Maintenance scheduling and planning: City of Tshwane Experience

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Director: Distribution Operation South
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12h00
Acknowledgement

Paper has been co-authored by Mr. Frans Manganye: Deputy Director – Rosslyn Distribution Operations in the City of Tshwane
Purpose

• To share the City of Tshwane’s experience with regard to Maintenance Planning and Scheduling in the distribution of electricity
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Background

- The City of Tshwane Metropolitan Municipality was formed in 2000 by the amalgamation of 13 councils incorporating:
  - Greater Pretoria Metropolitan Council,
  - City Council of Pretoria,
  - Town Council of Centurion,
  - Northern Pretoria Metropolitan Substructure,
  - Hammanskraal Local Area Committee,
  - Transitional Representative Councils of:
    - Mabopane,
    - Ga-Rankuwa,
    - Winterveldt,
    - Temba,
    - Pienaarsrivier
    - Crocodile River,
  - Portions of the Eastern and Western Gauteng Services Councils and,
  - Portions of the Eastern District Council
Background
Distribution Depots

- The City of Tshwane is divided into eight geographical depot service areas:
  - Atteridgeville/Fortsig depot
  - Princess Park depot
  - Rosslyn Depot
  - Soshanguve/Babelegi depot
  - ESKOM Areas
  - Wonderboom Depot
  - Centurion depot
  - Pretorius Park depot
  - Waltloo depot
Depot Functions

- Safety
- Breakdowns,
  - System failure
  - Theft
- Repairs and maintenance
- Depot Management
  - Personnel
  - Funds
  - Materials
Types of maintenance

- There are three types of maintenance i.e. corrective, preventative and refurbishment maintenance.
- The preventative maintenance is divided into two which is either time-based or condition based.
- All these are being considered when one generates a tactical maintenance planning based on short or long term strategy.
- Among the main strategic decisions that used to be taken in maintenance is the level of maintenance that is required to achieve the maintenance objectives within the budget constraints of any organisation.
Types of maintenance

Maintenance

before failure

Preventive

Condition based

Predetermined

after failure

Corrective

Immediate maintenance

Deferred maintenance

Cleaning, lubrication, adjustment, calibration, repair, refurbishment, replacement

Source IEC

Figure 1 — Maintenance practices and actions
Models in maintenance

• What maintenance type or strategy should be used for an equipment or item?

• How frequently should preventative maintenance be performed?

• When should an asset be discarded or replaced?

• What spares and how many of each type should be kept in the store?
System Reliability

<table>
<thead>
<tr>
<th>Function</th>
<th>Symbol</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Failure density</td>
<td>$f(t)$</td>
<td>-</td>
</tr>
<tr>
<td>Reliability</td>
<td>$R(t)$</td>
<td>-</td>
</tr>
<tr>
<td>Cumulative Distribution Function for failure (CDF)</td>
<td>$f(t)$</td>
<td>-</td>
</tr>
<tr>
<td>Failure of hazard rate</td>
<td>$\lambda(t)$</td>
<td>$time^{-1}$</td>
</tr>
<tr>
<td>Mean Time To Failure</td>
<td>MTTF</td>
<td>$time$</td>
</tr>
</tbody>
</table>
System Reliability

Source: www.relex.com
System Reliability

- Example of Reliability calculation for the Weibull distribution:
- The failure characteristics of a switch in an electrical distribution board have a Weibull distribution. The value of the shape parameter, $\theta$, is 3.5 and the characteristics life, $m$, is 60 days. Calculate the reliability of the switch after 40 days and after 80 days;
- Solution
  - Reliability after 40 days: 
    $$R(40) = \exp \left[ - \left( \frac{40}{60} \right)^{3.5} \right] = 0.785$$
  - Reliability after 80 days: 
    $$R(80) = \exp \left[ - \left( \frac{80}{60} \right)^{3.5} \right] = 0.065$$
System Availability

- The availability of an item can be defined as the probability that an item will, when used under specified conditions, operate satisfactorily and effectively.

- Availability is an extremely important attribute of any system and comprises the reliability and maintainability of the system.

- The SAIDI of a network indicates the duration of a sustained interruption the average customer would experience per annum.
  \[ \text{SAIDI} = \frac{\text{total customer interruption durations p.a.}}{\text{total number of customers served}} \]

- The ASAI represents the fraction of time (often expressed as a percentage) that a customer has received supply during one year.
  \[ \text{ASAI} = \frac{\text{Customer hours service availability p.a.}}{\text{customer hours service demand p.a.}} \]
## Maintainability

<table>
<thead>
<tr>
<th>Function</th>
<th>Symbol</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repair density</td>
<td>$m(t)$</td>
<td>-</td>
</tr>
<tr>
<td>Maintainability</td>
<td>$M(t)$</td>
<td>-</td>
</tr>
<tr>
<td>Cumulative Distribution Function (CDF) for repair</td>
<td>$G(t)$</td>
<td>-</td>
</tr>
<tr>
<td>Repair rate</td>
<td>$v(t)$</td>
<td>$time^{-1}$</td>
</tr>
<tr>
<td>Mean Time To Repair</td>
<td>MTTR</td>
<td>$time$</td>
</tr>
</tbody>
</table>
This is the industry’s current mind-set
Maintenance Philosophy, Standards and Procedures of City of Tshwane

- For the distribution network i.e. 11kV to 220v the following categories are applied as far as maintenance is concerned:
  - Public lighting
    - Streetlights
    - High mast lights
  - Substations
  - Overheads
  - Cables
Technological tools used in Planning and Scheduling

• SAP PM
• PowerMap
  – Abnormals Management
  – Log sheets
  – Resource allocation
    • Standby
    • Overtime
  – Safety management
  – Record management
Budgeting and Resources Allocation

• This is *model* used by the depots to allocate resources like funds, artisans, vehicles to specific tasks over a period.
Maintenance Management Plan

• Every year the distribution section reviews its Management Maintenance Plan to be in line with the budgeted requirements and compatible with all the programs such as SAP PM, etc.
• However, some distortion is been encountered due to escalation in theft of copper conductors which runs in the region of R22 million.
<table>
<thead>
<tr>
<th>Month</th>
<th>Incidents</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>206</td>
<td>R2,894,405.00</td>
</tr>
<tr>
<td>February</td>
<td>177</td>
<td>R2,001,988.00</td>
</tr>
<tr>
<td>March</td>
<td>273</td>
<td>R2,461,640.00</td>
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<tr>
<td>April</td>
<td>199</td>
<td>R1,608,277.00</td>
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<tr>
<td>May</td>
<td>206</td>
<td>R1,145,352.00</td>
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<tr>
<td>June</td>
<td>155</td>
<td>R1,113,366.00</td>
</tr>
<tr>
<td>July</td>
<td>184</td>
<td>R883,572.00</td>
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<tr>
<td>August</td>
<td>164</td>
<td>R749,900.00</td>
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<tr>
<td>September</td>
<td>143</td>
<td>R777,365.00</td>
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<tr>
<td>October</td>
<td>152</td>
<td>R682,297.00</td>
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<tr>
<td>November</td>
<td>165</td>
<td>R649,100.00</td>
</tr>
<tr>
<td>December</td>
<td>47</td>
<td>R451000.00</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>2071</strong></td>
<td><strong>R15,438,212.00</strong></td>
</tr>
<tr>
<td>2008</td>
<td></td>
<td></td>
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<td>---------</td>
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</tr>
<tr>
<td>January</td>
<td>127</td>
<td>R 712,445.00</td>
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<tr>
<td>February</td>
<td>194</td>
<td>R 945,964.00</td>
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<tr>
<td>March</td>
<td>209</td>
<td>R 955,162.00</td>
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<tr>
<td>April</td>
<td>215</td>
<td>R 720,001.00</td>
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<tr>
<td>May</td>
<td>183</td>
<td>R 978,981.00</td>
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<tr>
<td>June</td>
<td>184</td>
<td>R 758,095.00</td>
</tr>
<tr>
<td>Total</td>
<td>1112</td>
<td>R 5,070,648.00</td>
</tr>
</tbody>
</table>
More info – Tshwane Utilities

- Number of Incidents
- Replacement Value
Lessons Learned

- System availability index of over 95%.
- Good abnormal situation management e.g. repairs any 11Kv fault with 24 hours of fault and put to service.
- Ensure that the MMP is interactive and is modified in line with new assets being added to the network.
- A 50% asset replacement value be used as a benchmark for maintenance budget.
- Refurbishment program to be catered for e.g. a 3.5% - 4% budget for the program.
- Routine checks under preventative maintenance should be done despite all other challenges.
- A certain percentage should be collected from the tariffs for maintenance purpose. This will help and prevent National blackouts.
- The construction division should at all time communicate and work together with the maintenance division in order to ensure the Maintainability of the system not be compromised.
Thank You

Questions ! ?
Asset Management in process flow

1. Maintain Safety Awareness Methodology (SAM)
2. Do Safety Awareness Field Education (SAFE)
3. Maintain Organisation Structure → Develop People
4. Develop Business Plan → Develop Production Plan
5. Plan Infrastructure → Maintain Infrastructure
7. Provide Resources
8. Improvement Administration
9. Measure Work & Improve
10. Measure Infrastructure & Improve
11. Measure Performance & Improve
12. Measure Organisation HUM & Improve
13. Safety management cycle
14. Organisation management cycle
15. Asset management cycle
16. Infrastructure management cycle
17. Work management cycle