

**The Lifetime Reliability Solutions
Certificate Course in Maintenance and Reliability
Module 1 – Introduction to Principles of Reliability and Precision Maintenance**

**Session 1
AN OVERVIEW OF MAINTENANCE**

This introductory session will give an overview of the key words and concepts used in addressing plant reliability improvement. Improvements in plant reliability will be a direct function of the effectiveness of managing:

- Maintenance Costs
- Condition Monitoring
- Failure Analysis
- Reliability Improvement

It is necessary to understand what is meant by these terms and, more importantly, what they mean in the context of various workplaces.

1. Maintenance

A Definition: Maintenance describes the management, control, execution and quality of those activities which will reasonably ensure that design levels of availability and performance of assets are achieved in order to meet business objectives.

Maintenance management has until relatively recent times been a subset of the operations function but now it is recognised as a key element of asset management for the required lifetime of an asset. It is much more than “fixing things up”.

If maintenance expenditure is viewed as the necessary premium to be paid for reliability insurance, then it follows that all maintenance activity should be directed towards maximum returns on that investment, ie improved reliability. Rarely is that found to be the focus. Usually the emphasis is on returning the machine to service as quickly as possible without any serious consideration of reliability improvement while the opportunity is presented.

- Maintenance is a Risk Control activity.
- Risk = Probability x Consequence

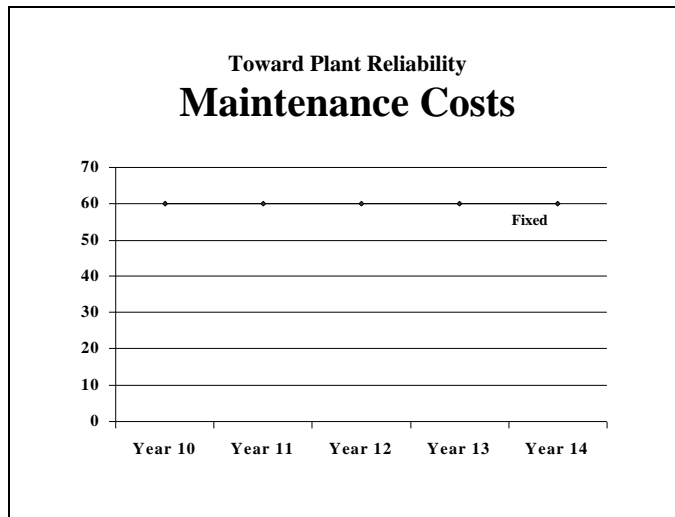
The expenditure of maintenance dollars on risk management (eg condition monitoring, process control, etc) should be directly related to the probability and consequences of failure. This is a very significant decision point in the management of condition monitoring expenditure!

Often reasonable judgements based on experience can be made without the rigour and expense of exhaustive failure modes analysis. Sometimes, however, a formal risk assessment must be made and decisions made based on those outcomes.

- **Core maintenance activities are defined by design and process.**

The ‘base load’ of maintenance activity in a plant is determined by the sum of all the maintenance activities specified by the designers and OEM’s. Operational experience may also dictate certain maintenance activity (eg de-scaling every four weeks).

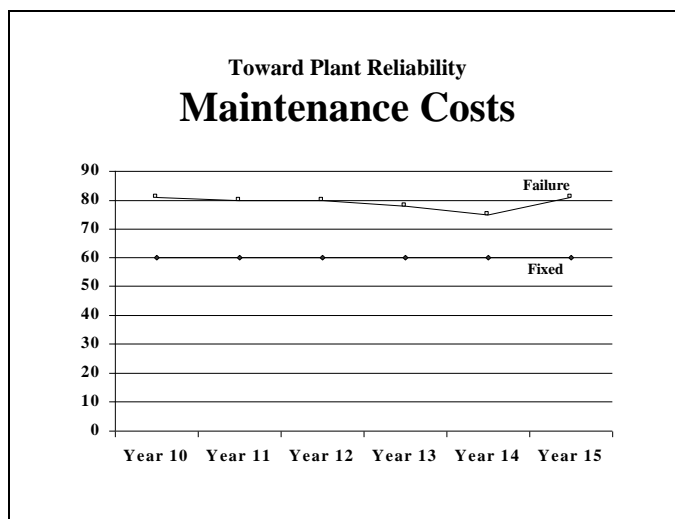
The cost of the ‘base load’ of maintenance is estimated at the project investment analysis stage as one of the costs of production and is budgeted as such. The chart below shows an idealised situation where the ‘base load’ maintenance costs in a mature plant are the same each year.



- **Additional maintenance activity results from premature equipment failure.**

While the ‘base load’ maintenance costs in a mature plant may include an allowance for unexpected failures, it is often the case that significant additional maintenance costs are incurred in dealing with premature equipment failures.

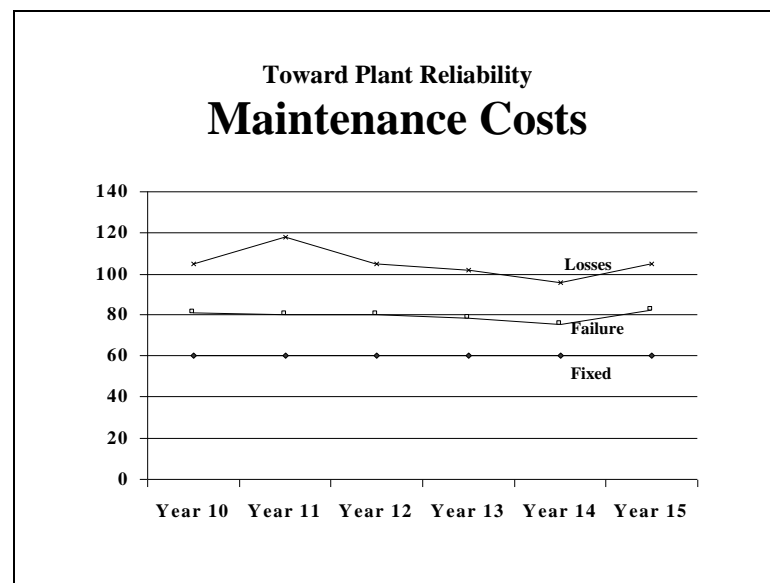
What is the additional cost of premature equipment failure in your plant? Do you know? Could you find out?



- **Unexpected failures may incur other costs or losses.**

Premature equipment failure may also incur other costs such as lost production, diversion of planned maintenance resources, penalties for late delivery, etc.

Are you aware of typical figures for these consequential losses in your plant? Could you find out?



- **Effort should be put into eliminating equipment failures.**

If you have been able to determine the total cost of premature equipment failure and the consequential losses in your plant, you have set yourself a target for profit improvement!

2. Reliability

A Definition: Ability of a machine/system to perform its intended function as and when required.

The reliability of a machine or system is only as good as its weakest link. These ‘weak links’ need to be identified and managed with a view to eliminating them.

- **Maintenance cannot achieve reliability beyond design limitations.**

The design limitations of a machine (wear, corrosion, mechanical integrity, etc) will always define its service reliability. Even the best quality maintenance will have little influence on these service barriers.

- **Reliability can be improved by design corrections.**

The whole maintenance team can potentially have a significant input to the process of designing out faults or minimising them. A different focus on maintenance activity is required using every opportunity to understand the cause and process of each failure and documenting this information.

- **Reliability is reduced by poor workmanship, incorrect operation etc.**

Uninformed or disinterested maintenance work can reduce reliability well below design potential and lead to premature failures. Likewise machine operation or ‘housekeeping’ activities (like hosing down) without regard for design limitations will almost certainly lead to premature failure.

3. Availability

A Definition: The proportion of total time that an item of equipment, or a system, is capable of performing its specified function, normally expressed as a percentage.

Availability of a machine or system is a budget item for the plant operating budget and should therefore be a critical KPI in any production plant. Machine reliability may affect achieved availability and thereby directly affect profitability.

Utilisation of Availability.

Availability demands will greatly influence the choices in maintenance strategies, including Condition Based Maintenance. This is the first and most fundamental determinant of investment in risk minimisation.

- Continuous process plant – availability is a critical function of production
- Less than continuous operation – availability may not be so important
- Maintenance strategies will be heavily influenced by availability criteria.

4. Failure

A Definition: A Failure has occurred when an item of equipment, or a system, is not capable of performing the duty for which it is intended.

Premature failure has many different causes. Root Cause Analysis is the optimum approach to understanding ‘why’ and taking appropriate corrective action. Failure management will be dealt with more extensively later in the course.

Typical causes of premature failure include;

- Incorrect assembly or installation
- Incorrect operation (load, temperature, speed)
- Lubrication factors
- Poor design or component quality
- Ingress of abrasive or corrosive elements

5. Condition Monitoring

A Definition: The process of systematic data collection and evaluation to identify changes in performance or condition of a system, or its components, such that remedial action may be planned in a cost effective manner to maintain reliability

While the basic definition of **Condition Monitoring (CM)** may have general application across many industries, the objectives for **Condition Based Maintenance (CBM)** may vary greatly.

- **CM uses selected measurements to detect changes in operating conditions.** Many failure modes have measurable responses and develop over periods of time. These are the ideal applications for CBM. Sampling may be continuous, (eg turbo-machinery) or periodic (eg monthly survey on conveyor drive).
- **CM gives early warning of potential failure.**

If the measured parameters are well chosen and properly measured and analysed, there will be valuable information gained for maintenance planning purposes. It is essential that what defines 'normal' is understood and documented so that the severity of variations can be measured.

- **CM gives information about the nature of the failure.**

From this a prognosis should be able to be determined. The rate of sampling and access to maintenance history on the machine may have an influence on the quality of the final decisions made.

- **CM allows management of failure to full life potential.**

Identification of a failure mode does not necessarily mean that an immediate maintenance action is needed. Just when maintenance action must be taken is the toughest part of managing a CBM programme! Your reputation may depend on it!! The best course is to involve as many informed people in the decision making process.

- **CM evaluates corrective action.**

Immediately after a machine has been repaired it should be subject to condition monitoring testing. This will potentially identify assembly or installation faults that may lead to early failure (infant mortality) or affirm the quality of improvement achieved through the application of improved work practices or maintenance standards.

We will now study how Condition Monitoring can be applied to result in Condition Based Maintenance.
