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***Defining, Measuring and Evaluation of  
the Maintenance Management Key  
Performance Areas within Metalloys***

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## Abstract

This study focuses on the effective definition and measurement of maintenance management key performance areas, with the final aim on improvement. This study is further aimed at interdepartmental benchmarking, in order to tap on the internal resources within a decentralised maintenance management environment, for future improvement.

In order to gain a better understanding of the importance of maintenance management and its role within an organisation, it is best described as a dilemma to be managed, rather than a problem to be solved. All parties involved need to be properly informed in order to gain future top management support.

In order to effectively establish a measurement for the gap analysis, the following steps were followed:

- Identifying and defining the maturity roadmap of maintenance.
- Defining key maintenance performance areas and elements of measure.
- Benchmarking different practices associated with key performance areas.
- Development of a measurement process of defined areas of performance.

Results were collected from questionnaires in order to define the maturity of the approach towards managing a specific element / practice, the actual deployment, the result achieved and the improvement initiatives implemented (ADRI Cycle).

The best result of each element / practice will then be used in order to define the first phase of improvement for the other departments. The second phase will entail following the normal process of continuous improvement, supported by a sound change management process in order to ensure sustained improvement.

## Definitions:

### Plant & Equipment

The physical equipment (hardware) together with all necessary supporting computer systems, software, procedures and information, etc. necessary to assure the on-going safe, sustainable and reliable operation producing prime products to schedule.

### Equipment Throughput (or Tonnage Rate)

A measure of the amount of quality product produced by a Plant / Equipment, usually stated in tones per hour (t/h).

### Business Processes

Management processes, procedures and controls which specify the way in which the organisation manages and operates its plant and equipment to achieve the required business outcomes. Typically, these will be specified in documents such as the Safety Manual, Quality Manual, Maintenance Management Manual, Work Control Procedures, and Maintenance Systems User-Guide, etc.

**Process KPI's** Measure and monitor compliance with the designated business processes used to manage the performance of the plant & equipment. These KPI's provide information on how well the day-to-day affairs, necessary to assure that the plant and equipment performs to expectation, are managed.

**Outcome KPIs** Measure and monitor the resultant performance of the plant and equipment in terms of availability, reliability, throughput, quality and cost per unit produced.

**CMMS =** Computerised Maintenance Management System which can be SAP/R3, Mincom-MIMS, or any other system whether computerised or manual.

**MPDS =** Maintenance Plan Development System used to determine the optimum maintenance strategy for managing equipment condition based on the analysis of failure modes, characteristics and consequences.

## Equipment Maintenance Plans

Output from MPDS. These are stored in the CMMS as predetermined maintenance tasks for planned preventive (routine) maintenance and for planned repairs.

**Work Backlog** The amount of maintenance work identified on work orders but not yet done. It includes planned preventive (routine) maintenance work which is over-due, but it excludes future planned preventive work (which is usually referred to as the forward workload). The units of measurement for backlog are weeks based on the expected availability of labour to address the backlog work.

## Planning Lead Time

The amount of time between when a work order is raised (date raised) and when the work is required to be done or is done (date completed). The shorter the lead time, the more difficult it is to effectively plan the job and include it in the planned and scheduled work load.

## Schedule Compliance

The number of planned work orders that were scheduled to be carried out in a particular period, but were not completed within that period.

RCM = Reliability Centered Maintenance

JIPM = Japan Institute of Plant Maintenance

OEE = Overall equipment effectiveness

OEE = Equipment Availability x Performance Efficiency x Rate of Quality Products

$$\text{Quality Rate} = \frac{\text{Production amount} - \text{Quality Defects} - \text{Reprocessing}}{\text{Production amount}} \times 100\%$$

$$\text{Performance Rate} = \frac{\text{Average actual Performance rate (t/h)}}{\text{Standard Performance rate (t/h)}} \times 100\%$$

ADC = Automatic data collection

PPT = Planned production time

MDT = Mean downtime = expectation of the down time

MDT = 
$$\frac{\text{Total Downtime during specific planned production time}}{\text{Number of failures during specific planned production time}}$$

MDT = MTTR+MWT

MTTR = Mean time to repair = expectation of time to restoration

MWT = Mean waiting time = expectation of time for restoration to start

MTBF = Mean time between failures = expectation of the operation time between failures

MTBF = 
$$\frac{\text{Planned production time} - \text{downtime}}{\text{Number of failures during planned production time}}$$

Availability = the ability of an item (a machine) to be in a state to perform a required function under given conditions at a given instant of time over a given time interval.

Availability (A) = 
$$\frac{\text{Planned production time} - \text{downtime}}{\text{Planned production time}} \times 100\%$$

Availability (A) = 
$$\frac{\text{MTBF}}{\text{MTBF} + \text{MDT}} \times 100\%$$

Because MDT = MTTR + MWT

Availability (A) = 
$$\frac{\text{MTBF}}{\text{MTBF} + \text{MTTR} + \text{MWT}} \times 100\%$$

Absolute availability ( $A_{\text{abs}}$ ) is based on calendar time. Planned production time includes all the available hours in year.

$A_{\text{abs}} = \frac{\text{Calendar time} - \text{downtime}}{\text{Calendar time}} \times 100\%$

$$MTBF_{abs} = \frac{\text{Calendar time} - \text{downtime}}{\text{Number of failures during calendar time}} \times 100\%$$

$$A_{abs} = \frac{MTBF_{abs}}{MTBF_{abs} + MDT} \times 100\%$$

Relative availability ( $A_{rel}$ ) is based on a planned production time. The values are real and they indicate the real failure behavior state of an individual machine.

$$A_{rel} = \frac{\text{Planned production time} - \text{downtime}}{\text{Planned production time}} \times 100\%$$

$$MTBF_{rel} = \frac{\text{Planned production time} - \text{downtime}}{\text{Number of failures during planned production time}} \times 100\%$$

$$A_{rel} = \frac{MTBF_{rel}}{MTBF_{rel} + MDT} \times 100\%$$

TPM = Total Production / Productivity Management

CI = Continuous Improvement

OEM = Original Equipment Manufacturer

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