Eskom	Strategy	Komati Power Station

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1. INTRODUCTION

Manage Maintenance Base is the process in which the Maintenance Execution Strategy as well as the Inspection and Test Strategy are developed, specifying the maintenance and inspection tasks as well as the frequencies ("What" and "When") of an asset for it to be maintained.

The construction of the solar photo voltaic (PV) Demo plant for Komati Power Station has been procured, and commissioned, prelude to the execution of Phase 1 and Phase 2 of Component B for the Komati Repowering Project. Maintenance and cleaning strategies will be implemented on the demonstration plant and optimised so that it be replicated to the rest of Komati solar projects, failures experienced and eventually solution implementation in the Demo PV solar plant will ultimately play a huge role as experience developed in the main PV plant.

The document outlines the maintenance execution strategy for the Solar Demo PV Plant situated adjacent to the SSB building at Komati power station.

2. SUPPORTING CLAUSES

2.1 SCOPE

The following components are minimum requirements within the maintenance execution strategy, which are the implementation of the Maintenance Engineering output requirements:

- Identification of the individual assets to be maintained.
- Definition of specific component maintenance strategy, (What and When)
- Development of detailed preventative maintenance strategy,
- The Reliability Basis Optimisation (RBO) process step-by-step approach,
- Determination of cataloguing items to ensure that materials, and equipment specifications are available to aid maintenance execution,

2.1.1 Purpose

All maintenance plans shall align with the Maintenance Execution Strategy.

To achieve this purpose, this document prescribes “What needs to be done and when it will be done”. Planned Maintenance and Testing is performed to ensure sustainable, optimal asset performance at the lowest cost.

The defined strategy and plans shall include all testing and inspection requirements to obtain reliable information for accurate assessment of asset condition, which in turn will be used for decisions on the future lifecycle management strategy.

This document outlines the maintenance execution strategy for the Komati Power Station Solar Demo PV plant. Furthermore, the strategy prescribes the maintenance responsibilities and identifies recommended spares to be kept on site for the system.

2.1.2 Applicability

This maintenance execution strategy is applicable to Komati Power Station Pilot PV facility only.

2.2 NORMATIVE/INFORMATIVE REFERENCES

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

[1] 240-150642762 Generation PSR

[2] 240-114967625 Eskom ORHVS.

[3] 285-169245 Komati PS Pilot Solar PV Plant Technical Specification

2.3 DEFINITIONS

Definition	Description
Maintenance	A combination of all technical, administrative, and managerial actions during the lifecycle of an item intended to retain it in, or restore it to, a condition in which it can perform its required function.
Maintenance Philosophy	The principal approach decided upon for performing maintenance, such as pro-active or re-active maintenance.
Maintenance Strategy	The type of maintenance selected for specific asset / plant and equipment, such as time or condition-based maintenance, corrective or preventative maintenance.
Maintenance Plan	A plan that details the maintenance that needs to be done on a specific asset / plant item or component and the frequency and quality requirements for that maintenance.
Maintenance Schedule	The timing of the Maintenance Plan information stipulating when in the calendar year, work needs to be done.
Preventive Maintenance	Planned time or schedule-based maintenance carried out with the explicit objective of preventing functional failures and is directed towards maintaining the physical condition of the asset / plant or equipment. It includes scheduled overhauls and scheduled replacement of worn-out parts or failure prone components.
Corrective Maintenance	The process of restoring asset / plant and equipment which have failed or deteriorated to a state which renders it capable to meet the acceptance criteria required for its particular application.
Condition Based Maintenance	Predictive maintenance carried out as a result of findings from analysis of parameters measured under a condition-monitoring regime, or from recommendations from reliability analysis.
Reliability Centred Maintenance	RCM represents a disciplined decision logic approach that focuses on the consequences of failure to develop the most cost-effective lifetime maintenance programme. The decision logic question is sequenced to those parts of the asset / plant that are maintenance significant. Significant components failure modes are evaluated to identify appropriate maintenance tasks and their costs.
Condition Monitoring	Non-intrusive monitoring carried out to determine the physical condition of asset / plant and equipment.
Inspection	Activities, which by means of examination, observation or measurement, determine the conformance of material, parts, components etc., to predetermined specifications and quality requirements.
In-service Inspection	All inspection and testing conducted on plant and equipment at regular intervals and prescribed by regulatory and statutory codes or other types of specification throughout its service life.
Testing	All activities required determining the actual performance or condition of an item.

Definition	Description
Technical Plan	The technical plan is the five-year window of the Lifecycle Manage Plan (Life of Plant Plan).
Lifecycle Management Plan	This is the plan that details the financial and technical requirements with respect to all planned projects over the life of the plant. This plan covers Capital, R&E, and Routine Maintenance and Planned Maintenance costs.

2.4 CLASSIFICATION

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

2.5 ABBREVIATIONS

Abbreviation	Description
ISO	International Standardisation Organisation
QC	Quality Control
QCP	Quality Control Plan
RBO	Reliability Basis Optimisation
HOD	Head of Department
EMD	Electrical Maintenance Department
SAP	System Application and Products
SOW	Scope of Work
GO	General Outage
OEM	Original Equipment Manufacturer.
MV	Medium voltage
LV	Low Voltage
ACB	Air circuit breaker
VCB	Vacuum Circuit Breaker
MCB	Miniature Circuit Breaker
MCCB	Moulded Case Circuit Breaker
KKS	Kraftwerk Kennzeichen System (German for Power plant Classification system)
CT	Current Transformer
VT	Voltage Transformer
IR	Insulation Resistance
PV	Photo Voltaic

2.6 ROLES AND RESPONSIBILITIES

Area	Department	Responsible
Engineering	Electrical Engineering	Electrical Engineering Manager
Solar Demo PV Plant maintenance	Electrical Maintenance Department	Electrical Maintenance Manager

2.7 PROCESS FOR MONITORING

Works management process

2.8 RELATED/SUPPORTING DOCUMENTS

All related and supporting documentation are referenced under section 2.2 of normative and informative references.

3. MAINTENANCE EXECUTION STRATEGY

3.1 GENERAL REQUIREMENTS

- Maintenance (preventive, and spare parts replacement) and performance monitoring activities shall be carried out.
- Results from maintenance activities, including tests and findings from periodic inspections shall be stored accordingly for future reference and trending, and shall be shared with engineering as and when required.
- Maintenance shall be carried out on plant components paying regard to warranties, the supervisor responsible shall ensure they are not voided as a result of negligence and the use of improper tooling.
- All utilised tools during maintenance shall be calibrated, and calibration certificates made available for results credibility and safety of plant and personnel.
- Maintenance shall be compliant to the requirements detailed in 240-150642762 Generation PSR and 240-114967625 – Eskom ORHVS.
- Preventive maintenance also includes module cleaning, inverter servicing, foundation and mounting structure maintenance, inspection of junction boxes, conduit runs, combiner boxes, communication equipment, monitoring equipment, erosion control, drainage system control, vegetation management. Vegetation management must be performed to ensure modules are not shaded, a fire hazard is not created, unrestricted access to the major equipment of the site is maintained.
- As a minimum, inverter maintenance includes: the inspection and tightening of connections, ensuring water and dust tightness, cleaning, and replacement of filters, lubricating moving parts which may include fans, handles, and disconnects, running electronic diagnostics, routine maintenance according to manufacturer’s recommendation.
- When solar irradiation measured by two reference cells differs by more than 5% for continuous five-day period or quarterly basis, this necessitates the cleaning of all PV modules. This is specifically where one reference cell is cleaned weekly and the other one not (this needs to be part of routine maintenance - there is need to clearly mark which one gets cleaned weekly and which one only gets cleaned once all panels are washed) - then clean both when all the panels are cleaned to reset the measurements.
- Visual inspection of PV Module requires one to be on the lookout for glass breakage, yellowing and browning, corrosion, delamination, cracks on cell, hotspot, deformed connection box, module mounting and module frame condition amongst others. Thermal camera works very well for these inspections - in bigger plants drone fitted with thermal camera does the inspections much faster.

- String box/junction box/combiner box visual inspection include box screw tightness, incoming and outgoing cable tightness, cable labelling, water, and dust tightness.
- Visual inspection of cables (DC, AC or wiring) considers the following factors: discolouration and damage on outer sheath which may compromise watertightness, labelling, verify they are made properly to avert heat generation in connection, integrity and general completeness from load to source.
- The replacement of parts during corrective maintenance shall be in such a manner that the new parts do not yield a reduced efficiency of the rated output, moreover, should difficulty be encountered in obtaining the OEM specified parts, engineering shall be involved in not only soliciting proper replacements but also to ensure rightful processes are followed in so doing.
- Appendix B outlines minimum requirements for preventive maintenance plan guideline.
- VI curves on your strings are also a good method to establish if there are faults in a specific string and can be used on individual panels as well.

3.2 SYSTEM OVERVIEW

3.2.1 System and Process Description

The plant consists of a combination of PV modules, PV ground mounting structures and foundations, inverters, AC distribution boards, AC and DC cabling, control and monitoring systems, meteorological measuring stations etc.

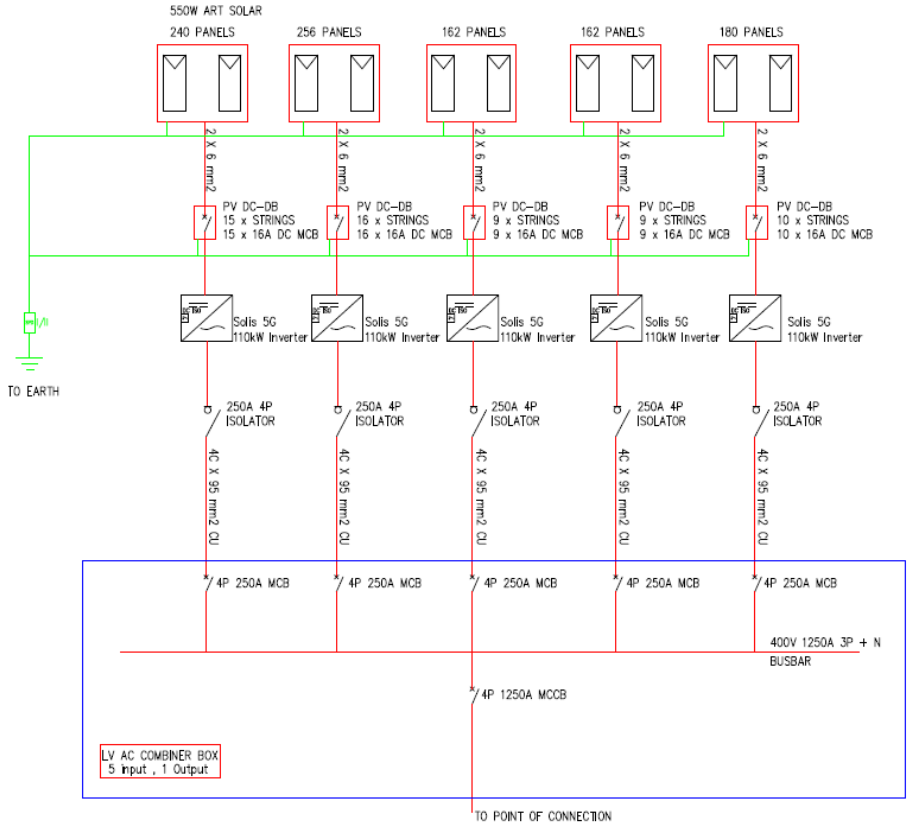

Figure 1: System overview from POC to Panels

The electrical schematic, in Figure 1, shows how the five inputs from the five 110kW inverters combine into a single output through the 4 pole 1250A Moulded Case Circuit Breaker.

3.2.2 Plant Performance

Plant performance is monitored either locally, via the inverter HMI screen with powered LED indications corresponding to power, operation, and alarm, or remotely via the following online applications:

- SOLIS (https://www.soliscloud.com)
- ELUM (https://e-lum.io/login?returnUrl=%2Fsite%3Fid%3Dc4189c36-7250-4ac8-b750-ae16905aaef2)

3.2.3 Operating Philosophy

Yet to be developed for the Demo PV plant

3.2.4 Criticality of Asset

Criticality of each component is defined as:

Functional Importance Category	Potential Consequences (Risk)
Critical	Safety, Health or Environmental
	Statutory Impact
	Production Loss (>5% loss of period > 8hrs)
	Hidden (redundancy, protective device)
Non-Critical	Significant Costs
	Secondary Damage
RTF	No significant effects beyond repair of the failure itself. *A Run To Failure component is one for which the consequences of failure are acceptable without any preventive maintenance being performed and there is no simple cost effective method to extend the useful life of the component.*

Table 3.1: Functional Importance Evaluation Criteria

3.2.5 Environmental Impact

The special biodegradable cleaning detergent (including all chemical substances to be used) whose procurement is underway, for trial running purposes, will be verified against environmental requirements that concern flora and fauna, amongst others.

Environmental issues are normally avoidable through proper design and maintenance, however where challenges arise, the operations and maintenance personnel must detect them and respond promptly. Environmental compliance may be triggered by components of the PV system itself, such as components that include hazardous materials and by-products that may be used by the O&M service provider such as herbicides and insecticides.

3.2.6 Safety Impacts

Solar plants are electricity generating power stations and have significant hazards present which can result in injury or death. Risks should be reduced through proper hazard identification, proper planning of works, briefing of procedures to be followed, documented and regular inspection, and maintenance. Personnel training and certification and personal protective equipment are required for several tasks. All jobs have

some safety requirements such as fall protection for work at heights and electrical arc-flash, and general electrical safety for electrical work, eye, and ear protection for ground maintenance.

Safety requirements as determined by law and the Employer, i.e., lifesaving rules, and ultimately OHS Act 85 of 1993 as well as employers' health safety standards shall all be adhered to at all material times.

3.2.7 Risk Assessment

The maintenance executing personnel to identify all potentially hazardous tasks, prepare safe working procedures, and carry out pre-job briefs prior to commencement of maintenance activities. This ensures that the staff is safety conscious and are fully conversant with the potential risks involved. Furthermore, the same team invariably documents task/issue-based risk assessment whilst the engineering team identifies, documents, analyses and manages all arising technical risks for the Demo PV plant.

3.2.8 Assumptions

N/A

3.2.9 Future Plant / Design Modifications and Requirements

N/A

3.2.10 Remnant Life

25 years

3.2.11 Lifecycle Management Plan (LCMP) / Life of Plant Plan (LOPP)

Modules are designed to generate electricity for a minimum of 25 years under the environmental conditions of the site.

3.2.12 Technical Plan

N/A

3.3 MAINTENANCE STRATEGY DETERMINATION PROCESS

The RBO process is a step-by-step approach to develop and optimise the plant Reliability Basis, by incorporating plant specific knowledge, maintenance and failure history and industry best practice, to finally achieve an effective Plant System Strategy.

The optimisation process further includes the understanding of how equipment fails the development of defence mechanisms to counteract these failures and the application of technology to proactively predict potential failures.

A balance has to be found between the amount of maintenance performed and the resulting reliability of the equipment.

The Reliability Basis Optimisation is done by:

1. **Examining** each piece of equipment with a view of how it can be expected to fail,
2. Determining what **maintenance tasks** should be done regularly to prevent such a failure from occurring,

3. Determining the **optimum interval** for each such failure defence task.

Figure 2 shows the RBO process pictorially and below is described a detailed step by step explanation of the process.

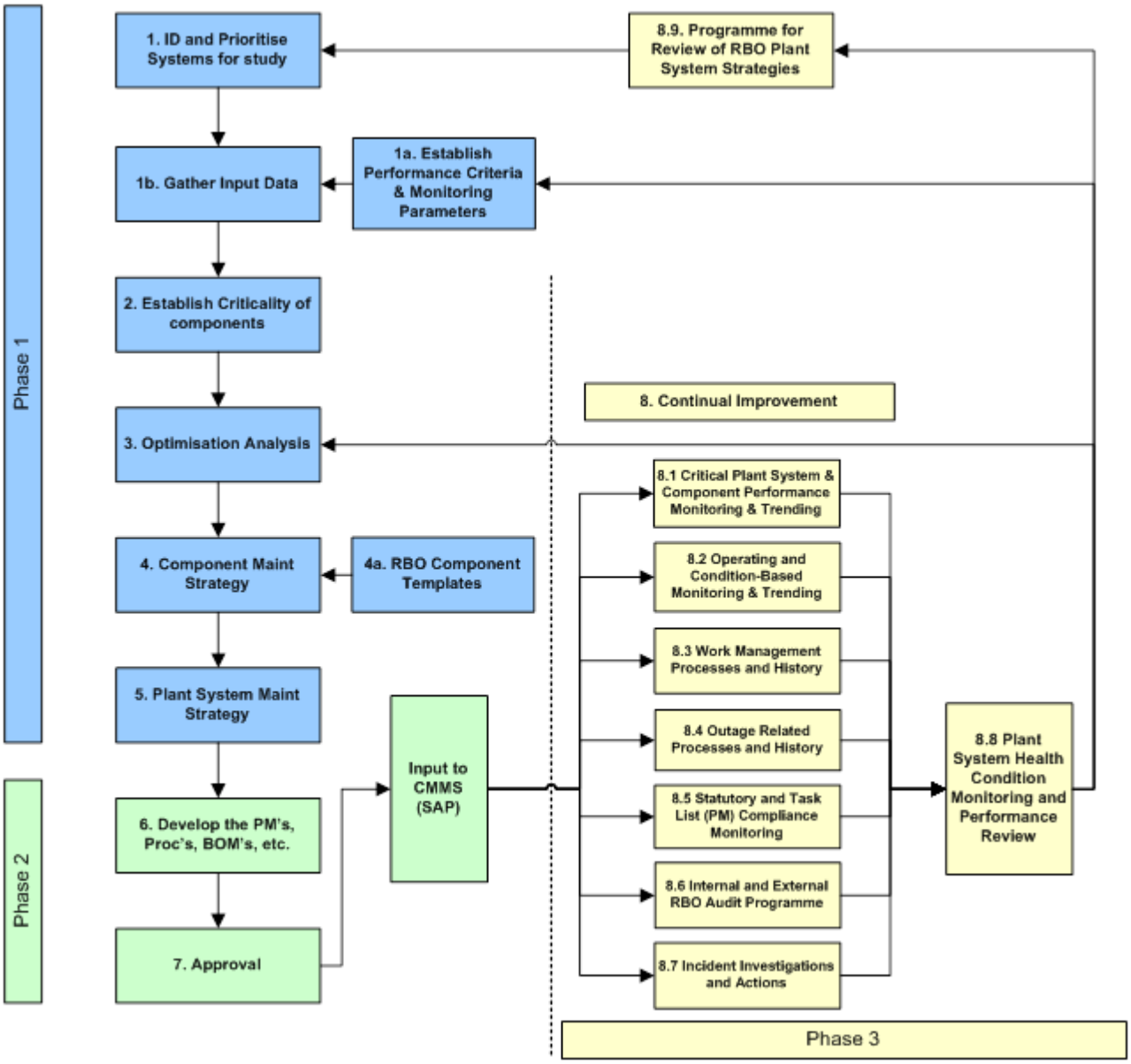

Figure 2: Flow Diagram for Reliability Basis Optimisation

Step 1: Identify Plant Systems Including boundaries to be analysed.

The boundaries of the system should be specific (e.g., the system ends at outlet flange of the de-aerator gate valve with functional location 00 XXXXXX). This level of detail is required as it prevents grey areas by making it clear where the next system starts thereby avoiding components being left out of analysis.

Gather Input data, Establish Performance Criteria and Monitoring Parameters

A walk-down of the system to be analysed should be conducted prior to analysis. This should aim to verify that components on the physical plant and components on the plant drawings correspond.

The following data is also collected in preparation for analysis.

1. Plant hardware breakdown structure (functional locations or other)
2. Plant system drawings (flow diagrams, P&IDs, etc.)
3. List of components to be analysed (to be populated in spreadsheet)
4. Current Maintenance Strategies for each component. (PMs from SAP)
5. Maintenance and Operating Procedures
6. Previous analyses e.g., RBO, RCM, FMECA, etc.
7. RBO analysis from identical plants in other stations (for benchmarking)
8. Capital/Modification Plans in progress or completed.
9. OEM documents and/or Contracted Out Plant
10. Maintenance History from CMMS
11. RBO Templates for Best Practice Maintenance Strategies (GGCS)
12. Components desired capabilities (minimum operating parameters or acceptable levels)
13. Component parameters to be monitored (e.g., temperature, pressure, vibration, etc.)

Step 2: Determine and document the Criticality or Functional Importance Evaluation (FIE) of plant system components.

Maintenance should be focused on preserving critical System, Structure and Component functions. Thus, in order to achieve this, it is important to identify which Systems, Structures and Components support critical functions. Some components may not support critical functions but can have serious consequences if they fail in a certain manner (e.g., barring gearbox coupling engages while mill is in service), and this must be considered.

On the spreadsheet populated with all the systems components, all components should be evaluated to determine in what ways they can fail to fulfil their functions. This is termed the **functional failure** evaluation. Once the functional failures have been identified for each component, the component should be assessed for functional importance, in accordance with the set criteria in Table 3.1. The **functional importance** is then recorded in the spreadsheet.

As the success of the resulting Maintenance Strategy relies on accurate component categorisation, it is important to ensure that staff with the appropriate experience review the FIE. A panel of experienced staff from Operating, Maintenance and Engineering should be used to perform this review.

Critical

Critical components are those where the consequences of failure are serious and where the aim must be to defend against all plausible failures.

Non-critical

Non-critical components are still important components but are those where failure can be tolerated.

Run-to-Failure (RTF)

- Components are Run-to-Failure where there are no effects beyond repair of the actual failure itself.

- All components identified as RTF, must be validated and the reasons documented within the spreadsheet.

Step 3: Optimisation Analysis

This analysis entails:

1. Scrub (search) existing Task Lists and tasks to identify duplication,
2. Search for similar System Models from other Power Stations,
3. Search for relevant Head Office RBO Templates (GGCS)

Step 4: Component Maintenance Strategy

Analysis then commences on the individual components or parts where necessary.

RBO Templates (Generation Generic Component Strategies)

For each Critical and Non-critical component, identify the applicable RBO template (GGCS) from the library available from Generation AMD. Consider the following:

1. Basic design (Is the component of similar design in that the component will fail in the same manner as those covered by the RBO template)
2. Functional Importance (Critical, Non-critical)
3. Operating Environment (Harsh or mild).
4. Duty cycle (high or low)

The RBO templates are housed on the Eskom website link below:

http://genweb-assetmanagement.eskom.co.za/live/content.php?Category_ID=2014

Should there be a technical reason to deviate from the recommendations of the GGCS, this reason should be documented so that the thought logic can be followed by the personnel who will review the document in future.

In the absence of RBO TEMPLATE (GGCS) perform a failure mode analysis.

Component Failure Mode Analysis (FMA)

Where no applicable RBO TEMPLATE (GGCS) is available, perform an FMA on the component. Identify and list against each component, all plausible failure modes (FMs) that will lead to functional failure of the component. For each failure mode, identify and list all possible failure causes. After which a suitable mitigation task and frequency (interval) has to be decided upon.

TASK SELECTION

For each failure mode and cause combination, identify the most applicable and effective tasks to defend against the failure. Preventive maintenance tasks should be selected in the following order of priority:

Condition Monitoring Tasks

Task aimed at detecting the onset of failure, in order to prevent a functional failure.

1. There must be a measurable parameter whose change over time can be correlated to failure onset.
2. The failure development period should be long enough to allow appropriate action to be taken.
3. The task should be non-intrusive.

Time Directed Tasks

Task aimed directly at failure prevention or retardation.

1. The task is carried out at the preset interval without any further input and is designed to prevent or retard failure.
2. The task usually entails some form of intrusion into the equipment.

Failure Finding Tasks

Task aimed at discovering a hidden failure condition before an operational demand.

1. Task is performed to detect whether something has already failed, in order that action can be taken to prevent the multiple failure.

TASK INTERVAL SELECTION

Based on the task type, select a suitable task periodicity.

1. For Condition Monitoring tasks, the periodicity should be based on the failure development period. (Period between the point at which the potential failure condition can be detected and the point at which the functional failure would occur).
2. For Time Directed tasks, the periodicity is based on the age at which the component shows a rapid increase in the conditional probability of failure. This age is estimated based on maintenance history and international experience (EPRI Templates).
3. For Failure Finding tasks, the periodicity should be based on the risk of multiple failures.

The task interval is based on an assessment of the acceptable level of risk associated with the failure. Should there be a lack of available reliability data; specialist opinion and international experience are also used to determine a suitable task interval.

Record Component Maintenance Strategy

1. The RBO Team decides on an appropriate Component Maintenance Strategy (using RBO TEMPLATE (GGCS) or FMA method) and documents it with appropriate task descriptions and frequencies.
2. The RBO Team documents the decision process for future reference.
3. The RBO Team identifies PMs, WPs, SMPs, SOPs, BOMs and other documents for development, review, or deletion.

Step 5: Compile and approve the Plant System Maintenance Strategy

The System Engineer compiles and documents a draft Plant System Maintenance Strategy document which prescribes the “when” to do “what” based on the combination of individual Component Maintenance Strategies. The System engineer is responsible for the contents of this document as well as for keeping it updated.

The Plant System Strategy not only contains maintenance related issues, but also includes the following strategies related to that particular plant system:

1. Operating Strategy (related to the operation, change-over and/or testing of streams, redundant and standby equipment)
2. Outage Strategy (related to unit outages as well as non-unit outages, at what frequency will the equipment be taken out, pre-outage interventions required, etc.)
3. Maintenance Strategy will comprise of the individual Component Maintenance Strategies, which become the essential building blocks of the Reliability Basis. (Component breakdown, failure modes and what to be done when)

4. Spares Strategy (related specifically to capital or strategic spares)
5. Proposed Modifications (planned and based on the Analysis study)
6. Any other areas for research, modification, or investigation to improve the condition monitoring and predictive maintenance efforts.

Once the Plant System Strategy has been drafted by the System Engineer, this document is circulated for review and approval, as follows:

1. Internal team review (by members of the analysis participating members, maintenance functions, etc.)
2. External Power Station review (this is normally only needed if the power station believes that external specialists off-site can add value to the content of the document)
3. Approval by the Engineering Manager.
4. Distribute the Plant System Strategy within the Power Station and to AMD at Head Office.

Step 6: Implementation of the Plant System Strategy (Phase 2)

This phase involves the development of each one of the tasks identified in the Maintenance Strategy. This development will take place in the Works Management/ Maintenance functions and involves the detailed step by step process of doing the inspection or work.

All task lists are to be reviewed by the System Engineer prior to approval by the relevant function, to assure that all related aspects of the Maintenance Strategy have been incorporated.

1. Compilation of PMs and SMPs (inclusive of BOMs and work packages):

   The PM schedule and procedure format of the particular power station is used as a standard.

2. Removal of redundant PM's and re-packaging of tasks:

   During the optimisation process, certain tasks will be made redundant, replaced by condition monitoring tasks and/or have their frequencies changed and therefore groupings of tasks may have to be re-packaged.

Step 7: Approval of PMs and SMPs

These documents are to be reviewed and approved by the relevant Department individuals after a review by the System Engineer, whose role is to assure that all related aspects of the Maintenance Strategy have been incorporated.

1. Uploading into SAP

   All documents developed are to be uploaded into the CMMS (SAP) and all these documents can be viewed by any person from that site or even another site.

2. Switching on the CMMS (SAP) PM's

   When appropriate, all PMs are to be switched on and these then become active from here on. The normal CMMS (SAP) controls of Work Management/ Maintenance execution then apply from hereon.

Step 8: Continual Improvement

Strategy Document Reviews

System Engineers are required to update their strategies whenever a change of task list is required in their plants. As a minimum, the strategy document shall be reviewed at least once a year.

Even if there are changes during the year, the yearly review should still be conducted to ensure that analysis is done to identify components that are being over maintained and to ensure that failure history is being analyzed.

The documentation system should be such that all previous analysis remains available for reference hence a revision number should apply to all updated documents.

The new revision document should highlight (preferably in the first pages), what changes have been made within that document. It is suggested that is say the yearly review is rev 3, the minor revisions during that year be rev 3,1; rev 3,2 etc. and the revision will only move up to rev 4 during the yearly review of the following year.

For purposes of the annual review, the System Engineer should download history from SAP for the previous years and compare this against the listed strategy to determine if the task is still relevant, is being performed too frequently or too little and/or if a new strategy is required. The annual RBO Review Program will be developed by each site.

The annual review should verify the following aspects:

1. All changes (physical functional location, component manufacturer, operating parameters, feed material, etc.) or modifications done have been included in the Plant System Strategies,
2. Drawing numbers used are referenced in the strategy document,
3. Spares required especially for RTF components should be listed,
4. For each task identified in the Plant System Strategy, a Task List shall exist in SAP,
5. The Plant System Strategy shall reflect the SAP task list number (maintenance item) per component task,
6. Each SAP task list is active and generating work orders at the defined frequencies,
7. The maintenance history specified by the System Engineer in the strategy document is being captured by the maintenance personnel and analyzed by the System Engineer. If additional history is required, this should be updated on the strategy document,
8. Resource requirements (manpower, spares, tools, scaffolding, time, lifting equipment, etc.) have been clearly identified for each Task List,
9. Task List instructions are clearly listed (no one-liners allowed),
10. Plant System Strategy Tasks are optimal in terms of plant system reliability, failure data and cost,
11. Shortcomings and Corrective Actions required are identified.

This review shall be documented to show this review has been carried out and formally communicated to the Engineering Manager for approval.

External Audits

In order to assure that all components have been considered, have strategies and that the strategies are in SAP, AMD will initiate an audit process. As it is not possible to audit every single component, these audits will take the form of sample audits and shall be conducted every 3 years.

Auditing for Plant System component listing completeness

AMD will conduct sample audits by selecting random components and the Station should provide evidence of the component having been analysed in a strategy document. Should this component not be located in a strategy document, the assumption will exist that it was not covered. Drawing numbers used should be referenced in all strategy documents.

Auditing to assure all component strategies are in SAP.

For each component that is not a run-to-failure, the Station should be able to demonstrate that a task list exists for the component in the CMMS. This may be by way of associating a maintenance task number to a component on the spreadsheet column “documents required”. A random check will also be done in SAP to ensure that strategies that have been made redundant are switched off. Points will be allocated as appropriate.

3.4 MAINTENANCE STRATEGY (SPECIFIC EQUIPMENT AND COMPONENT MAINTENANCE STRATEGY)

Refer to appendix B.

4. AUTHORIZATION

This document has been seen and accepted by:

Name	Designation
Freeman Chiranga	Senior Engineer Prof Electrical
Kuda Mareya	Senior Engineer Prof Auxiliary
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5. REVISIONS

5.1 REVISIONS TO DOCUMENT

Date	Rev.	Compiler	Remarks
July 2024	0.1	Mdu Vilakazi	First Compilation for review by the authorisation team in clause 4.
August 2024	0	Mdu Vilakazi	Reviews effected and document finalised for authorisation.

6. DEVELOPMENT TEAM

The following people were involved in the development of this document:

- Mdu Vilakazi

7. ACKNOWLEDGEMENTS

None.

APPENDIX A: RECOMMENDED SPARES LIST

DC Components			
Equipment	**Description**	**Unit**	**Quantity**
DC Cable	6sqmm single core DC cable (Red)	m	250
DC Cable	6sqmm single core DC cable (Black)	m	250
MC4	MC4 Connector twin pack	ea.	50
Circuit Breaker	4 Pole 16A 1000VDC 6ka Circuit Breaker	ea.	5
AC Components			
Circuit Breaker	3 Pole 10A 400V 6kA Circuit Breaker	ea.	1
Circuit Breaker	1 Pole 32A 240V/415V 6kA Circuit Breaker	ea.	1
Circuit Breaker	1 Pole 20A 240V/415V 6kA Circuit Breaker	ea.	1
Circuit Breaker	1 Pole 10A 240V/415V 6kA Circuit Breaker	ea.	1
Circuit Breaker	1 Pole 6A 240V/415V 6kA Circuit Breaker	ea.	1
Circuit Breaker	3 Pole 250A 240V/415V 40kA Circuit Breaker	ea.	1
AC Cable	2.5sqmm GP Wire - Red	m	100
AC Cable	2.5sqmm GP Wire - White	m	100
AC Cable	2.5sqmm GP Wire - Blue	m	100
AC Cable	2.5sqmm GP Wire - Green and Yellow	m	100
AC Cable	1 Core - 70sqmm Braided Cable	m	10
Communication Cable			
Comms Cable	Shielded UV Protected Cat6 Cable	m	200
PV Module			
PV Module	Bistar - 550W Half-Cut Mono Perc	ea.	2

APPENDIX B: PREVENTIVE MAINTENANCE PLAN GUIDELINE

Equipment	**KKS**	**Maintenance Intervention**	**Frequency** [w - weekly m - monthly yr – yearly, MM – Manufacture s manual]
Solar Panel Modules	Refer to KKS List	Visual Inspection	1 m
		Infra - Red Scanning	6 m
		Cleaning	3 m
		Vegetation Management	2 w
Inverter	35-00PGM01IV001	Fan Test	1 m
	35-00PGM01IV002	I/V Curve Scan	3 m
	35-00PGM01IV003	Calibrate Inverter Output Energy and Voltage	1 yr
		Operating temperature range	1 m
		Verify the presence of strange noise I/S	1 m
	35-00PAG01IV004	Fan Maintenance	3 m
		Cleaning of air filters	MM
	35-00PAG01IV005	Cleaning (Heat Sink, LCD, LED)	3 m
		Efficiency measurement (DC/AC conversion)	1 m
		Anti-Islanding Test	1yr
		Synchronisation Test	1yr
DC Cables	Refer to KKS List	Visual Inspection	3 m
		IR Testing	1 yr
DC Protection Box	35-00PGM01PB001 - 3	Visual Inspection	3m
	35-00PAG01PB001 - 2	Infra - Red Scanning	6 m
AC Isolator	35-00PGM01IS001	Visual Inspection	3 m
	35-00PGM01IS002	Cleaning	3 m
	35-00PGM01IS003	Infra - Red Scanning	6 m
	35-00PAG01IS001	Breaker Operation Checks	1 yr
	35-00PAG02IS002		
AC Combiner Box	Refer to KKS List	Visual Inspection	3 m
		Cleaning	3 m
		Energy Meter Calibration	1 yr
		CT Calibrations	1 yr
		Infra -Red Scanning	6 m
		Breaker Operation Checks	1 yr
			1 m
Mini-Sub		Visual Inspection	3 m

		CT Calibrations	1 yr
AC Cables	Refer to KKS list	Visual Inspection	3 m
		IR Testing	1 yr
Earthing System	Refer to KKS list	Visual Inspection	3 m
		Earth Resistance Measurements	1 yr
Lightning Protection System	Refer to KKS list	Visual Inspection	3 m
		Finials Alignment Checks	3 m
		Earth Bonding Continuity Tests	1 yr
Auxiliary DB	Refer to KKS list	Visual Inspection	3 m
		Cleaning	3 m
Control Room DB	Refer to KKS list	Visual Inspection	6 m
		Cleaning	6 m
Meteorological Station	Refer to KKS list	Visual Inspection	3 m
		Sensor Cleaning & Alignment	3 m
		Calibration Checks	1 yr
IR Sensors	Refer to KKS list	Cleaning	1 w
		Calibration	1 yr
Mounting structure and foundation.	Refer to KKS list	Visual inspection of mounting structure	1 m
		Checking of integrity of mounting structures and clamping.	1 m
		Inspection of corrosion in fasteners, structure and check adequacy of fasteners tightness.	6 m
		Visual inspection on foundation	1 m
KKS list spreadsheet	 PVDemo KKS List - SAP Uploads rev 1.xls		