. Determining Maintenance Task Intervals

Mistakes in determining maintenance task intervals are common (usually because the factors that determine the task intervals for the different types of maintenance are poorly understood).

A common statement that maintainers make is *"We need to check our critical equipment more often than our non-critical equipment".* This sounds like good 'common sense' but is, in fact, wrong for On-condition maintenance. An on-condition maintenance task entails checking equipment to see if it is in the process of failing and only carrying out a corrective maintenance action if it is found to be failing.

For example, a bearing may be checked to see if it is noisy (ie indicating that it is failing) and if it is found to be noisy, arranging for a new bearing to be fitted (ie the corrective action). The task interval is determined by the time taken from the bearing becoming noisy to the point when it, say, seizes; this period of time is referred to as the P-F interval (or the failure development period). So if the P-F interval for the bearing is two weeks, then the bearing must be checked for noise at intervals less than two weeks (this is because the task might be carried out, say, the day before the noise develops and so the equipment would be left in service – the task must be repeated within the P-F interval if the failing bearing is to be predicted). Crucially, the task interval is *not* determined by the criticality of failure.

Task Intervals for Condition-based Maintenance...



*The task must be carried out within the P-F interval if the failing bearing is to be predicted). The task interval is **not** determined by how **often** the bearing fails or the **criticality** of failure.*

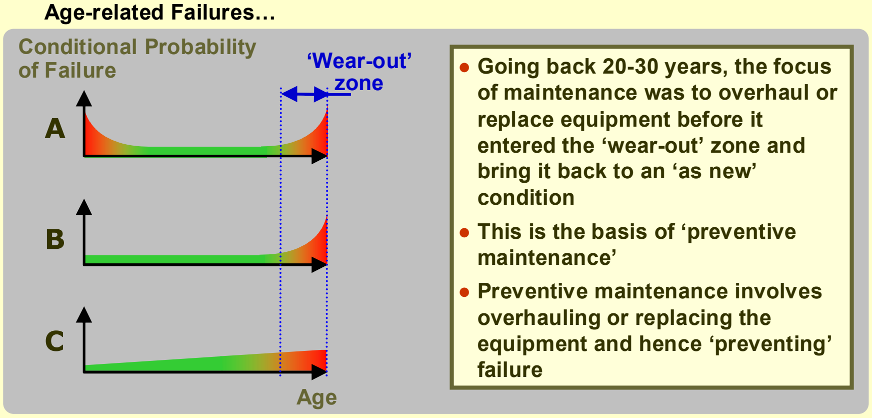
Similarly, a common statement that maintainers make is *"It doesn't fail so often, therefore, I don't need to check it so often"*. Again, this sounds like good 'common sense' but is, once again, wrong for On-condition maintenance.

Continuing the example of the noisy bearing, there is a temptation after, say, 18 months of weekly checks without any sign of imminent bearing failure to decide (incorrectly) that the task interval can be safely extended to, say, two weeks. After, say, a further 18 months of two-weekly checks without any indication of imminent bearing failure the decision is taken to increase the task interval again to, say, one month. By extending the task interval the cost of the on-condition maintenance has been significantly reduced but the likelihood of the task predicting the failure is also significantly reduced. When (after, say, a further year) the bearing eventually fails and the consequences are suffered (because the task failed to predict the failure), the credibility of on-condition maintenance is questioned and even considered to be a waste of time. The task must be carried out within the P-F interval if the failing bearing is to be predicted). Crucially, the task interval is not determined by how often the bearing fails.

Another statement that is common is *"We monitor our equipment MTBFs carefully so that we can determine how often we should overhaul/replace equipment"*. In fact the task interval (ie the fixed interval at which the scheduled restoration or discard task is carried out) is determined by the "life" of the equipment.

In essence, scheduled restoration and scheduled discard tasks prevent failures occurring by either restoration or replacement before an age-related failure occurs. Failure patterns A & B suggest that (if the initial period in A is ignored) the equipment is more likely to fail after it has reached a certain 'age' (ie the point at which the conditional probability of failure starts to rise rapidly). In RCM this 'age' is referred to as the "life" of the equipment (or sometimes the 'useful life').

Age-related Failures…



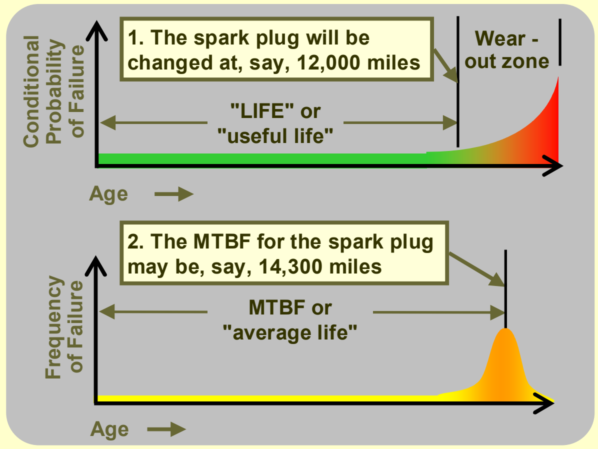
*Failure patterns A, B and C generally apply to simple items of equipment or complex items that have a **dominant** failure mode. The failures are usually characterised by erosion, corrosion, wear or fatigue etc.*

For failure pattern B, the frequency of failure typically peaks at some point after the end of the "life"; the point at which the frequency of failure peaks is sometimes referred to as the 'average life' or the MTBF.

Crucially, "life" and MTBF are different figures and if they are confused and the MTBF is inadvertently used to determine the task interval for a scheduled restoration or discard task, then many failures (on approximately half the asset population) will occur before the task is carried out.

> For example, on a petrol engine car it is normal to replace the spark plugs every, say, 12,000 miles as experience shows that starting, performance and emissions may be adversely affected if the plugs are not replaced. The actual MTBF (ie the 'average life') may be significantly longer than 12,000 miles.

The difference between "Life" & MTBF...



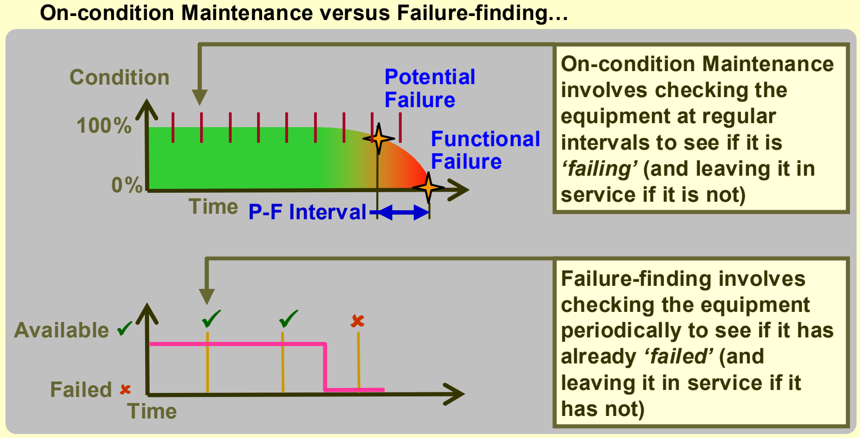
The spark plug will be replaced before it enters the wear-out zone. The task interval is determined by the "life".

The "life" and MTBF are different figures and must not be confused.

Many maintainers think that there are just three types of maintenance: *predictive*, *preventive* and *corrective*. In doing so they have made the common mistake of confusing *On-condition* tasks (ie predictive maintenance) and *Failure-finding* tasks (ie detective maintenance) and thinking that they are one and the same; they are completely different.

On-condition tasks involve checking to see if the equipment is 'failing' so that an imminent failure can be predicted; as described above, the task interval is determined by the P-F interval. A Failure-finding task, however, is checking to see if the equipment has already 'failed'; in this instance the task interval is calculated formulaically and does depend on the criticality of failure and the failure rates of the equipment concerned. The aim of a Failure-finding task is to improve the availability of the equipment (so that its probability of being in a failed state when required is tolerably low).

On-condition Maintenance versus Failure-finding...



For On-condition maintenance, the task interval is set to be less than the P-F interval; for Failure-finding, it is determined formulaically.

4. Failure Rate Data

Many organisations have a (sometimes obsessive) desire to collect data so that they can calculate equipment failure rates in order to iterate to an even better maintenance schedule in the future. This myth is promoted by many in the maintenance arena (often because they have a vested in interest in encouraging organisations to collect historical data) but the usefulness of the information gathered is dubious:

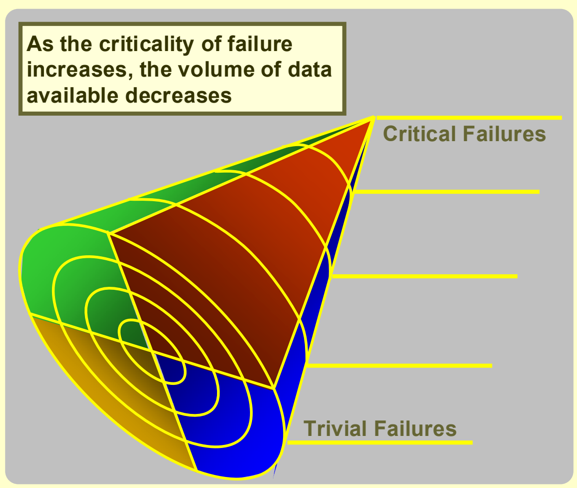
- It takes a substantial investment in time and resources to make sure that the data quality (adequacy, accuracy, relevance etc) is good; for most organisations, this investment is not normally justifiable (except where the consequences of failure are very severe)

- In terms of equipment maintenance there is the problem of what has become referred to as Resnikoff's[4] Conundrum. Simply put, the problem is that in order to collect failure data, there must be equipment failures. In order for there to be equipment failures, then there must be either no maintenance program in place to prevent these failures (which is quite likely for trivial failures), or the maintenance programme that is in place is inadequate. Hence for most organisations with a half-decent maintenance programme, monitoring equipment failures is unlikely to secure statistically significant data about failures that matter (which is the information we need) whereas we might well be able to secure statistically significant information about failures that do not matter - ie those failures we allow to occur - which is unlikely to be of much use
- Large populations of equipment with the same functions and (sufficiently) similar operating contexts are rare (except for some operators of large vehicle fleets, large utility companies or specialised OEMs that are closely involved with the operation and maintenance of their products). Most industrial organisations do not have many multiples of identical equipment operating to the same system requirements and under the same operating context. The net effect is that data gathered about failures is rarely sufficient to be statistically significant (even if it is collected over a protracted period of time).

With the exception of failure-finding tasks, the failure rate of equipment is not used to determine maintenance task intervals. The failure rate is, however, used to determine whether or not maintenance is *worth doing* and in determining spare parts stocking policy.

In summary, therefore, the belief that collecting failure rate data leads to better maintenance is, in most instances, a myth. In practice serious decisions about maintenance have to be made with inadequate hard data simply because the data that we need is rarely available. RCM provides a framework to highlight what information is needed and a structure to enable RCM Analysis groups to make the necessary decisions about maintenance task intervals (in particular) in the absence of hard data.

Failure Rate Data...



The belief that collecting failure rate data leads to better maintenance is, generally, a myth.

In practice serious decisions about maintenance have to be made in the absence of hard data (simply because the data that we need is rarely available).

5. Protective Systems

In modern, high risk process plant it is not uncommon for the maintenance of the protective systems to account for more than 30% of the maintenance labour spend on site; the reason for this is simply the number of these systems that have been installed (and need on-going maintenance).

Organisations that rely heavily on protective systems frequently make the mistake of assuming that their protective systems will act when required (ie if the protected function fails) and reduce the maintenance carried out on the

[4] HL Resnikoff, Mathematical Aspects of Reliability-centered Maintenance, 1978

protective systems to save money. However, protective systems can and do fail.

Over the years, the introduction of technology solutions and automation into many organisations was primarily focused on reducing product unit cost (largely by increasing throughput and reducing headcount - particularly production personnel). This transition has been successful in many industries and most organisations now rely very heavily on the installed technology and automation.

In addition to reducing product unit costs, the wide-scale application of technology and automation has done much to improve safety and environmental integrity. Many high-risk industries are very reliant on automation to ensure safety and environmental integrity - the risk of major incidents occurring has been reduced substantially by the introduction of protective systems (which are often configured in 'layers' so that failure of any one protective system is protected by another protective system etc).

The large population of protective systems installed and the level of protection provided does come with a risk - complacency on behalf of the maintainers (which is further compounded when organisation are under financial pressure to reduce spend). Automation in general and protective systems in particular can and do fail; some modern control systems are designed to identify and sound an alarm if there is a failure in the protection system but many do not. In practice, organisations may well be unaware that protective systems are in a failed state which, in turn, makes them very vulnerable to serious consequences if the protected function subsequently fails.

There have been some significant headline industrial accidents that have occurred because protective systems have been in a failed state when called upon to operate; several of these incidents have been as a direct result of complacency with regard to protective systems and some have been attributable to maintenance cost-cutting.

RCM allows organisations to determine the maintenance requirements of the protective systems so that the combined probability of the system being in a failed state when the protected function subsequently fails is reduced to a tolerable level. This ensures that maintenance spend is directed to where it will do the most good.

Protective Systems...

- E-stops
- interlocks
- shear pins
- check valves
- rupture discs
- gas detectors
- stand-by plant
- warning signs
- pressure switches
- vibration switches
- overspeed switches
- pressure relief valves
- temperature switches
- ultimate level switches
- emergency medical equipment
- overcurrent circuit breakers and fuses
- emergency clothing and breathing apparatus
- secondary and tertiary containment structures
- fire systems (detection, warning and fighting etc..

Organisations that rely heavily on protective systems sometimes reduce the maintenance carried out on these systems to save money (mistakenly assuming that the protective systems will act when required).

Protective systems can and do fail – sometimes with disastrous results when the protected function then fails. Some of the world's biggest accidents are a result of protective systems not working when required.

6. Conclusion

The drive to improve cost effectiveness has led organisations to focus on increasing equipment reliability so as to improve overall performance (and hence cost effectiveness). Successful reliability growth and performance improvement is all about 'doing the *right* maintenance on the equipment'. There is a great temptation to improve cost effectiveness by reducing maintenance budgets – this works in the very short term but not in the medium and longer terms.

The maintenance arena is littered with an assortment of myths, mindsets and mistakes which often mean that the resulting equipment maintenance does not achieve the desired outcome, is frequently flawed and is sometimes plain wrong. In particular, it is a myth to think that quick-fixes work in the maintenance arena. Achieving reliability growth or performance improvement is neither quick nor easy; if it was, you would have done it by now!

Reliability-centred Maintenance [RCM] is a proven approach for determining the *right* maintenance for plant and equipment in its operating context. With its beginnings in the demanding civil aviation industry, RCM is not a 'quick fix' but applied correctly, it can transform an organisation's approach to maintenance and hence lead to substantial improvements in equipment reliability, overall performance and cost effectiveness. RCM optimises the maintenance for the on-site equipment and in so doing ensures that money spent on maintenance is spent where it will do the most good.

Applying RCM correctly takes both time and resources. However, for an organisation with high value assets, the investment required to get the maintenance *right* is often a drop in the ocean compared with cost of getting it *wrong*. In brief, the return on investment for RCM is substantial provided that the assorted maintenance myths, mindsets and mistakes are dispelled and the *right* maintenance is implemented.

7. Further Information

This paper was written by Simon Deakin and Steve Bailey of Mutual Consultants Ltd. See also Maintenance Myths, Mindsets and Mistakes Parts 2 & 3, *Improving Operational Reliability & Availability* and *The Maintenance Arena* respectively.

Please do not hesitate to contact either of us for more information on how RCM can transform equipment performance and achieve desired operational reliability and availability:

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