Eskom	Report	Distribution

Title: **ASSET PERFORMANCE MANAGEMENT TOOL FUNCTIONAL REQUIREMENTS FOR DISTRIBUTION**

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1. Introduction

A business need was identified to improve and sustain the reliability, availability and maintainability of the Distribution assets by deploying an Asset Performance Management (APM) tool.

The APM tool is expected to provide the following benefits to Eskom Distribution:

- improve asset reliability and availability while minimising risk and cost through optimal asset management practices.
- enhance decision-making through the integration of diverse data sources
- improve the integration between asset management and operations
- provides a platform for analysing and identifying asset risk for timely decisions-making
- optimise spares inventory levels
- maximise the useful life of assets

2. Supporting clauses

2.1 Scope

This document sets out the functional requirements for the Asset Performance Management tool.

The document does not specify any specific APM tool solution; however certain requirements in terms of technology maturity, proven technical performance and track record will be taken into consideration in selecting suitable technologies.

2.1.1 Purpose

The purpose of this document is to define the functional requirements for the APM tool.

2.1.2 Applicability

This document is applicable to Eskom Distribution.

2.2 Normative/informative references

Parties using this document shall apply the most recent edition of the documents listed in the following paragraphs.

2.2.1 Normative

[1] ISO 9001 Quality Management Systems

[2] Guide to Integrated Risk Management, ©Eskom Ltd, 2009

[3] No. 85 of 1993 Occupational Health and Safety Act

[4] 240-83126800 Maintenance Standard Template

[5] 240-44509543 Process Control Manual (PCM) for Design System (Develop Maintenance and Logistics Support Design)

[6] 240-44509564 Process Control Manual (PCM) for Perform Design Analysis

[7] 240-45920887 Process Control Manual (PCM) for Manage Maintenance Base

[8] 240-45921037 Process Control Manual (PCM) for Optimise Operational Asset Performance

[9] 240-41913642 Process Control Manual (PCM) for Continuous Maintenance improvement

[10] 32-1306 Process Control Manual (PCM) for Define Maintenance Plans (Wires) (Develop/Review Asset Life Cycle Management Plans)

2.2.2 Informative

[11] 474-190 Design Base Standard

[12] 240-41836800 Establish Maintenance Objectives, Procedures and Documentation (Wires)

[13] 32-1307 Execute Work (Wires)

[14] 240-49230148 Maintenance and logistics support design guideline

2.3 Definitions

2.3.1 General

Definition	Description
Age Analysis	It is a process to determine the remaining and end-of-life of an asset.
Asset	Any items that form part of the electrical Distribution system that is required in order to transmit electricity. Also called equipment.
Asset Class	A type classification of assets, which have a defined set of characteristics which are the same, which are of such a nature that assets of the class can be used interchangeably for a particular purpose.
Asset Health	Asset condition relative to asset end of life.
Asset Health Index	A measure of the condition relative to end of life of each member of a given asset class/s, based on defined criteria. This is done using health measures and weights based on age sensitive materials and components, aging conditions, mechanisms and measurements. The rating system provides an overall view of the health of the asset It is used for long-term asset planning as well as to provide an indication on the health of the asset fleet.
Design Base	The Design Base of an Asset is the combination of those key design outputs that define the functions, capabilities, capacities, physical sizes and dimensions (Physical Base), limits and set points, shutdown and start-up sequences, normal and out of normal operations (Operating Technical Specification) and maintenance elements (Maintenance Base); that are required for the asset to meet its required performance, reliability and availability within the limits of the external constraints.
Excursions	Any deviation outside the operating envelope and Maintenance Base while the asset is within service.
Failure Modes and Effects Analysis	An analytical procedure in which each potential failure mode in every component of an asset is analysed to determine its effect on the reliability of that component and, by itself or in combination with other possible failure modes, on the reliability of the asset and on the required function of the component; or the examination of an asset (at the system and/or lower levels) for all ways that a failure may occur. For each potential failure, an estimate is made of its effect on the total system and of its impact. In addition, a review is undertaken of the action planned to minimize the probability of failure and to minimize its effects
Operating Envelope	Operating envelope provides direction with respect to the operating requirements needed to specify operating limits and ranges of the asset over its operational life. This specifies the “What and When” and is derived from the Design Base (Maintenance Base and operating manuals).

Definition	Description
Reliability Centred Maintenance	Reliability Centred Maintenance is a process used to determine the optimum maintenance requirements for physical assets based on asset and component functions, criticality, failure modes and causes

2.3.2 Disclosure classification

Controlled disclosure: controlled disclosure to external parties (either enforced by law, or discretionary).

2.4 Abbreviations

Abbreviation	Description
APM	Asset Performance Management
CBM	Condition Based Maintenance
CM	Corrective Maintenance
CMMS	Computerised Maintenance Management System
Coe	Maintenance Centre of Expertise
FMECA	Failure Mode, Effect, and Criticality, Analysis
PCM	Process Control Manual
RCM	Reliability Centred Maintenance
DX	Distribution

2.5 Roles and responsibilities

Maintenance Centre of Expertise (Maceo) is accountable for this document.

2.6 Process for monitoring

Potential APM tool suppliers will be assessed against the requirements in this document.

2.7 Related/supporting documents

Not applicable.

3. APM Tool Context

The context of the APM tool is illustrated in the figure below. The green block represents the APM tool, and the blue blocks indicate the inputs and outputs to and from the APM tool.

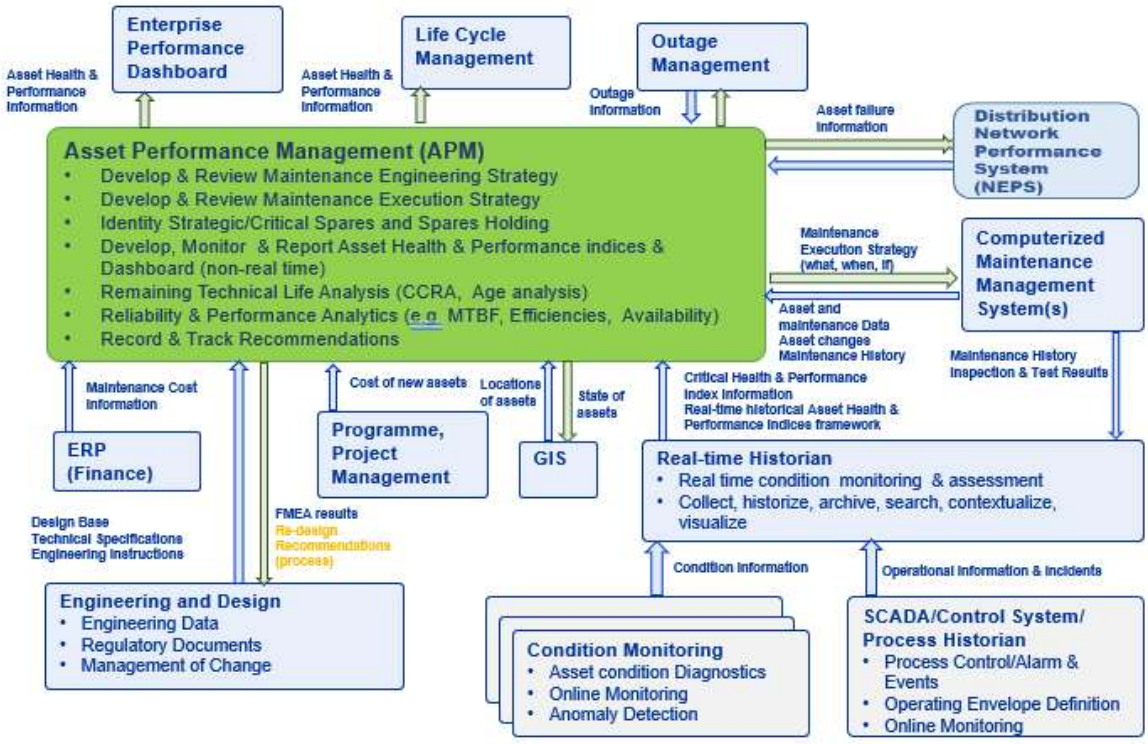


Figure 1: APM Tool Context

a) The objective of the APM Tool is to assist the business in:

1) Developing and reviewing Maintenance Engineering Strategies with the assistance of FME(C)A, RCM, etc. methodologies.

2) Developing and reviewing Maintenance Execution Strategies with the assistance of FME(C)A, RCM, partial RCM, etc. considering Equipment Criticality, Meteorological and Environmental conditions. Including asset modification tasks

i. Recommending changes to Maintenance Execution Strategies based on deteriorated / improved Asset health / performance and approve such changes through Workflow.

ii. Track all Maintenance Execution Strategies applied to an asset and the reason for changes to it.

iii. Cost Maintenance Strategies.

3) Identifying strategic and critical spares and determining their appropriate inventory levels essential for efficient recovery after asset failure and for maintenance.

4) Developing, measuring, monitoring and reporting of the Asset Health and Performance Indices.

5) Conducting performance analytics (i.e., reliability, availability, maintainability, probability of failure based on asset age / health)

6) Conducting asset remaining technical life analysis (i.e. age analysis)

7) Recording and tracking progress on recommendations resulting from the development of the strategies, tasks and analysis activities.

b) The following should be noted:

1) The requirement for the real-time monitoring of asset health and performance indices falls within the scope of the Real-Time Historian / related tool.

2) The Real-Time Historian or a related tool will provide the APM Tool with the relevant online asset condition and performance information

3) CMMS is considered the asset register for asset data and maintenance work management (maintenance planning, optimisation, scheduling, and execution).

3.1 Core Functionality

3.1.1 Develop and review maintenance engineering strategy during design/retrospectively

3.1.1.1 Eskom processes supported

The Eskom processes that are supported by this requirement are:

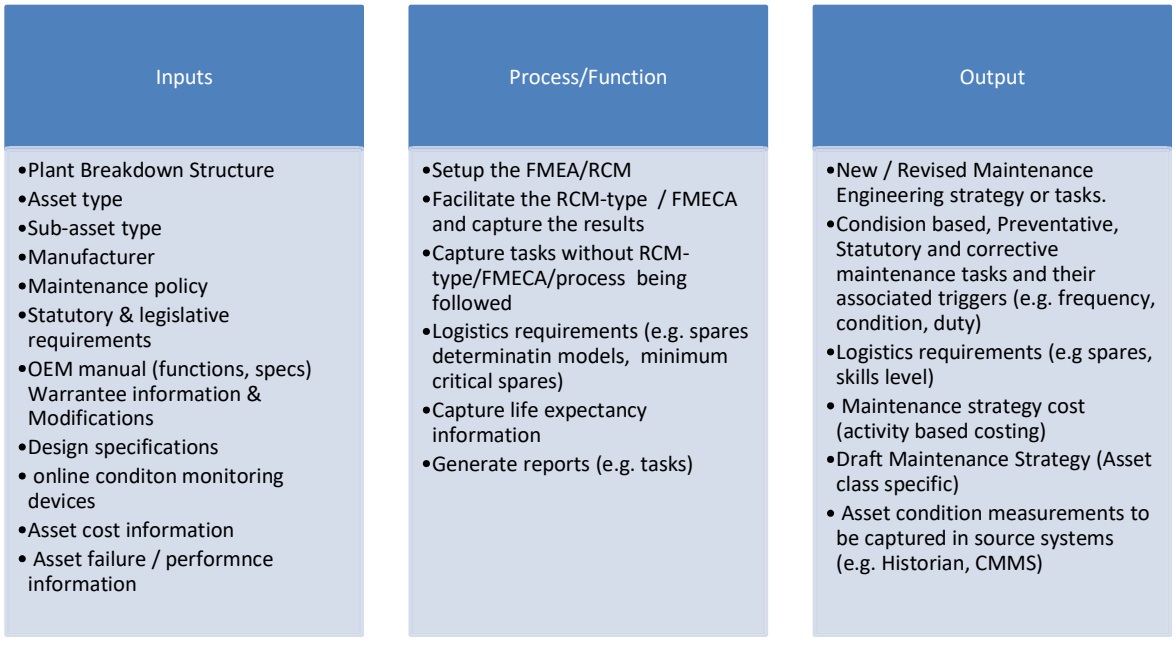
a) Process Control Manual (PCM) for Design System (Develop Maintenance and Logistics Support Design)

b) Process Control Manual (PCM) for Perform Design Analysis (Perform Logistics Engineering Analysis)

c) Process Control Manual (PCM) for Perform Design Analysis (Perform Reliability Engineering Analysis)

3.1.1.2 Diagram

The inputs, process/function, and output for the develop and review maintenance engineering strategy capability is illustrated below. The details are provided in the subsequent sections.



3.1.1.3 Objective/Description

The Maintenance Engineering Strategy defines the maintenance requirements and associated logistics for assets. This strategy is developed during new designs or retrospectively in the case of existing assets. This strategy is reviewed throughout the life of the assets. The review could be triggered by one or more of the following factors:

a) Changes in design

b) Modifications, upgrades or downgrades.

c) Recommendations from maintenance execution strategy

d) Asset health / performance / risks

e) Obsolescence

3.1.1.4 Functionality Required

a) The Maintenance Engineering Strategy is developed either for asset classes or at the sub-class level depending technological differences.

b) To be able to determine the Maintenance Engineering Strategy various techniques (e.g. FME(C)A, RCM, partial RCM, etc.) are applied. The APM Tool shall be able to facilitate these techniques and the results managed.

c) The APM Tool shall facilitate the FME(C)A process and captured results. (Refer to 240-83126800 The maintenance Standard Template. The following data shall be captured in configured data fields against the various levels of asset classifications:

   1) Asset class

   2) Asset components

   3) Functions of components

   4) Failure mode and its classification (functional, hardware, combination of functional and hardware)

   5) Failure cause

   6) Failure effect (i.e. consequence of failure mode) and its classification (Local failure effect, Next higher-level failure effect, End failure effect)

   7) Detection method (i.e. method to detect failure mode, e.g. visual inspection, condition monitoring)

   8) Compensating provisions (i e. design features that have the ability to prevent or reduce the effect of the failure mode, e.g. redundant items)

   9) Failure mode severity (i.e. indication of the significance of the effect of a failure mode) based on severity classifications

   10) Probability of failure

   11) Failure mode criticality (e.g. critical, non-critical & run to failure). If “run-to-failure”, capture the reason

   12) Comments/recommendations

d) It shall also be possible to import FMECA from other sources, e.g. Microsoft office etc.

e) The APM tool shall produce the following reports resulting from the FME(C)A process:

   1) Criticality matrix(es) - A combination of the severity of a failure effect and the probability of occurrence of that specific failure mode

   2) FME(C)A Worksheet

3) Decision tree analysis

4) Draft maintenance strategy

f) The APM tool shall capture, review recommendations and forward or export recommendations via workflow to the relevant area for approval and action. The progress/status of the recommendations shall be monitored within the APM Tool.

g) The APM Tool shall facilitate the (1) FMECA, (2) RCM (3) partial RCM/ using the results of the FMECA process to develop the maintenance engineering strategy, and capture the results. The following data shall be captured per failure mode:

1) Condition monitoring tasks (including online & offline inspection and test tasks)

2) Preventative maintenance tasks its classification (Time directed, Condition directed, Duty directed, Failure finding, Run-to-failure)

3) Statutory maintenance tasks

4) Corrective maintenance tasks

5) Task trigger (e.g. condition thresholds, time passed/frequency, operating hours, cycles, excursions, exceeding operating envelopes)

6) Reason for task selection

7) Operability (i.e. is the asset operable during the tasks or is an outage required to perform the task)

8) Data to be captured during task execution

h) For each of the identified maintenance tasks, the following data shall be captured:

1) The sub-tasks and the sequence in which the maintenance tasks shall be performed

2) Tasks support requirements and quantities regarding:

i. Spare Parts

ii. Facilities

iii. Maintenance execution documentation

iv. Personnel

v. Skills requirements

vi. Estimated task completion time

vii. Training needs

viii. Training equipment and material

ix. Personnel resource requirement

x. Support and test equipment provisioning list

i) The APM Tool shall also be able to capture the above data (tasks, triggers, support requirements and quantities) without following a facilitated RCM logic process, by:

1) Capturing developed task selection models

2) Using task selection models to develop and review the maintenance engineering strategy for assets/components in a system

j) The APM tool shall produce the following reports:

1) FME(C)A / Partial RCM /RCM reports – tasks sorted by failure mode, failure criticality, failure effect, maintenance/inspection/test tasks, plant breakdown structure

2) Consolidated condition-based tasks, preventative and correct maintenance task list

3) Consolidated task supportability requirements list

4) Worksheet

k) On completion of the development or review of the Maintenance Engineering Strategy the following shall be executed:

1) Baseline the strategy and its associated data

2) Trigger an action informing the relevant parties that the Strategy has been completed.

3) Trigger a recommendation for the review of the Maintenance Engineering Strategy and the Asset Health and Performance Framework

4) The asset life expectancy is determined by capturing the design life expectations (e.g. designed age) and

5) The indicative cost of ownership (e.g. maintenance strategy cost)

3.1.1.5 Information Input requirements:

a) Plant Breakdown Structure from the CMMS or Design base

b) Asset Type & Sub-asset types

c) Manufacturer, OEM Manuals, Warrantee information & Modifications

d) Technical specifications (e.g. Input thresholds, Design Specifications) from the Design Base

e) Maintenance policy

f) Statutory & legislative requirements

g) Asset cost information

h) Online condition monitoring devices on assets

i) Asset failure / performance information

3.1.1.6 Information Outputs

a) New / Revised Maintenance Engineering strategy or tasks

b) Condition based, Preventative, Statutory and corrective maintenance tasks and their associated triggers (e.g. frequency, condition, duty)

c) Logistics requirements (e.g. critical spares, skills levels)

d) Designed life cycle

e) Maintenance strategy cost (activity-based costing)

f) Asset condition measurements to be captured in source systems (e.g. Historian, CMMS)

3.1.2 Develop and review maintenance execution strategy

3.1.2.1 Eskom processes supported

The processes that are supported by this requirement are:

a) Process Control Manual (PCM) for Manage Maintenance Base

b) Process Control Manual (PCM) for Perform Design Analysis (Perform Reliability Engineering Analysis)

3.1.2.2 Diagram

The inputs, process/function and output for the develop and review maintenance execution strategy capability is illustrated below. The details are provided in the subsequent sections.

Inputs	Process/Function	Output
•Maintenance Engineering Strategy •Asset information •Critical operational information (e.g. supplier to a major customer) •Duty cycle (e.g. frequency of operation / loading) •Redundancy factors (design & operational) • Asset health information •OEM manual conditon monitoring information (both online & offline) •OEM required modifications •Consequencial cost of asset failure • Asset Master Data (e.g. make & type) •Cost of Maintenance •Designed Life Cycle expectancy •Logistics requirements (e.g. minimum critical spares)	•Determine likelihood of failure based on operating environment, asset health status and MTBF, duty cycle • Determine criticality rating based on network location, incorporate consequencial cost of failure, redundancy factors (e.g. N-1) •Refine maintenance task frequency by using task selection models taking into account likelihood and consequence • Determine spares holding	• Maintenance execution strategy •Refined maintenance tasks (Asset specific & frequency (when) / condition / duty •Expected maintenance cost •Strategic/critical spares holding

3.1.2.3 Objective/description

The Maintenance Execution Strategy defines maintenance, inspection and test tasks for individual assets taking into account factors that influence asset condition / performance deterioration and functional importance. The maintenance execution strategy is developed as the asset is deployed, and it is reviewed and updated throughout the life of the asset. Changes in an asset's maintenance execution strategy can be due to:

- Modifications to the asset
- Equipment reliability knowledge base
- Asset history (perform component reliability analysis)
- Asset monitoring
- Design/modification specification change
- OEM Manuals
- Excursions/ Deviations from designed performance
- Operating the asset beyond safe thresholds.
- Changes to the environmental / meteorological conditions (eg high pollution, coastal area).
- Changes to the Assets Health or Performance level.
- Lifecycle Management Strategy
- Maintenance base changes
- Maintenance best practice findings and recommendations
- Maintenance engineering strategy changes
- Recommendations (actions) during investigations of occurrences/incidents.

The Maintenance Execution Strategy refines the Maintenance Engineering Strategy based on the physical asset's criticality (consequence of a failure or malfunction) condition (health), historical performance, and duty cycle/loading within their respectable operating environment and physical environment (Refer to *240-83126800* The maintenance Standard Template).

3.1.2.4 Functionality required

a) Determine likelihood of asset condition deterioration, failure or malfunction of the asset based on:

1) operating environment (e.g. environmental – weather conditions, service environment) maintenance history
2) asset health index rating
3) asset performance indicators (e.g. MTBF),
4) duty cycle of asset (e.g. load factor, operating temperatures, number of operations,)
5) Operating envelope & excursions

b) Determine criticality rating of the asset based on:

1) Network/system location
2) Environmental factors
3) consequential cost of failure (e.g. cost to restore, loss of load/income)
4) redundancy factor (e.g. N-1, redundancy in design)

c) Refine (change defined tasks and/or add new tasks) the asset maintenance tasks and capture the results (what (maintenance tasks), when (trigger), if (decision to be taken)) by:

1) Considering the likelihood and criticality rating above
2) Using a facilitated FMECA / RCM / partial RCM process/logic
3) Reviewing the annualised cost of maintenance vs. likelihood and consequential cost analysis results
4) Provide and capture reasons for the refinement/change required.

d) Grouping and optimising of maintenance execution strategy (tasks) per multiple assets in order to minimise outages

e) The refined maintenance tasks and task triggers shall be within the parameters set by the maintenance engineering strategy.

f) The APM tool shall produce the following reports:

1) RCM reports - sorted by failure mode, failure criticality, failure effect, maintenance/inspection/test tasks, plant breakdown structure
2) Consolidated and refined asset condition monitoring tasks, preventative and corrective maintenance, inspection and test task list

g) On completion of the development or review of the Maintenance Execution Strategy:

1) Baseline the strategy and its associated data
2) Trigger an action informing the relevant parties that the Strategy has been completed (e.g. upload data into Computerised Maintenance Management System (CMMS).

h) The APM tool shall:

1) Record all changes made to the Maintenance Execution Strategy together with the reason for such change, the effective date of such change and the approver's credentials.
2) Recommend changes to the Maintenance Execution Strategy based on various triggers and send those recommendations via workflow for approval.

3) Cost the Maintenance Engineering Strategies.

i) The APM tool shall determine the strategic and critical spares holding requirement through:

1) methodologies such as e.g. failure rate analysis, Monte Carlo simulations etc.

2) Consideration to the current number of operational assets

3) Lead times

4) Determining optimal geographical location for the storage of strategic spares through modelling parameters.

5) Consider the asset health and performance to forecast spares requirements

3.1.2.5 Information input requirements

a) Maintenance Engineering Strategy

b) Asset information (from CMMS)

c) Critical operational data (e.g. location, environmental factors)

d) Redundancy factors (Design & Operational)

e) Duty Cycle or loading (Through historian or related tool)

f) Condition monitoring data (from Real-time Historian / Condition Monitoring systems)

g) Performance monitoring data

h) Outage/incident history

i) Asset design life

j) Asset remaining life

k) Cost of Maintenance

l) Logistics Requirements (incl. resource and time requirements)

3.1.2.6 Information outputs

a) New/Revised Maintenance Execution Strategy

b) Strategic and critical spares requirements

c) Expected maintenance cost

3.1.3 Develop the asset health & performance framework

3.1.3.1 EHPUM processes supported

The Eskom process that is supported by this requirement:

a) Process Control Manual (PCM) for Optimise Operational Asset Performance (Establish Asset Health & Performance Framework)

3.1.3.2 Diagram

The inputs, process/function and output for the develop asset health and performance framework capability are illustrated below. The details are provided in the subsequent sections.

Inputs	Process/Function	Output
•Asset health parameters •Asset performance parameters (design base, technical performance KPIs) •OTS parameters • Business technical performance information •Asset risk related aspects (e.g. obsolescence) •Network contraints (e.g. under rated equipment etc.)	•Configure the parameters (asset health, technical performance information) to be monitored •Configure rules & algorithms for indices, risk and performance parameters, aggregate data and set action levels • Configure groupings of health / performance information (e.g. Grid level, substation, asset class, asset type, component) for operational, tactical, strategic views • Configure display methods •Configure data sources & extraction methods	• Configured Asset Health framework •Configured Asset Performance framework

3.1.3.3 Objective/description

The objective of developing the Asset Health and Performance Framework is to standardise the requirements for asset health and performance monitoring and continuously improve asset health and performance based on asset health and performance history, operational and design base data. Including the prediction of future performance and health of assets.

3.1.3.4 Functionality required

a) Configure the asset parameters to be monitored and the relationship among them:

   1) asset health

   2) asset performance

   3) technical specifications

   4) business technical performance indicators (e.g. asset KPIs)

b) Configure the rules, formula and/or algorithms for the asset health indices & performance indicators and other risk factors such as obsolescence or under rated equipment.

c) Configure the action levels and actions related to the threshold rules set, e.g. if an index is above the specified threshold, then issue an action to be perform (e.g. notification to the CMMS to perform an investigation)

d) Configure groupings (e.g. Network / substation / asset class / asset type / component) of indices for operational, tactical, strategic views with the ability to drill down/up

e) Configure the methods/rules to be applied to when individual assets are combined to reflect the asset health and performance indices associated with groupings.

f) Configure the display method for the asset health and performance indices and trends, e.g. tabular, histogram, geospatial.

g) Configure the trigger points that would initiate a review of Maintenance Execution Strategies.

h) Configure the reporting requirements (templates)

i) Configure the extraction, interfacing or data upload method(s) to obtain data from the various data sources. This will depend on the data source implementation.

j) Configure comparison rules (e.g. compare an asset's indices to indices of similar assets, and indices as per the design base)

k) Perform health and performance data validation checks against the design base specification to ensure alignment and reliable data in the sense of being reasonable / usable.

l) Baseline the configuration (as per approval obtained for the framework)

m) Allow for changes/updates to the configuration and re-baseline the configuration

3.1.3.5 Information input requirements:

a) Parameters for Asset Health & Performance, technical, and business technical performance information

b) Parameter designed criteria

c) Operating Technical Specification (OTS) parameters

d) Asset risk parameters (e.g. obsolescence, under rated equipment)

e) Parameter rules & algorithms

f) Parameter action levels and action requirements

g) Excursion values and duration.

3.1.3.6 Information outputs

a) Configured asset health framework

b) Configured asset performance framework

3.1.4 Monitor & report asset health & performance indices

3.1.4.1 EHPUM process supported

The Eskom process that is supported by this requirement:

a) Process Control Manual (PCM) for Optimise Operational Asset Performance (Monitor Asset Health & Performance Data)

3.1.4.2 Diagram

The inputs, process/function and outputs for the monitor and report on asset health and performance indices are illustrated below. The details are provided in the subsequent sections.

Inputs	Process/Function	Output
•Configured Asset Health & Performance Framework •Maintenance results (inspection/test results) •Condition assessment information •Outage reports (issues, plant condition) •Obsolescence information •Operations appraisal reports •Asset performance information •Asset operation information / including sensor information	•Upload the data •Run framework rules & algorithms •Display asset health & performance indices and trends (tabular, graphs, geographical) •Identify deviations and send actions/recomendations	•asset health & performance indices & trends •Actions/recommendations

3.1.4.3 Objective/description

The objective of monitoring and reporting on an assets health and performance indices is to collect and validate asset health and performance data as stipulated by the asset health and performance framework.

3.1.4.4 Functionality required

The APM tool shall include the following functions:

a) Upload the individual asset data as defined by the configured extraction, interfacing or data upload method(s)

b) Validate the data against the design base/specifications to ensure data are usable

c) Run/execute the configured rules, formulas & algorithms that define the framework.

d) Identify deviations based configured action levels

e) Execute the actions in accordance to the configured rules.

f) Record the actions and reason for the action so that the action progress can be tracked.

g) Navigation & drill down/up through the configured groupings (e.g. view per Network / asset class / asset type)

h) Perform comparisons in accordance to configured comparison rules (e.g. compare an asset's indices to indices of similar assets, and indices as per the design base)

i) Display and generate reports (i.e. predefined report templates used to generate standard reports) regarding asset health & performance indices and trends in accordance to the configured display methods and groupings. Generate the configured reports, for example:

   1) Asset health indices histogram (e.g. per parameter, asset, asset class, substation)

   2) Asses health & performance exceptions

   3) Number of assets vs asset health indices

   4) An asset’s indices in relation to indices of similar assets,

   5) An asset’s indices in relation in relation to design requirements

6) Failure probability vs asset health index

7) Report on premature failures (i.e. when current age + remaining technical age < designed age)

3.1.4.5 Information input requirements

As identified in the performance and health frameworks:

a) Maintenance history, e.g. inspection & test results, failures, costs.

b) Asset assessment information

c) Outage/incident history

d) Obsolescence information

e) Operations appraisal reports

f) Asset performance information

g) Asset operation information / including sensor information

3.1.4.6 Information outputs

a) Calculated Asset Health & Performance Indices and trends

b) Recommendations/actions for deviations identified

3.1.5 Analyse asset health & performance

3.1.5.1 EHPUM process supported

The Eskom process that is supported by this requirement:

a) Process Control Manual (PCM) for Optimise Operational Asset Performance (Analyse Asset Health & Performance Data)

b) Process Control Manual (PCM) for Perform Continuous Improvement (Analysis Equipment Performance)

3.1.5.2 Diagram

The inputs, process/function and outputs for the analyse asset health and performance indices are illustrated below. The details are provided in the subsequent sections.

Inputs	Process/Function	Output
•Asset health & performance indices & trends •asset health / performance Alerts •Maintenance results (inspection/test results) •Condition assessment information (e.g. Historian) •Outage reports (issues, plant conditon)	•Perform asset health & performance trending •Perform statistical analysis •Display data/graphs/visualisation •Generate asset health & performance analysis reports •Perform failure prediction •Compare costing (expected vs actual), risk and performance •Compare different maintenance strategies	•Asset health analysis reports •Asset perfromance analysis reports •Reports on common failure modes per asset class

3.1.5.3 Objective/description

The objective of analyse the Asset Health & Performance of an asset is to analyse and report on the health and performance data of the asset and trends as well as recommending improvement opportunities.

3.1.5.4 Functionality required

The APM tool shall include the following functions

a) Perform asset health & performance trending

1) Track asset health and performance over time

2) Compare a specific asset's health and performance against that of similar assets

3) Compare a specific asset's health and performance against the Design Base specification, e.g. efficiency, effectiveness, condition, reliability, availability, technical performance, failure rate and maintenance and operational cost

b) Use statistical methods to analysis asset condition, health, availability, reliability and performance

1) Loading of industry benchmark failure rates, cost and performance data (e.g. ITOM)

2) Configure and load data for benchmarking. E.g. Cost versus performance

3) Capture maintenance and failure costs per asset

4) Select the data (e.g. asset health, performance, condition, maintenance results) to be used for the analysis

5) Apply analytical & statistical formula(s)/techniques to the data. For example:

- Root cause analysis
- Weibull
- Pareto
- Standard deviation

6) Perform failure prediction

7) Display failure rates curves from industry data

8) Display failure rate curves using Eskom data

9) Display and compare industry and Eskom failure curves

10) Perform benchmark comparisons and analysis

11) Determine the common failure modes per asset class

c) Display/report on health and performance of network assets using graphs / geospatially visualisation.

1) Equipment ranking by risk of failure

2) Failure predictions

3) Accumulative failures vs age

4) Histogram for asset loading

d) Compare (e.g. graph) costing (expected vs actual), risk and performance

e) Capture potential abnormal conditions

f) Capture improvement opportunities to improve asset health and performance with its preliminary benefits and risks

g) On completion of the analysis:

1) Baseline the analysis and its associated data

2) Trigger a recommendation regarding the improvement opportunities to sustain and/or improve the health and performance of assets

3.1.5.5 Input information required

a) Outage history

b) Maintenance history

c) Condition assessment history

d) Calculated Asset Health & Performance Indices & Trends

e) Asset health / performance alerts

3.1.5.6 Information outputs

a) Asset Health analysis reports

b) Asset Performance analysis reports

c) Reports on common failure modes per asset class

3.1.6 Technical remaining life analysis

3.1.6.1 Eskom processes supported

The Eskom processes that are supported by this requirement:

a) Process Control Manual (PCM) for Optimise Operational Asset Performance

b) Process Control Manual (PCM) for Perform Design Analysis (Perform Reliability Engineering Analysis)

c) Process Control Manual (PCM) for Define Maintenance Plans (Wires) (Develop/Review Asset Life Cycle Management Plans)

3.1.6.2 Diagram

The inputs, process/function and outputs for the technical remaining life analysis are illustrated below. The details are provided in the subsequent sections.

Inputs	Process/Function	Output
• Inspection and test results • Asset age • Failure probability • Asset health • Asset performance • Design base thresholds • Condition information • Obsolescence	• Determine asset risk of failure • Calculate fit curves (probability of failure • Determine asset technical remaining life	• Asset technical remaining life

3.1.6.3 Objective/description

The objective of the Remaining Life Analysis is to determine the technical remaining of assets. This serves as an input into economic asset remaining life analysis.

3.1.6.4 Functionality required

The APM tool shall include the following functions:

a) Determine asset (and asset groups) technical remaining life

b) Display/report on data / graphs / geospatially visualisation, e.g.

1) Histogram of number of assets per age group

2) Geospatial view of assets per age group

3) Asset technical remaining life vs design life vs economic life

4) The assets current age plus the remaining technical life expectancy is to be determined and compared to the design life expectancy (e.g. designed age). Report on all assets not due to reach the designed age.

c) On completion of the analysis the following must be executed:

1) Baseline the analysis and its associated data

2) Where applicable trigger a recommendation for the review of

- Maintenance Engineering Strategy,
- Maintenance Execution Strategy
- Asset Health and Performance Framework
- Asset economic life analysis
- Life cycle planning
- Financial asset register

3.1.6.5 Information input requirements

a) Maintenance history (e.g. inspection/test results, failures, costs)

b) Asset Age

c) Asset Health & Performance Indices

d) Condition history

e) Operations data

f) Design base thresholds

g) Obsolescence

3.1.6.6 Information outputs

a) Asset technical remaining life

3.2 General Functionality

3.2.1 Asset hierarchies

a) The APM Tool shall have the ability to handle a single asset on its own, or be able to group a number of assets as one asset. Different asset types/classes shall be catered for.

Therefore these shall be modularized for easy structure review.

1) A high-level classification of equipment / assets such as substation / line equipment, (conductors & devices, towers and fixtures). The DX Maximo asset classification system shall be used for this configuration in APM.

2) A mid-level classification of equipment / asset such as transformers, switchgear, protection system.

3) A low-level classification of equipment / asset within an equipment group such as transformer core, transformer windings, transformer dielectric insulation system, bushings, external cooling system.

b) The APM tool shall be able to organise assets according to various element hierarchies

1) Plant breakdown structure

2) Organisational accountability

3) Reporting views

4) Asset types

c) The hierarchies shall be obtained from other systems (e.g. CMMS, Design Base for Plant Breakdown structure) and also be able to be manually managed.

3.2.2 Reports

a) The APM tool shall include the following functions to generate reports

1) An easy-to-use ad-hoc report writer that provides access to all data.

2) A report scheduler that will automatically submit a report on a predetermined basis and distribute that report as per defined criteria (e.g. print to printer, send via email).

3) Print reports, asset health & performance indices and trends

4) Download reports, asset health and performance indices, trends and comparisons to Microsoft Office

5) Sent reports, asset health & performance indices, trends and comparisons as attachments to email facility (Microsoft Outlook)

3.2.3 Recommendations/action management

a) The APM tool shall include the following functions for all recommendations, actions and improvement opportunities:

1) Workflow to facilitate the approval of recommendations and tasks

2) Recording of the recommendation, reason for the recommendation, supporting data, creator, to who actioned, date that recommendation was approved.

3) Obtain approval(s) for recommendation

4) Acknowledge and respond to recommendations

5) Report on the progress of recommendations

6) Close out date

3.2.4 Selection management

a) The APM tool shall include the following functions for creation and maintenance of selection criteria e.g. condition ratings, condition scoring (e.g. oil quality), quality scoring, results scoring (e.g. DC Resistance), health index scale, criticality scoring (e.g. end of life criteria), severity scoring:

1) Capturing/modifying of approved selection criteria

2) Baselining selection criteria

3.2.5 Data loading

a) The APM tool shall include the following functions:

1) Data quality verification during data loading process

2) Reporting of failures in data errors identified

3) Non digitised Asset and Maintenance information.

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