HOW TO INSTITUTE PLANT AND OPERATIONAL KPI’S TO INCREASE PLANT AVAILABILITY

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Rand Water
Gauteng, South Africa
AREAS OF SUPPLY

Consumers - > 13 Million
Area - 18 000 sq km
Pipelines - 3500 km
Total Reservoirs - 54

Map showing areas of supply with cities such as Rustenburg, Brits, Carletonville, Vereeniging, Sasolburg, Heilbron, Johannesburg, Pretoria, and Bethal.
✓ Potable Water Pumps – 25 to 300 ML/d
✓ Raw Water Pumps – up to 450 ML/d
✓ Motors – 200kw to 6230kw
✓ Pump to an elevation of +/- 400m
✓ Pipelines – 400mm to 3.5m diameter
AFRICAN STYLE
BUSINESS STRATEGY

Rand Water Vision

To be the industry leader and partner of choice in sustainable water services

Rand Water Strategic Objectives

✓ Position Rand Water as the partner of choice in water services
✓ Satisfy all customers
✓ Improve efficiencies and quality
✓ Achieve transformation
✓ Create a dynamic learning organisation
Importance of Assets

• Assets are acquired for their ability to produce the product on which an organisation base its existence.

• They are required to perform specific functions.

• Maintenance should focus on preserving this function.

• RCM looks at preserving primary and secondary functions of equipment based on the consequences of failure.

• Maintenance tactics are determined by the way in which equipment fails:
  ✓ Failure pattern
  ✓ Failure development period
  ✓ Potential failure condition
Plant & Equipment

Formal PCA

Reliability Engineering Process to be used

High Criticality

- RCM

Medium Criticality

- PMO

Low Criticality

- RCA

Proactive

Reactive
RAND WATER MAINTENANCE STRATEGY

Maintenance Split

- Pro-active Maint (Planned)
  - Condition-Based or Preventive
    - Condition Monitoring
    - Restoration or Discard
  - Functional Test
  - Default Actions
    - Run To Fail
    - Redesign

Re-Active Maint (Unplanned)
- Breakdown Work
- Ad Hoc Work

RCA

RCM
PMO

Maintenance Split - Ratio = 70% Planned : 30% Unplanned - Baseline
Maintenance Management Process

Pro-active Maintenance (Planned)

MAXIMO/SAP

Assess Asset LCC & TCO

Monitoring

Reporting

Maintenance Strategy

Reactive Maintenance (Unplanned)

Continuous Improvement
# Purpose of KPI’s

<table>
<thead>
<tr>
<th>KPI PURPOSE</th>
<th>DESCRIPTION</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Focus</td>
<td>Monitor the results of actions</td>
<td>To see if they highlight relevant factors that are truly important to outcomes from actions.</td>
</tr>
<tr>
<td>Change</td>
<td>Track the effect of making change</td>
<td>When making a change to a process, how is one to know that it will be a useful change. This is where an appropriate KPI will prove or disprove if change is beneficial.</td>
</tr>
<tr>
<td>Score</td>
<td>Act as a means to measure progress towards achievement.</td>
<td>The aim is simply to gradually improve what we do. In this case the performance will be a baseline for improvement and all other future performances aim at being better than the result.</td>
</tr>
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# Purpose of KPI’s

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<tr>
<td>Track</td>
<td>When you must meet set targets.</td>
<td>When a target is set, it becomes critical to track efforts used to meet targets.</td>
</tr>
<tr>
<td>Predict</td>
<td>Proactively warn of future performance</td>
<td>In every organisation, there are people who are aware of the danger signs” that forewarn of future problems. Put a suitable KPI that purposefully, track and monitor, to prevent and reduce the risk of failure.</td>
</tr>
<tr>
<td>Improve</td>
<td>Drive Continuous Improvement</td>
<td>Where organisations have several similar operations, it is valuable to introduce identical KPI’s into each group.</td>
</tr>
</tbody>
</table>
RELIABILITY IMPROVEMENT

• Reliability improvement methods and metrics are being utilized to meet the increasing demands placed on utilities to achieve optimum levels of Plant availability.

• A key aspect of any reliability improvement program is the comprehensive capture and analysis of actionable, accurate, performance data.

• For years, manufacturing leaders have struggled with the challenge of working with the deficiencies and controversies of manually collected data (i.e. stop watch and clip board and manipulation of data).
PLANT AVAILABILITY IMPROVEMENT MODEL

MAXIMO - CMMS
PLANT STATUS

AVAILABILITY
Per Pump set

RELIABILITY
Per Pump set

TRIP STATS
Per Pump set

10 – TEMP
6 – VIBRATION
2 - EXT. POWER

NO OF CALLOUTS

RCA

CONTINUOUS IMPROVEMENT
PLANT AVAILABILITY IMPROVEMENT MODEL

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PLANT
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RCA

RCA POLICY &
PROCEDURE

CONTINUOUS IMPROVEMENT
PLANT STATUS
TRIP STATISTICS
PERFORMANCE REPORT GUIDE TO POSSIBLE PROBLEM — LEVEL 1

MAXIMO PLANT STATUS

AVAILABILITY Per Pump set

RELIABILITY Per Pump set

TRIP STATS Per Pump set
- 10 – TEMP
- 6 – VIBRATION
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NO OF CALLOUTS

RCA

RCA POLICY & PROCEDURE

CONTINUOUS IMPROVEMENT
AVAILABILITY

DEFINITION

The proportion of total time that an item of equipment is capable of performing its specified functions, normally expressed as a percentage.

FORMULA

Availability = (Running time + Standby time)/total time.

REMARKS

It is calculated by dividing available hours by the total number of hours in any given period. (Available hours are the total hours in any given period, less the downtime hours) (Downtime hours is the time that an item of equipment is out of service, as a result of equipment failure)

This information is compiled from Plant Status changes, which have to be accurate to be meaningful. All the required information is compiled from accurate plant status reports.
PLANT RELIABILITY (MTBF)

**DEFINITION**

It is the average length of time between one failure and another failure for an asset or component.

- MTBF is used for repairable assets of a similar type.
- MTTF is used for non-repairable assets e.g. Light bulbs, rocket engines etc.
- Both these terms are used for asset reliability.

**OBJECTIVES**

This metric is used to assess the reliability of an asset. Reliability is usually expressed as the probability that an asset will perform its intended function without failure for a specified time period under specified function.

**AN INCREASING MTBF INDICATES IMPROVED ASSET RELIABILITY.**

**FORMULA**

Operating time (hours) / Number of failures
RELIABILITY QUALIFICATION

• Lagging Indicator

• Best used at asset or component level

• To be used by maintenance and reliability team.

• Performed on critical assets and trended over time.

• For low MTBF – RCA, FMEA analysis must be performed to see how we can improve Reliability.
PLANT RELIABILITY (MTBF)

Sample calculation

If an asset had 10 failures in 1000 hours of operation, as indicated in the diagram below:

\[
\text{MTBF} = \frac{\text{Operating time (hours)}}{\text{Number of failures}}
\]

MTBF = 1000 HOURS / 10 FAILURES = 100 HOURS.

CONVERT TO DAYS = 100 / 24 HOURS = 4.16 DAYS
# TRIP STATISTICS

![TRIP STATISTICS Image](image-url)
PERFORMANCE REPORT GUIDE
TO POSSIBLE PROBLEM — LEVEL 1

MAXIMO
PLANT
STATUS

AVAILABILITY
Per Pump set

RELIABILITY
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TRIP STATS
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NO OF CALLOUTS

RCA

RCA POLICY & PROCEDURE

CONTINUOUS IMPROVEMENT
ROOT CAUSE ANALYSIS

Monthly Reliability / weekly report to include a spreadsheet that displays the following info:
- No of trips on all main pumps
- Trip stats of all main pumps
  - Temperature
  - Vibration
  - Low Suction
  - Eskom Trips, etc

- If a main pump trips more than 2 times for the same reason in one month.
- If reliability for the pump set drops below the 12 month average as per internal target
- ALL MAJOR FAILURES

Reliability Report to highlight conditions that may require further Investigation using Root Cause Analysis.
CONTINUOUS IMPROVEMENT - RCFA

Weekly/ Monthly
Print out reliability/availability reports from Maximo

1
Availabilty

> 85% ≤ 85%

1.1 Further investigation not required

1.2 Investigate reasons Use criteria as per policy (RW SAM 00030 P)

2 Reliability

> 40 days ≤ 40 days

2.1 Same as 1.1

2.2 Same as 1.2.1 or 1.2.2 to 1.2.5 should criteria for RCA be met

1.2.1 Does not meet criteria for RCA

1.2.2 Meets criteria for RCA

1.2.3 Arrange RCA session with site

1.2.4 Implement solution

1.2.5 Follow up to ensure that all solutions have been implemented

Note:
Where failure of a system or equipment has severe safety, environmental or financial consequences, RCA’S must be done to eliminate recurrence or manage the situation.
SUMMARY

✓ Automate trip / failure recording.
✓ Use Reliability KPIs to manage equipment not Staff.
✓ Link improvements to reward scheme.
✓ Ensure there are policy and procedure in place for RCA’s.
✓ For sustainability, management must play an active role to ensure corrective and preventive measures are implemented.
✓ Training of staff
✓ Form a Reliability improvement team of dedicated stakeholders.
✓ Arm workforce with information.
SUMMARY

✓ Ensure that the objectives of maintenance and operations is aligned to the Business Strategy
✓ Optimize physical asset management using sound AM principles
✓ Motivate work force through good working conditions, objective performance management system, fair incentive bonus scheme, suggestion schemes, etc.
✓ Ensure competence of work force through continuous assessments and development based on needs
✓ Provide resources to perform work
✓ Celebrate successes!!!
RELIABILITY IMPROVEMENT
GOAL

A LIFETIME OF HIGHLY RELIABLE PRODUCTION PLANT AND EQUIPMENT.

Thank you
References


• Watercare – December 2003 –New Zealand

• Stevenson D. Barta B. Manson N. Asset management for water services sector in South Africa (WRC report).
MEAN TIME TO REPAIR (MTTR)

DEFINITION
Mean Time to Repair (MTTR) is the average time needed to restore an asset to its full operational capabilities after a failure. MTTR is the measure of asset maintainability. Maintainability is usually expressed as the probability that the asset can be restored to its specified operable condition within a specified interval of time, when maintenance is performed in accordance with prescribed procedures.

OBJECTIVE
This metric is used to assess the maintainability and effectiveness of plans and procedures.

FORMULA

\[ MTTR = \frac{D}{N} \]

MTTR = Mean time to repair
D = Downtime
N = Number of failures
MEAN TO REPAIR (MTTR)

Sample calculation

If an asset had 10 failures in 1000 hours of operation and their repair times were 2, 6, 10, 6, 5, 10, 1, 2, 5 and 3 hours as shown in the diagram below:

Then the MTBF is:

Formula

\[ MTTR = \frac{\text{Total amount of time expended in a specified period (hours)}}{\text{number of repair events in a specified period.}} \]

MTTR = \frac{(2+6+10+6+5+10+1+2+5+3)}{10} = X \text{ Hours.}

50/10 = 5 \text{ Hours}
MEAN TIME TO REPAIR (MTTR)

COMPONENT DEFINITION

✓ REPAIR TIME – The time required to restore the function of an asset after failure or imminent failure. It includes both scheduled and unscheduled repair time.

✓ FAILURE – The inability of an asset to perform its required function. This excludes proactive repairs.

✓ REPAIR EVENT – The act of restoring the function of an asset after a failure. This also termed corrective work.

QUALIFICATION

✓ To be used by maintenance personnel and reliability engineers.
MEAN TIME TO REPAIR (MTTR)

QUALIFICATION

✓ To be used by maintenance personnel and reliability engineers.

✓ Repair Time (duration of repair) includes from start of repair to the end of the repair.

✓ This includes the time for checking the asset for its functionality prior to handing it over to operations.

✓ The Craft workers skill level, use of proper repair procedures, availability of the correct tools and spares etc. can significantly reduce MTTR.

✓ This metric provides the best data when used for the same type of asset/component in a similar operating context.
PROACTIVE WORKORDERERS

Percentage of work orders generated from PM inspections.

✓ How do we know that PM inspections are done?
✓ Are the work order generated from PM’s are linked to the PM schedule?
✓ How does these W/O’s link to the PM?
MANPOWER UTILISATION

• **Definition**

The proportion of available time a person is working.

• **Formula**

\[
\text{Utilisation (\%)} = \left( \frac{\text{Hours worked} + \text{loss time (RW related)}}{\text{Normal working hours} - \text{loss time (Non RW related)}} \right) \times 100
\]

**Lost time (RW related)**

- Time spend during union activities
- House keeping
- PCP
- Rest time
- Store duties
OVERALL EFFECTIVENESS OF THE MAINTENANCE DEPARTMENT

**Definition**

✓ An indication of the level of service the maintenance department provides to their customers.

**Formula**

✓ Overall effectiveness = Time to approve + time to respond + time to repair + time to complete the paperwork.
PM TURNAROUND TIME

Calculate percent of PM/SS Work Orders in the previous month where the PM’s were completed on time.

The work is Completed on Time if the Actual Finish Date is less than or equal to Start by Date + 20 % of the PM and SS frequency (up to a maximum of 28 days).
<table>
<thead>
<tr>
<th>Frequency</th>
<th>Grace Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 week</td>
<td>2 days</td>
</tr>
<tr>
<td>2 weeks</td>
<td>3 days</td>
</tr>
<tr>
<td>1 monthly</td>
<td>6 days</td>
</tr>
<tr>
<td>2 monthly</td>
<td>12 days</td>
</tr>
<tr>
<td>3 monthly</td>
<td>18 days</td>
</tr>
<tr>
<td>6 monthly</td>
<td>28 days</td>
</tr>
<tr>
<td>1 yearly</td>
<td>28 days</td>
</tr>
<tr>
<td>2 yearly</td>
<td>28 days</td>
</tr>
<tr>
<td>5 yearly</td>
<td>28 days</td>
</tr>
</tbody>
</table>
PM TURNAROUND TIME

- Daily inspections/ Non core maintenance will be regarded as RM and will not form part of this measure.

- Only Electrical, Mechanical and Instrumentation Crafts will be measured.

- This measurement will include traveling time.

- Material reliant PM’s should have lead-time activated for the Procurement or sourcing of materials.
REMARKS

✓ Time to approve is measured from reported time to approved time.

✓ Time to respond is measured from approved time to Start time of job.

✓ Time to repair is measured from Start time to Completion time of job.

✓ Time to complete paperwork is measured from completion time of job to the time the work order status is “Complete”

✓ The total is expressed in days and fractions of a day.
REMARKS

Lost lime (RW related)
- Supervisory duties
- Waiting for spares/material
- WCA
- Acting foreman
- Driving duties
- ABET
- Evacuation drill
- Fire fighting drill
- Meetings
- Training
- Travelling
- Inclement weather
- Workplace meeting
- Medical
- Sports meetings

Lost time (Non RW related)
- Normal leave
- Special leave
- Sick leave
- Absent