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CONTENTS

Page

EXECUTIVE SUMMARY **4**

1. INTRODUCTION **5**

2. SUPPORTING CLAUSES **5**

2.1 SCOPE 5
2.1.1 Purpose 5
2.1.2 Applicability 5
2.2 NORMATIVE/INFORMATIVE REFERENCES 5
2.2.1 Normative 5
2.2.2 Informative 5
2.3 DEFINITIONS 6
2.3.1 Disclosure Classification 6
2.4 ABBREVIATIONS 6
2.5 ROLES AND RESPONSIBILITIES 7
2.6 PROCESS FOR MONITORING 7
2.7 RECORDS 7

3. MAINTENANCE REQUIREMENTS **8**

3.1 AIR HEATER SYSTEMS BREAKDOWN AND DEFINITION 8
3.1.1 Rotor and Heat transfer elements 8
3.1.2 Casing and Ducting 8
3.1.3 Drive Mechanism 8
3.1.4 Shaft, Bearings and lubrication system 8
3.1.5 Sealing system 8
3.1.6 Sector plates 8
3.1.7 Soot-blower system 8
3.1.8 Fire Detection and Protection systems 8
3.1.9 Erosion protection 9
3.1.10 Instrumentation 9
3.2 ROTOR AND HEAT TRANSFER ELEMENTS 9
3.2.1 Rotor Structure 9
3.2.2 Element Packs, Supports and Condition Monitoring 9
3.2.3 Element pack washing and drying 11
3.3 SEALS 12
3.3.1 Radial Seals 12
3.3.2 Axial Seals 12
3.3.3 Circumferential Seals 12
3.3.4 Radial Sector Plates 13
3.3.5 Axial Sector Plates 13
3.4 CASING TRANSITION DUCTING AND ACCESS DOORS 13
3.4.1 Access Doors 13
3.5 DRIVE MECHANISM 14
3.5.1 Main drive motor and coupling 14
3.5.2 Main drive Gearbox 14
3.5.3 Drive Pinion (Kendal) 15
3.5.4 Drive Pin-rack (Kendal) 15
3.6 SHAFT, BEARINGS AND LUBRICATION SYSTEM 16
3.6.1 Shaft and Alignment 16
3.6.2 Locating/Guide Bearing 16
3.6.3 Main Support bearing 16
3.6.4 Oil lubrication system 16
3.7 SEAL SETTING 16

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3.8 SOOT-BLOWER SYSTEM 16
3.8.1 Steam supply piping 17
3.8.2 Fixed Pipe System 17
3.8.3 Reciprocating Pipe System 17
3.9 FIRE DETECTION AND PROTECTION SYSTEMS 17
3.9.1 Fire detection system (Where fitted) 17
3.9.2 Fire-fighting water supply piping 18
3.9.3 Fire water nozzles 18
3.9.4 Casing drainage for fire-fighting water 18
3.9.5 Fire-fighting system hardware testing 18
3.9.6 Fire-fighting procedure and system 19
3.10 EROSION PROTECTION 19
3.10.1 Identification and control of erosion areas 19
3.10.2 Minimum reference list of known repair areas 19
3.10.3 Repair of eroded areas 19
3.11 INSTRUMENTATION 20
3.11.1 Process and Protection Instrumentation 20
3.11.2 Condition monitoring instrumentation 21
3.12 SPARES AND MANAGEMENT OF SPARES BOM 21

4. INSPECTION AND TESTING 21

4.1 ONLINE INSPECTION 21
4.1.1 Plant-walk verification 21
4.1.2 Operational assessment and incidents 22
4.1.3 Contractors documentation 23
4.2 OUTAGE CONDITION AND SOW INSPECTION DOCUMENTATION 23
4.2.1 Preventative replacement SOW 23
4.2.2 Compulsory Inspection/assessment 23
4.2.3 Scope of Work management 25
4.2.4 Quality Control Documentation 26
4.3 DOCUMENTATION OF PROOF TESTS AND INSPECTIONS 26
4.3.1 Important “Proof of functioning or Compliance” tests 26
4.3.2 Document acceptance requirements 26

5. AUTHORISATION 27

6. REVISIONS 27

7. DEVELOPMENT TEAM 27

8. ACKNOWLEDGEMENTS 27

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EXECUTIVE SUMMARY

The Rotating Matrix type Air Heater – generally referred to the Ljungstrom design – is a complex machine, and inherent to its function of Gas to Air heat-exchange, is subject to severe conditions of erosion.

The organisations' Management and Maintenance personnel must have a clear understanding that the execution of Air Heater maintenance cannot be presented as a "normal run of the mill" task. The effective maintenance of the machine presents a multitude of intricate and interrelated details, and if not correctly managed with the appropriate knowledge and skill levels, it will result into severe plant production losses and stoppages.

Continued operation of the plant, with known deficiencies, such as air heater element blockage, Soot-blower malfunction, sealing failures, etc. will result in the accumulation and exaggeration of damage to components with severe consequences such as plant load losses – and is best addressed on urgent basis, in order to sustain relative reliability between operational shut-downs.

The effective Management of the Preventative Maintenance program, requires of the in-depth knowledge of the machine and processes recommended within this Specification.

Periodic evaluation of compliance to planning, processes and engineering analysis is essential to achieve sustainable good performance.

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1. INTRODUCTION

The correct execution of Maintenance on Rotating Matrix (Ljungstrom) type Air Heaters are aimed at obtaining the best performance and life expectancy of components that are subject to frictional wear and ash erosive wear. Accurate detailed execution of repair scope strives to ensure that unplanned failures is eliminated in order to ensure effective operation and performance between planned outage intervals.

2. SUPPORTING CLAUSES

2.1 SCOPE

2.1.1 Purpose

This Maintenance Specification stipulates the minimum requirements for inspection and executing repair and preventative maintenance and monitoring performance on the Air Heaters, in order to ensure that the best operational service are obtained between repair intervals.

2.1.2 Applicability

This Specification applies to all Rotating matrix (Ljungstrom) type Air Heaters installed on Eskom fossil fired Boilers.

The Specification is to be used by both Eskom System Engineers and Maintenance Contractors for proposing and planning of the appropriate maintenance Scope of Work, and for stating minimum requirements for compliance execution to Contractors engaged in Maintenance Contracts.

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] 240-119862281: Air Heater Leakage Guideline.

[2] 240-119862303: Air Heater Fouling Prevention Guideline.

[3] 240-100914307: Regenerative Air heater element pack and preservation storage standard.

[4] 240-106628253: Standard for Welding Requirements on Eskom Plant.

[5] 240-131963944 Draught Plant Preservation Standard

[6] 240-100914307 Regenerative Air Heater Element Packs Storage and Preservation Standard.

[7] Station Air Heater washing procedure.

[8] Station Air Heater Fire-fighting procedure.

[9] Station Draught Plant Return to Service procedure.

[10] 240-87694581 Performance Testing of Air Preheaters Standard

2.2.2 Informative

[11] 240-111508338: Process Control Manual (PCM) for Outage Management

[12] Applicable NDT and wall thickness monitoring standards.

[13] 240-89218264: ID Fan’s out of capacity guideline.

[14] 474-11040: Air Heater fire detection/protection – minimum requirements.

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[15] 240-89217730: Standard for Draught Plant Protection functions

2.3 DEFINITIONS

Definition	Description
Rotating hood	The description of the layout/configuration of the Air Heater type – the regeneration of heat through the element packs is obtained via the **rotation** of internal **hoods** (ducts) which guides gas/air flow through the heat-exchanging elements.
Rotating matrix	The description of the layout/configuration of the Air Heater type – the regeneration of heat through the element packs is obtained via the **rotation** of a shaft/rotor, containing the element packs/**matrix** which allows rotational exposure of the elements to gas/air flow for regenerative heat exchange.
Regenerative	Regeneration in the heat-exchange context is the mechanism of continuous heat exchanging cycles through the cyclic deposit of heat and extraction of the heat out of the same member.
Capping	The phenomena of the stator to take up a curved or dished shape due to unequal expansion resulting from temperature differences between the top and bottom surfaces.
Entrained-ash	Entrained-ash is defined as the gas and ash “charge” that is captured within the element packs as they transition from the gas stream to air stream during the continuous sealing-off and reversal of the direction of flow during the rotating and re-generative heat-exchange process.
Retained-ash	Retained-ash is defined as ash contained inside the element pack matrix through regenerative cycles as result of settling in element spaces with low flow or due to element plate design.
Bypass flow	Bypass flow are flow paths created by design or erosion and that does not pass through the intended element pack matrix.
X-Factor	The mathematical calculation using process temperatures surrounding the element packs in order to assess the machines thermal efficiency.

2.3.1 Disclosure Classification

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

2.4 ABBREVIATIONS

Abbreviation	Description
BOM	Bill of Material
HE	Hot End
CE	Cold End
CIWS	Cast Iron Wear Seals
TIR	Total Indicated Run-out
PCD	Pitch Circle Diameter
C&I	Control & Instrumentation

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Abbreviation	Description
RTS	Return To Service
FD Fan	Forced Draught Fan
ID Fan	Induced Draught Fan
SOW	Scope of Work
QCP	Quality Control Plan
PS	Power Station
AN 1	Arnot Unit 1
DV	Duvha Power station
TT	Tutuka Power Station
KR	Kriel Power Station
HD	Hendrina Power Station
GV	Grootvlei Power Station
MT	Matimba Power Station
MJ	Majuba Power Station
FFFR	Fossil Fuel Firing Regulations
HP	High Pressure
NTU	Nephelometric Turbidity Units

2.5 ROLES AND RESPONSIBILITIES

a) Station System Engineers must be well versed on the content of the Specification and ensure to implement the requirements for the Maintenance program, Outage SOW, and Quality Control.

b) Each Power Station is responsible to implement the minimum requirements described in this Specification and to develop a spares stockholding plan to support the execution of Maintenance work.

c) The Maintenance executing Contractor shall possess all detailed execution procedures and training material to facilitate accurate execution of the stipulated Maintenance repair work.

2.6 PROCESS FOR MONITORING

Compliance monitoring to this Specification will be via peer reviews and Quality audits.

2.7 RECORDS

The following documentation shall be produced as a result of this Specification;

a) The Eskom Engineer shall develop Scope of Work documentation to guide effective and complete scoping using the activity schedules developed by Eskom.

b) The Eskom Engineer shall develop the referenced documents recommended in this Specification, pertaining to performance and erosion protection monitoring.

c) Each relevant Power Station shall develop the spares stockholding capability to support the accurate execution of required scope for a specific outage

d) The Maintenance Contractor shall possess instruction documents to guide accurate execution of the detailed tasks in accordance to this guideline.

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e) The Maintenance Contractor shall possess/develop Inspection Reporting documentation to facilitate effective and accurate condition Reporting, Analysis and Quality Control of the execution.

f) The Maintenance Contractor shall develop Quality Control documentation to secure effective verification and record-keeping of the quality of execution.

g) The Maintenance Contractor shall submit a detailed list of spares requirements based on the requested Scope of Work related to a particular outage.

3. MAINTENANCE REQUIREMENTS

3.1 AIR HEATER SYSTEMS BREAKDOWN AND DEFINITION

3.1.1 Rotor and Heat transfer elements

The rotor structure containing the inserted heat transfer element packs with supporting steel-structure.

3.1.2 Casing and Ducting

The casing and ducting refers to the ducting and casing around the rotor from the inlet flanges to the outlet flanges on the air and gas paths.

3.1.3 Drive Mechanism

The Drive mechanism refers to the drive, motor, coupling and gearbox for the center drive systems and the rotor mounted pin rack drive systems. Some plant is fitted with an auxiliary drive functionality integral to the gearbox, for (slow-drive) maintenance purposes.

3.1.4 Shaft, Bearings and lubrication system

The shaft and bearings refers to the main shaft supporting the rotor, thrust/support- and guide bearings with an auxiliary system for lubrication.

3.1.5 Sealing system

The sealing system refers to the axial, circumferential, hub and radial seals installed on the rotor and casing to provide sealing between the air and gas paths.

3.1.6 Sector plates

The sector plates refers to the axial and radial sector plates forming the sealing surfaces of the radial and axial seals fitted to the rotor. Some are adjustable and others are in a fixed position

3.1.7 Soot-blower system

The Soot-blower system refers mostly to the internal equipment, from steam inlet piping entering the Air Heater, internal piping, thermal expansion compensators, through to the steam blowing headers/nozzles. Two different concepts of steam soot-blower systems are in use – Fixed Pipe system and reciprocating pipe. The control actuators & instrumentation with minor piping is external to the casing.

3.1.8 Fire Detection and Protection systems

The functionality covers the installed water admission system from the point of entering the Air Heater, water drainage, and instrumentation for the detection of extreme/abnormal temperature conditions, and fire-fighting if required and where fitted.

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3.1.9 Erosion protection

This aspect on the machine covers all elements exposed to the erosive damage due to ash and high velocity flow. The management of erosion protection is covered by extensive drawings/plans and inspection reporting.

3.1.10 Instrumentation

Relatively little instrumentation is used on the Air Heater, comprising of a rotation sensor, fire detection, lubrication system monitoring and monitoring of steam conditions on the drain valves.

3.2 ROTOR AND HEAT TRANSFER ELEMENTS

3.2.1 Rotor Structure

a) Air Heater rotors must be inspected visually at every outage as best possible and any damage and wear must be recorded to be able to estimate the repairs that needs to be carried out in future outages accurately.
b) Access to repair rotors are normally achieved during pack changes so therefore it is imperative that the condition of the rotor is understood before pack change outages and needs to be properly budgeted for.
c) During a pack change the main structural welds of the rotor-to-hub plates must be NDT inspected to ensure there are no cracks on these welds on both the hot and cold end. This applies to both vertical and horizontal shaft air heaters. Any cracks needs to be repaired during the outage after failure analysis and a repeat NDT performed to confirm repair work.
d) The rotor tyre top and bottom runouts must be checked every outage during the inspection phase and any out of specification sections must be re-aligned during the outage to ensure continued proper sealing during operation.
e) The rotor tyre must also be inspected every outage for wear and erosion and this must be recorded in the database to allow planning for complete replacements in future outages. A generally accepted rule is that half the material thickness can be lost due to wear before replacement is required.
f) In the case of horizontal shaft air heaters care must be taken to ensure that the rotor is well balanced after pack changes or any rotor repairs.

3.2.2 Element Packs, Supports and Condition Monitoring

a) The aspects for monitoring and reporting on the condition of the Element packs (performed on 2-3 yearly intervals) are based on the philosophy outage regime that would be manifested by the health of the following indicators:
    1) Element pack **Wear rate** (sampling including location of the element packs sampled).
    2) Element pack **Supports**.
    3) Element pack **Gap sealing**.
    4) Element pack **Blockage manifesting as "Air/Gas flow Pressure drop"**.
    5) **Abnormal** erosive wear or cracking.
b) Element pack **Wear rate determination** is executed through a process of the extracting of all layers in separate rings of two identified element pockets/cavities. The extracted elements are inspected for blockage, split for the removal of one plate pair, re-compressed, and replaced. The removed plate-pair is used for engineering analysis through mass-loss comparison with new plates of same size and profile.
c) The following cautions are applied during element-sampling:
    1) Never sample the same pocket-elements more than once.
    2) The Engineer to ensure that the sample is located in an area subject to the most severe erosion (generally in the shortest gas-flow path), and that the sampled plate is representative of a full-plate size.
    3) The Engineer is to inspect the intermediate elements for blockage-condition.

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4) A wear report approaching 30% mass-loss must prompt planning for replacement during the next outage (to occur within a 3 year window), but is also dependent on the life cycle prediction, as a 35% mass-loss is considered as depleted-life. A detailed record of the mass loss must be kept and used as a predictive tool to estimate wear rate and remaining useful life to accurately determine pack change requirements.
5) All inspection findings and wear rates must be captured in an Inspection Report, signed off by the System Engineer.

d) CAUTION: Element pack wear and condition monitoring is ONLY reliable/predictable through normal wear conditions. The unit load-factor must be accurately represented in the analysis, and repeated element pack blockage and prolonged operation with blocked-condition elements must prompt for a more intensive evaluation of the remaining/forecasted life.

e) Element pack **Supports** must be rigorously inspected and any defects found must be repaired or replaced – especially if the unit was subject to prolonged operation with blocked elements and excessive bypass flow. In the case of horizontal shaft air heaters packs or pack segments are not allowed to be welded to the rotor. Only pack supports are to be fitted as per the original design requirements as well as pack wedges.

f) Inspection and reporting must comprise of a layout matrix of rings and segments in order to ensure that 100% of the element supports are covered, reported and repaired where required. It is good practice to plan for full pack support replacement during pack changes that is done in conjunction with rotor repair work. Pack supports should be in an all-round good condition in every basket and fully welded on one side to act as a sealing strip.

g) Element pack **Gap-sealing** is performed in order to counter excessive by-pass flow, in the case of excessive sizing mismatch between the element pack and the stator. **The following aspects are important to manage, if out-of-specification gaps exist on the Hot End:**
1) The target with element pack sizing and specification should be to avoid any out-of-specification gaps of larger than 6 mm all-round.
2) The use of a gap-closing mechanism, attached to the element pack surrounding “cage” is preferred for fully boxed packs.
3) Flat-bar cover-strips of 6mm x 25 mm mild steel can be pre-cut to match the rotor structure, and is weld-attached with 30mm x 100mm space welding method and the strip positioned to overlap flush with the elements.

h) Cold-end Element pack **Blocking** occurs if the element packs are subject to prolonged dew-point conditions during start-up from cold conditions and/or during continuous operation.

i) System Engineers are to monitor and address/correct this phenomena on the plant by implementing the following management tools:
1) Implement monthly monitoring, logging, analysis and reporting of Air and Gas pressure drop trends.
2) Implement monthly monitoring, logging, analysis and reporting of prolonged Air and Gas temperatures that lead to dew-point conditions.
3) Ensure that dew-point controlling functions are effectively maintained and correctly utilised to avoid/minimise dew-point operation taking into account each stations specific design.
4) Implement Combined Back-end Temperature trending, alarming and reporting.
5) Apply control with the drying process prior to returning washed/wet element packs to service. Each Station should develop and approve an acceptable methodology for the drying process, while being cautioned that ash deposition into wet element packs will result in severe plugging.
6) Ensure that monthly checks are conducted to check if sootblower systems are operating in the prescribed manner

j) The Soot-blower system’s ability to counter severe dew-point blockage is limited, and prolonged failure or non-operation of the Soot-blower system will lead to similar circumstances of blockage.

k) High Pressure washing is utilised to reverse the effects of Blockage. Refer to the applicable section below, dealing with the requirements and controls for High Pressure Washing

l) Signs of **Abnormal erosive wear** and/or cracking of element plates must be inspected, reported and analysed. Factors contributing to such failures that must be avoided are:

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1) Loss of, or insufficient compression on element packs.
2) Soot-blower/system failure (or sootblower getting stuck while in operation) with continuous blowing on localised areas.
3) Large preference-flow areas through element packs causing flow-induced vibrations and plate-fatigue.

3.2.3 Element pack washing and drying

a) Station layouts where the boiler water economiser (heat exchange tube-bank) is located directly above the Air Heater elements are prone to extreme risk of contamination of the Air Heater elements with excessive amounts of ash. This type of contamination must prompt the required action of low pressure flushing that must be executed with care to ensure proper drying of the elements. High pressure washing must be considered if ash deposits are difficult to remove.
b) Most Air Heaters operated in the South African context are subject to hardened ash on the Cold-End element packs and require high pressure water washing to dislodge and flush-out hardened ash deposits.
c) In these instances, it is essential practice to facilitate the “soaking” of blocked elements by means of low pressure water deposits, prior to executing the High Pressure washing activity.
d) The following aspects are important to manage with the execution of **high pressure washing**:
   1) Over and above the **Required Contractors Procedure** for the control of the high pressure washing exercise, the Station needs to register and implement a procedure to ensure that the management of water supply, drainage, dirty water disposal and element pack drying, is effectively dealt with in a control procedure. The procedure is to stipulate washing specifications as well as site-specific control-interfaces, such as:
      - Drainage control points.
      - Water disposal control in line with environmental (ZLED) requirements.
      - Pressure capacity of High Pressure pumps to be at least 600 Bar.
      - Provision of replacement nozzles at sizes ranging from 0.5 to 1 mm.
      - Rotation and traverse control.
      - Criteria for measuring the effectiveness of cleaning
e) An arrangement is to be made with the executing contractor for the provision and installation of traversing equipment covering the entire heat-exchange surface.
f) The provision of high pressure washing equipment has to comply to the requirements stated in the Eskom washing procedure.
g) Prior to HP-washing, it is vital to ensure that effective sealing and/or screening of plant that could be affected by the water and drainage, has been performed. Affected plant could be:
   - Cold-end Soot-blower nozzles facing into the down-flushing water/waste.
   - Immediate area field instruments.
   - Fans and lubrication systems located below the Air Heaters.
h) CAUTION: As noted above, it is important to screen and prevent the deposit of washing-sludge into the Cold-End soot-blower system nozzles.
i) Hourly monitoring and logging of sustained water pressure at the stations required pressure and healthy nozzle conditions are to be sustained during the HP washing process.
j) Inspection is to be performed at 24 hour intervals, in order to evaluate cleanliness and to establish focus areas and/or a revised water pressure application. Written record shall be kept of inspections performed, including the water sample test outcomes.
k) Condition monitoring: Water samples are to be taken for evaluation of exit/waste-water acidity and turbidity. Neutral acidity is considered to be between 6 and 8 pH, and acceptable turbidity gain below 100 NTU is an indication that no further ash-deposits are released to the water.
l) Post-washing activities, inspections and acceptance criteria for conditions must be stipulated and generally, the typical focus areas to be included are:
   - Fans and lubrication systems.
   - Fan casing drain-points.

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- Ducting compensators that are able to accumulate the down-flow of waste-water.
- Downstream ducting pressure tapping points and instrumentation.

m) CAUTION: The effective drying of the element packs after washing is crucial to prevent repeat blockage during start-up. The following aspects are to be considered for the drying procedure:
   1) It is essential to purge the boiler with high velocity airflow before the final shutdown at the onset of the outage.
   2) If the Boiler was not washed, extreme caution is required to prevent ash carry-over during the starting of Draught group fans with moderate (<50% MCR) flow velocities.
   3) Washing of Boiler economisers, which are located in the gas-path above the Air Heater, is a compulsory activity for prevention of re-blockage.
   4) Drip-drying – even after a period of 4 days, this is not deemed an effective method, and should not be the only means of drying used.
   5) Cold-air purging with uncontaminated air for a period of 6 hours is a minimum requirement – and must be performed with the air heater rotating.
   6) Added heat to combustion/cooling air can shorten the drying period, and should be utilised whenever possible.
   7) Drying should be undertaken with the use of the Air-pass only, thereby avoiding any gas-exit flow, which will mitigate risks of dirty-boiler ash carry-over – thus air will be exhausted via an open flow-path on the boiler bottom ash duct.
   8) Additional time allowed for heat-soaking the Elements during boiler warming and using a low-flow draught combined with a single low firing burner level, can shorten the drying cycle to approximately 3 hours.

3.3 SEALS

3.3.1 Radial Seals

a) All radial seals, clamping strips and bolts must be inspected during every outage for damage, wear and erosion and reported accordingly. Repairs must be carried out where required to ensure reliable operation of the unit and effective sealing.
b) It is normal practice to allow for a certain percentage replacement of the seals during interim outages (IR's and mini-GO's) while a complete replacement of seals and clamping strips must be planned for during major GO's.
c) Copper wear strips must be fitted on the cold-end seals to check the accuracy of the seal settings during normal operation.
d) Caution: Off-set slotted holes on clamping plates must be positioned in the correct way in order to prevent leakage through exposed holes.

3.3.2 Axial Seals

a) All axial seals, clamping strips, holding strips and bolts must be inspected during every outage for damage, wear and erosion and the information recorded on an inspection sheet for future reference and maintenance planning. Repairs must be carried out where required to ensure reliable operation of the unit and effective sealing.
b) It is normal practice to allow for a certain percentage replacement of the axial seals during interim outages (IR's and mini-GO's) and a complete replacement of axial seals and clamping strips must be planned during major GO's.
c) Copper wear strips must be fitted where practically possible to check the accuracy of the seal settings during normal operation.

3.3.3 Circumferential Seals

a) All circumferential seals, clamping strips, holding strips and bolts must be inspected during every outage for damage, wear and erosion and the information recorded on an inspection sheet for future

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reference and maintenance planning. Repairs must be carried out where required to ensure reliable operation of the unit and effective sealing.

b) It is normal practice to allow for a certain percentage replacement of the seals during interim outages (IR's and mini-GO's) and a complete replacement of seals and clamping strips must be planned during major GO's.

c) Copper wear strips must be fitted on the cold-end and hot-end where practically possible to check the accuracy of the seal settings during normal operation.

3.3.4 Radial Sector Plates

a) All radial sector plates must be inspected visually on every outage for damage and erosion and the information recorded on an inspection sheet for future reference and maintenance planning.

b) Every GO the radial sector plates must be measured for flatness and the data must be recorded on an inspection sheet to plan for future repairs.

c) On some air heaters the radial sector plates are adjustable and the primary seals needs to be inspected visually on every outage for damage and erosion and recorded on an inspection sheet. All mechanical adjusters must be inspected visually on every outage for damage and correct operation.

3.3.5 Axial Sector Plates

d) All axial sector plates must be inspected visually on every outage for damage and erosion and the information recorded on an inspection sheet for future reference and maintenance planning. Every GO the axial plates must be measured for bowing and the measurement data must be recorded on an inspection sheet .to plan for future repairs.

e) On some air heaters the axial plates are adjustable and the primary seals needs to be inspected visually on every outage for damage and erosion and recorded on an inspection sheet. All mechanical adjusters must be inspected visually on every outage for damage and correct operation.

3.4 CASING TRANSITION DUCTING AND ACCESS DOORS

a) The Air Heater casing main support structure underneath the support bearing is relatively maintenance free.

b) The rotor casing needs to be inspected on every GO for damage and erosion and repairs carried out accordingly.

c) Access doors are generally free from damage and erosion but must be inspected during every outage and repaired where required. New packing/seals must be fitted on every outage on the doors that were opened for the specific outage.

d) The Transition ducting is an integral part of the rotor casing and is subject to wear on the HE side and CE-sides.

e) Remedy for the wear is to re-instate the ducting by means of window repairs, with a like for like material thickness, in order to prevent ingress-flow over a 3-year period of operation – thus forming part of the 3-yearly inspection requirement. No patch repair of air heater casing and ducting is allowed.

f) Compensators are excluded from the scope of work for the air heater maintenance.

3.4.1 Access Doors

a) Access doors are generally free from damage and erosion but must be inspected during every outage and repaired where required. New packing/seals must be fitted on the doors that were opened for the specific outage.

b) Premature failure of access door seals is caused through fitting misalignment, incorrect sealing materials and fitting/repair deficiencies, and generally occur randomly depending on the whether the correct repair decision/quality workmanship was applied. Good quality repairs would postpone the need for repairs to doors up to 6-yearly GO intervals.

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c) Erosion damage that requires more than 50% repairs to the door and frame, should prompt for the complete cut-out and replacement of the door and frame.

d) Repeated extensive in-situ repairs to door seals must prompt investigation for incorrect repair practices being applied.

e) The correct sealing material is selected for the Hot End heat resistance. Incorrect material result in premature failure and is generally the initiator of leakage erosion on the doorframes.

3.5 DRIVE MECHANISM

3.5.1 Main drive motor and coupling

a) Main drive motors are designed to operate for 18+ years, but design life would vary between different applications.
b) As a critical component, thorough motor testing and servicing should be scheduled on 12 year intervals in order to avoid unscheduled failures.
c) The drive should form part of the Power Station Draught Group condition monitoring program and monitored on a monthly basis, using vibration analysis and infrared thermography to identify potential fault conditions or developing failures. Guidance should be obtained from the Condition Monitoring service provider on site regarding the condition of the drive train to inform potential outage work (e.g. replacement of motor or motor bearings).
d) Following maintenance intervention on motors, it is compulsory to verify the correct direction of rotation with Mechanical Control personnel as Witness.
e) The health of the Main drive motor coupling is important, and to avoid the development of severe damage, it is to be inspected/repaired on 3 yearly intervals. Vibration data on the drive train should also be closely monitored as coupling damage or misalignment can be identified from vibration spectra and data.
f) The main drive motor coupling must be thoroughly inspected for healthy condition on at least 6-yearly intervals.
g) Air Heater drives that were not fitted with auxiliary drives, make use of special tools - pneumatic drives mounted in place of the main drive – to facilitate maintenance activities: IMPORTANT – All rotating “Control” measurements must be done with rotation in the NORMAL direction of rotation.

3.5.2 Main drive Gearbox

a) The gearboxes are generally designed to operate for 15+ years without maintenance, but may vary between stations.
b) It is recommended that gearboxes be overhauled on a 12 yearly basis. In order to facilitate this it is also recommended that the station keep two gearboxes as maintenance exchange repair units.
c) Stations need to execute the required condition monitoring tests that will provide the required condition information to inform further scope of work that may be required, such as oil samples, checking for oil leaks, monitoring oil level, and performing vibration monitoring on set periodic intervals.
d) It is cautioned that incorrectly sampled oil does not detect settled contamination, and gearboxes also do not have an oil circulation filtration system – this creates a situation that requires consideration for scheduled 6 yearly oil replacements.
e) The maintenance philosophy should NOT be based on ‘run to failure’. A 12-year internal inspection and refurbishment interval is strongly recommended and to be executed by a reputable gearbox repair-contractor.
f) It is of utmost importance to sustain consistency of inspections and testing with a repair-contractor, in order to correctly analyse and engineer failure mechanisms, especially when repeated failures on gearboxes are experienced.

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3.5.3 Drive Pinion (Kendal)

a) Pinion wear shall be monitored on-line (subjective report), as well as objective measurement with the use of a gear-profile template and feeler gauge during 18-monthly outage inspection/reports.
b) Reduced wear-life is caused by:
   1) Incorrect meshing conditions (penetration depth).
   2) Incorrect or sub-standard Pin-rack installation.
   3) Operating conditions, subjecting the pinion to adverse temperature conditions encountered, especially during Air Heater standstill or Single Draught operating conditions.
   4) Incorrect manufacturing specifications.
c) Reduced pinion wear-life shall be reported, investigated, and corrective actions implemented.
   1) The Pinion and Pin-rack meshing depth shall be controlled and reported against the prescribed specification with all drive pinion change-outs. CAUTION: Measurements are recorded on the average Pin-rack radial run-out.
d) The pinion and pin-rack axial alignment shall be controlled and reported against the prescribed specification – this axial set-up of the pinion (which is adjustable on the gearbox mountings) is to provide for the correct centralisation considering the axial thermal expansion due to 'capping movement' of the stator and hood assemblies.
e) Pinions are to be provided with accurately positioned pre-drilled mounting holes, and mismatch of bolt-holes must be corrected on the hub.

3.5.4 Drive Pin-rack (Kendal)

a) Reduced wear-life is caused by:
   1) Incorrect meshing conditions with Pin-rack installation.
   2) Incorrect manufacturing specifications.
   3) Operating conditions, subjecting the Pin-rack to adverse temperature conditions encountered, especially during Air Heater standstill or Single Draught operating conditions.
b) Reduced Pin-rack wear-life shall be reported, investigated, and corrective actions implemented.
c) The Pin-rack wear shall be monitored on-line (subjective report), as well as objective measurement with the use of a vernier-calliper during outage inspection/reports. Wear of only the applicable working side is reported.
d) Reduced service life is considered if a wear-measurement of 2.5 mm or more is noted on 3-year inspection cycles.
e) Turning or replacement of Pin-racks must prompt for the control of the following installation parameters:
   1) Verified shaft alignment within the stipulated specification.
   2) For shafts with roller-bearing applications: The Pin-rack radial & axial alignment spacing shall be controlled and adjusted to specification during installation. Radial alignment is adjusted within 3 mm TIR, Axial alignment 6 mm TIR.
   3) Inter-segment pin segment spacing/gaps are controlled and reported to specification during installation, at maximum ±0.4 mm from the norm. Inter-segment clamping brackets are used during installation to control the consistency of gaps.
f) The installer is to prove correct alignment before reverting to full weld-attachment of the Pin-rack. The proving of fitment tolerances is to be witnessed by the site system engineer or maintenance QC controller.
g) Pin-rack mounting is to be performed with utmost attention and care, with particular attention being paid to the following:
   1) No welding is allowed across and/or near pins.
   2) Full welding all-round on the plate to rack interface is required.
   3) Placement position and length of the mounting plate.
   4) Full top/bottom welding of the mounting plate onto the hood/frame interface is required.

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h) Pin-rack mounting plates are best replaced with each pin rack turning or replacement outage. Laser-cutting or flame-cutting of plates is preferred. Guillotine cropping of plates is less desirable as it may cause distortion that affect mounting accuracy.

3.6 SHAFT, BEARINGS AND LUBRICATION SYSTEM

3.6.1 Shaft and Alignment

a) The shaft generally requires no maintenance, unless some damage is caused due to bearing failure.
b) The checking/verification of shaft alignment – as a method to detect any possible changes to the operational condition – is performed on a 3 yearly basis.
c) Shaft seals inspection must be done during every outage and seals must be replaced when required.

3.6.2 Locating/Guide Bearing

a) The inspection and condition monitoring of the locating bearing is important to ensure that no adverse condition develops that would affect and damage the shaft seals and rotor sealing system.
b) Rolling element locating bearings:
    1) The bearings are oil lubricated via an external pump/circulation system with an oil bath/sump oil-containing system local to the bearing. The bearing and system are to be inspected for condition and cleanliness on 3-yearly intervals, and sump to be checked for sediments and deposits. It may be required to replace the oil, especially when sediment or metal particles is observed, which may be indicative of bearing damage/failure developing. As a minimum, an oil sample should be taken to determine the presence of wear particles and integrity of the lubricating oil.
    2) Bearings are subject to compulsory replacement on 12 yearly cycles.

3.6.3 Main Support bearing

a) The inspection and condition monitoring of the support bearing condition is important to prevent collapse of the bearing that will result in stoppage of the rotor and damage to the rotor and sealing systems.
    1) Bearing inspections must deploy expert intervention to detect signs of debris, scoring damage, discoloration and/or cracking of bearing races or cylindrical rollers.
    2) Bearing replacement requires the expert verification of seating surface health and installation cleanliness, and this should be a formal QCP witness point during the replacement process.
    3) Bearings are subject to compulsory replacement on 12 yearly cycles.

3.6.4 Oil lubrication system

a) Oil-lubricated systems are serviced through reservoir inspection and oil replacement on 3 yearly intervals.
b) Control system filter, pump, pressure & flow set-up and cooler cleanliness requires health verification with re-commissioning after each cleaning intervention, which will be guided by a dedicated procedure and QCP check-list.

3.7 SEAL SETTING

a) All seal settings are to be carried out in accordance with an approved seal setting chart for each specific air heater and a setup procedure.

3.8 SOOT-BLOWER SYSTEM

Different types of Soot-blower systems are fitted on the Eskom fleet of Rotating Matrix Air Heaters.

The different types are described as follows:

a) Stationary Pipes with multiple nozzles.

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b) Reciprocating pipe with small nozzle bank.

c) Reciprocating pipe with spaced nozzles.

3.8.1 Steam supply piping

a) Steam piping penetrating through the fixed outer casing shall be monitored for sound seal-welding that prevent ingress-air erosion on the pipe/casing.

3.8.2 Fixed Pipe System

a) In general this system will comprise 3 different fixed pipes each with a bank of nozzles on each that collectively covers the entire air heater rotor. They are fitted both in the Gas Inlet and Gas Outlet side of the heater.
b) The pipes are subject to erosion and the pipes must be covered with adequate erosion protection. Erosion wear must be recorded and marked up on an inspection sheet and added to the Data Book of the Airheater for each outage.
c) The nozzles must be inspected on each outage to ensure that they are in good condition. Specific attention must be paid to the cold end nozzles as they face the gas stream directly and are more prone to erosion damage.
d) It is recommended to use a “go/no-go” gauge supplied by the maintenance/service provider to do a general inspection of the nozzles in conjunction with a visual inspection to check for concentrated ash or stem erosion.

3.8.3 Reciprocating Pipe System

e) In general this system will comprise one reciprocating pipe with a nozzle bank or spaced nozzles on a header pipe. They are fitted both in the Gas Inlet and Gas Outlet side of the heater.
f) The pipes are subject to erosion and the pipes must be covered with adequate erosion protection. Erosion wear must be recorded and marked up on an inspection sheet and added to the Data Book of the Air Heater for each outage.
g) The nozzles must be inspected on each outage to ensure that they are in good condition. Specific attention must be paid to the cold end nozzles as they face the gas stream directly and are more prone to erosion damage.
h) It is recommended to use a “go/no-go” gauge to do a general inspection of the nozzles in conjunction with a visual inspection to check for concentrated ash or stem erosion.
i) It is also important to inspect the reciprocating mechanism for proper operation.
j) The guide rollers needs to be inspected and repaired where required.
k) The pipe through casing must also be inspected and repaired to ensure minimal gas leakage.

3.9 FIRE DETECTION AND PROTECTION SYSTEMS

3.9.1 Fire detection system (Where fitted)

a) Internal to Air Heater components is the temperature measuring thermocouples with erosion protection shields. These thermocouples requires 3-yearly maintenance and inspection.
b) Installed locations must be identified for the potential 3 target monitoring areas:
    1) Flue Gas Inlet
    2) Flue Gas Outlet
    3) Hot Air Outlet
c) The thermocouple protection shields and added erosion protection require specific attention as follows:
    1) Erosion protection design must not be overly elaborate - shielding should allow the thermocouple to sense the heat with significant delay. An up-stream screen with “open” downstream thermocouple shield ensures sufficient exposure.
    2) The length of the erosion/protection tube must be aligned with the standard installation protrusion in order to ensure maximum wear-life for the probe.

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d) Systems with “local” temperature indications are monitored for functionality of measurement accuracy and alarm-activating relays should be tested on 18-monthly intervals.
e) In terms of Air Heater Fire Protection requirements of the FFFR, the Unit start-up temperature deviations must be incorporated into alarming functions and requires intensive monitoring during startup.

3.9.2 Fire-fighting water supply piping

a) The Fire-fighting water supply system (incorporating the “deluge valves”) up to the Air Heater casing is maintained by “other” contractors/maintenance service providers, but it remains the responsibility of the Air Heater maintenance team to ensure correct functionality is tested and declared before returning the air heater to service.
b) External water supply pressure control and isolation valves are subject to failure (leakage) and such incidents occurring during Unit/Air Heater operation can go undetected. The fitting of a leakage tell-tale valve – downstream from the main valves – is recommended, and is to be monitored during operation on a daily basis (and condition recorded on the operating daily check sheets).
c) Internal water supply piping is guided through the ducting and must be inspected for erosion, and suitably protected if erosion is evident.

3.9.3 Fire water nozzles

a) Where fitted the air heaters are fitted with a distribution nozzle on the side of the ducting which will spray water onto the rotor when a fire is detected.
b) It is important to inspect the system for erosion, blocked nozzles and damage during every outage.
c) Erosion patterns must be recorded and added to the Air heater Data Book to ensure planning for material can be done for future outages.

3.9.4 Casing drainage for fire-fighting water

a) All Air Heaters must be fitted with a bottom transition duct drainage point, and must be regularly tested for blockage during operation in order to prevent water carry-over into the ash-removal plant.

b) Observation of a tendency of these drains to block must be reported, to initiate a process for rectifying the design.

c) It is recommend that the water must be directed to the FFP basement area which has a dedicated ash-removal design as the washing water is very muddy and should not be ducted into the Stations drains systems.

3.9.5 Fire-fighting system hardware testing

a) Functional testing of the Air heater Fire-fighting system is mandatory and is executed during element pack washing events. In cases where air heater washing is not planned/done, minimum 6 yearly testing must be scheduled.
b) During testing, the following aspects are specifically verified:
    1) Internal inspection for missed points of wetting.
    2) Exercising of isolating valves that they fully isolate. This is done manually
    3) Correct functioning of pressure controlling “deluge” valves.
    4) Verification of nozzle function and cleanliness.
    5) Verification of drainage system function (if not tested though the execution of water-washing).
c) Compulsory system testing must be scheduled as part of Outage SOW.

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3.9.6 Fire-fighting procedure and system

a) Each individual Power Station must possess a dedicated Fire-fighting procedure, identifying the required reporting, management and activating points.
b) Maintenance crews are to familiarise themselves with the content, specifically on reporting requirements and water-activating points.

3.10 EROSION PROTECTION

3.10.1 Identification and control of erosion areas

a) Erosion protection is one of the most important maintenance aspects on Air Heaters, with a continuous effort required to improve and expand the list and design of protection areas.
b) Inspection of all areas subject to erosion is facilitated through a live check-sheet. This check sheet is used to capture the exact recording of the existence, wear-condition and effectiveness of protecting elements, and replacement recommendations made and executed.
c) Visual inspection is executed on erosion areas during the initial walk-through assessment, with a follow-up ultrasonic thickness verification where applicable, in order to table a complete scope of work during the Outage Scope review meeting.

3.10.2 Minimum reference list of known repair areas

a) Transition duct gas inlet and outlet
b) Transition ducting Secondary Air outlet
c) Soot-blower pipe in flue gas (hot end and cold end).
d) Fire protection piping and nozzles.
e) Fire detection thermocouples and leakage monitoring instruments.

3.10.3 Repair of eroded areas

a) The design of protection elements must have the goal to prevent erosion of structural elements or other components, for a minimum 3-year outage interval period, and where possible (and more desirable) to enable wear protection that protect elements for the full period between major 6-yearly Outage interventions.
b) The designed/proven repair methods and recommended materials are documented on drawings for each power station air heater design. The following design/selection aspects are considered:
    1) Flow-directional installation, and where multi-directional (turbulent) flow is encountered, the use of a side/flanking plate is recommended.
    2) The protection element selection is installed close to the protected member with maximum 20% size overlap (eg. a 100 mm diameter pipe has 120 mm wide protection element).
    3) The use of inverted channel-iron sections is preferred, for offering partial flank protection.
    4) Large diameter members protected with flat-plates are subject to “eddies-flow” and protected members may get damaged anyway with rapid depletion of width.
    5) High erosion rates are countered with the use of thicker materials – it is therefore recommended to rather use exotic materials to ensure that the desired wear-life can be achieved.
    6) Overlay (patch) repairs are used where repeatable erosion patterns occur, this would be required in areas where frequently replaceable protection layers will provide the most feasible solution.
    7) Insert (window) repairs are used when the original structure was damaged, either through slow undetected erosion or failure due to delayed repairs of the overlay protection layers.
    8) As far as possible – leakage erosion should not only be addressed through protection elements installation, but also through performing root cause analysis to eliminate the source.
c) Drawings will list the type and maximum quantity of materials required.
d) Attachment and weld-quality is of utmost importance, as detached elements can result in major damage to plant. The following aspects are to be considered:

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1) Weld quality is managed to the required standard and a Weld Procedure Statement shall be in place for all repair work performed. Weld quantity is established to prevent detachment through erosion.
2) Direct welding onto protected members is preferred with weld-position such that the welds are not subject to erosion.
3) Welds are to be positioned in such a way so as not to overly complicate removal/replacement of protection elements.
4) For relatively large piping members (>120 mm), the use of 30x30 mm angle-iron supporting brackets is recommended.

e) The protection elements do not consist of multiple (loose) plates attached with space-welding – continuous elements/plates are used or joined with full-penetration welds, This is a strategy deployed to reduce the risk of dislodged eroded sections causing damage to the air heater internals.

3.11 INSTRUMENTATION

Reference should be made to the Draught Plant "Minimum Protection Requirements" applicable to Air Heaters.

The purpose of listing the critical instrumentation is to:

a) Compile a Draught Plant RTS (Return to Service) procedure covering critical instrument verifications to ensure reliability.

b) Guide the Operating and Maintenance Engineers regarding the purpose and application of the provided instrumentation.

Air Heater maintenance personnel are required to comply to the test and verification requirements for air heater instrumentation to ensure the accurate functioning of all control and protection instrumentation. Instrumentation plays a vital role in assisting the system engineer to monitor the condition and do performance assessment of the air heater.

3.11.1 Process and Protection Instrumentation

a) Oxygen content control – While this measurement falls outside of the Air Heater scope, it is an important field instrument to verify and maintain, as it is used in conjunction with the outlet Oxygen increase measurement to report on Air Heater leakage. Incorrect oxygen measurement can cause critical boiler failures or costly increase to Fan power-consumption and is always used in conjunction with pressure-drop analysis.

b) Rotation failure measurement must be verified for suitable protection and stable performance, as the heavy mechanical maintenance works can damage critical field instrumentation installed on the rotating elements.

c) Fire detection thermocouples – erosion protection details were stipulated with re-commissioning to verify correct installation, protection and operational functionality is achieved.

d) Lubrication system pressure/flow/temperature indications must be operational at all times – inherent critical verification is required during recommissioning. This is vital to prevent spurious trips or possible component damage.

e) Dew-point control is dependent on condition monitoring temperature instrumentation. Erosion protection and accuracy verification is important – incorrect dew-point control and faulty instrumentation presents no direct load-loss, but is a "silent killer" as moisture results in air Heater blockages resulting in major load-loss costs.

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3.11.2 Condition monitoring instrumentation

a. Motor drive amps – This is the most important monitoring aspect for seal setting and emerging problems, thus verification of operation is critical. Increases in current is generally indicative of increased friction at seal surfaces or motor electrical/failure conditions.

b. Temperature indicating process parameters – are important indicators to flag possible upstream process variations that affect Air Heater performance. The temperatures are also used for back-end temperature (dew-point) process control.

c. Pressure indicating process parameters – are important for the sole purpose of element pack health monitoring and trending and flags other deficiencies and/or planned maintenance requirements. Continued operation with blocked element packs causes major life-affecting damage to element packs and air heater rotor structure and must be avoided.

d. Outlet oxygen measurement – This is for the verification of “on-line” leakage, and affects analysis of root-cause for process changes that may be required to address the problem.

3.12 SPARES AND MANAGEMENT OF SPARES BOM

a) Management of Spares requires the dedicated effort to continual improvement the accuracy and extent of the details, in order to secure effective execution of maintenance strategy for the air heaters.

b) Spares lists are to be structured in accordance to plant layout (as per approved plant breakdown structure) and headings.

c) Spares availability cannot be measured and managed on main items alone. The success of Spares management lies in the provision of accurate details and availability of each spare-able item.

d) Due to the unpredictability of scope on high-wear plant equipment and components, resulting from operational changes, prolonged operational periods, and the inter-related effect of failures, spares-holding and bills of material must be complete – meaning for the maximum scope applicable to the scheduled outage. Partial stock-availability will result in partial repairs, with a spiralling decline in performance, and increased unreliability.

e) The System Engineer is responsible to ensure that a consolidated list of spares is available, with continuous improvement of content.

f) The Maintenance Contractor is responsible to contribute towards the population of the spares list, and to confirm the spares BOM, after evaluating the Outage/Repair Scope of work submission.

4. INSPECTION AND TESTING

4.1 ONLINE INSPECTION

4.1.1 Plant-walk verification

The plant aspects to be monitored with daily/weekly plant walks are important – reporting from these on-line inspections will flag failures, detect early signs of failure/deteriorating plant health and the monitoring of changing process conditions that may warrant remedial action.

Recording of observations is made and reported to Maintenance personnel, and load-affecting deficiencies identified are elevated to the System Engineer. The following are key aspects to be included in on-line inspections:

a) Abnormal/Excessive noise or external leakage is observed and noted.

   1) Steam leaks during soot-blowing is clearly audible.

   2) Increase in low-frequency vibrations should prompt for further investigation

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3) Air heater seal related issues (Seal rubbing noises or internal “thumping” noises) are clearly audible and should be a prompt for further investigation.

b) Motor drive-amps should be recorded/monitored on a daily basis, and reported should any abnormal variation/deviation from design base specification be observed.

c) Lubrication system health in terms of oil/grease levels, filter maintenance, fault alarms and leakages are monitored and reported.

d) Soot-blower function and steam feed conditions are monitored while soot-blowing is in operation in accordance to stipulations in the applicable section on Soot-blowers above.

e) Drive system vibrations are not specifically monitored on any on-line system, but subjective observation should be made, and abnormal noise or vibration noted at the drive system should be reported to the system engineer for further investigation or request for detailed vibration analysis.

f) Pinion and Pin-rack wear is subjectively observed and reported as an input to Outage SOW planning.

4.1.2 Operational assessment and incidents

Some machines are adversely affected when exposed to process abnormalities or system operating parameter excursions.

The purpose of elevating the importance for awareness of operational incidents is that it provides knowledge for root-cause analysis and informs decision-making on changes that may be required to address operational, maintenance and design deficiencies.

Inspections are also aimed at identifying, recording and reporting of incidents that affect plant health.

a) Operational assessment and trend identification

1) Blockage and flow imbalance – trend identification will assist with balancing high velocity erosion and temperature imbalance which affects the downstream gas-cleaning plant performance.

2) Blockage and temperature imbalance – identification will assist with managing adverse effects to the elements as well as downstream gas-cleaning plant. Blockage results in an irreversible upward spiralling of plant damage if left unchecked.

3) Element pack wear – trending is important for optimal replacement scheduling in line with financial and outage planning requirements, without adversely affecting plant performance.

4) All of the above aspects are early identifiers of deteriorating performance and risk of failures and the effects will be evident with the engineering trending of the machines heat-exchange “X-factor”. Refer to the provided definition.

5) Start-up Fire – most incidents arise during the start-up of the air heater and therefor justify intensive observation and monitoring of alarm tools for flagging the risk. In most cases, the fuel source is provided from lubrication system failures or adjacent plant or process failures (eg. fuel oil carry-over, and PF carry-over).

b) Operational incidents

1) Single draught operation – The logging of conditions arising from this mode of operation can result in changing the thermal behaviour of the machine with severe consequences for increased seal wear.

2) Air Heater Soot-blower failures – Early identification limits operational effects. Blocked element conditions arising from this failure mode can be counter-acted with a temporary review and adjustment of the soot-blowing cycles.

3) Boiler Soot-blower failures – Early identification limits adverse seal-wearing conditions. Flue gas temperature excursions are reported for rectification by other responsible personnel.

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4) Continued dew-point operation – Early identification limits slowly emerging performance degradation, and management is critical as the rectification often lies with personnel responsible for adjacent plant, unaware of failure on their plant.

4.1.3 Contractors documentation

a) On-load plant walkdown/inspection documentation is developed and made available, containing effective reporting mechanisms for trending, and flagging of anomalies of critical failures.

b) Report format, layout and content is approved for use by the Eskom Engineer, and is subject to practicality changes and learning points.

c) A comprehensive written report is issued on weekly basis, with verbal reporting on a daily basis of urgent anomalies.

d) Records are retained for the duration of the contract and handed over to Eskom at termination of the contract.

e) A formal inspection documentation management system shall be put in place for the duration of the contract where all on-load/online and outage inspection records and information are managed. A full electronic set of this information shall be hand over to Eskom at termination of contract.

4.2 OUTAGE CONDITION AND SOW INSPECTION DOCUMENTATION

4.2.1 Preventative replacement SOW

a) The Employer System Engineer compiles and submits the basic Outage Scope of Work, based on known life-cycles and maintenance intervention requirements of individual components, as stipulated in the applicable sections of this document.

b) The Contractor Engineer reviews the Scope of Work, and proposes additions to the Scope of Work. This would be based on observed defects reported during the operational period, as well as omitted Scope of Work from previous outage interventions.

c) It needs to be noted that any Scope of Work for components which is primarily subject to an erosive wear mechanism can only provide an 80% accurate reflection of the real/final scope, thus requiring some verification and update of the actual scope after the initial inspection phase.

4.2.2 Compulsory Inspection/assessment

a) The purpose of this inspection is to assess the real condition of the Air Heater and to confirm the actual Outage Scope of Work.

1) The Contractor's key experienced personnel conducts and reports on the inspection(s) performed.

2) The initial visual walk-through inspection is performed with the involvement of the Employer's Engineer (as a minimum).

3) The Inspection content is tailored and defined for each specific outage type, eg. all the stipulated measurements cannot be scheduled for a limited-duration shut-down opportunity, and outage duration would be a key determinant of the scope of work that can practically be executed to the required standard and quality.

4) Continued detail inspections that form part of the initial SOW inspections, incorporating measured wear of components and the status of adjustable settings, is performed, documented and reported by the Contractor. Significant anomalies or damage identified during such inspections must be brought to the attention of the Eskom System Engineer as soon as

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practically possible so that remedial action can be planned and undertaken based on the risk of equipment failure versus impact on outages schedule and duration.

5) The inspection is guided by a pre-formulated document, ensuring that all possible visual damage is assessed and reported in walk-through sequence.

b) Measured Inspection of components condition and reporting

1) CAUTION – All rotating “Control” measurements must be done with rotation in the NORMAL direction of rotation.

2) The continued detail inspection of measured details, as stipulated for the individual items contained in this document, is recorded on an individual sheet per component. The Inspection Sheet will provide full details of what is measured, measured results, reference specification, and recommended actions.

3) Complex inspection results (such as shaft or hood alignments), requiring an increase of Outage Scope is analysed by the Contractor’s Engineers and recommended actions are recorded on the data-sheet.

4) The reports are submitted to the Employer’s Engineer as a controlled, edited, and complete document for evaluation and planning a review of the initially defined Scope of Work – Referred to as the “Rev. 1 SOW”.

5) The outcome of the Rev.1 Scope of Review evaluation meeting would be a finalised Scope, requiring minimal to zero further changes, and results in the finalisation of a detailed Contractual Task Order with associated program of work and Quality Control documentation.

c) The inspection sheets shall cover the following minimum (but not limited to) inspection areas (as detailed in each scope/plant section in this Specification, and as applicable to each individual Power Station/plant). The inspection document shall be clear in indicating current/measured condition v/s required design base condition, thus motivating the requirement for repair.

1) Inspect air heater rotor for damage and erosion.

2) Inspect radial seals for damage and erosion.

3) Inspect axial seals for damage and wear.

4) Inspect circumferential seals for damage and wear.

5) Inspect sector plates for damage and erosion.

6) Inspect axial seal plates for damage and erosion.

7) Inspect hot end and cold end tyre for damage and erosion.

8) Inspect casing internally for damage and erosion.

9) Inspect drive system for oil leaks.

10) Inspect lubrication system for oil leaks.

11) Inspect packs for damage, erosion and loose plates.

12) Inspect pack supports for damage and erosion.

13) Inspect stay rods in ducting for damage and wear.

14) Inspect fire protection system for damage and erosion.

15) Inspect the expansion joint covers for damage and wear.

16) Inspect hub seals for damage and wear.

17) Inspect the soot-blower system for erosion, damage and movement.

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18) Inspect sealing actuators (e.g. sector plate) for damage and correct operation.

19) Inspect Fire-fighting system and water drainage and confirm operability.

d) Further detailed Scoped Inspections

1) Inspection on components that are to be stripped for complete assessment and maintenance, are separately Scoped for execution, and are typically items such as the following:

- Bearing wear condition.
- Element pack wear sampling.

2) The condition and recommended replacement/action is reported and agreed on an “as and when executed” basis.

4.2.3 Scope of Work management

a) The effective translation of plant inspection observations and measured recordings into repair and maintenance scope is a key element in providing the assurance of reliable RTS performance.

b) The key role-players required to execute every element of the defined management process are the following personnel:

1) Employer and Contractor System Engineers.

2) Maintenance execution manager or supervisor.

3) Employer and Contractor Contract’s manager/controller.

4) Contractor’s maintenance staff performing the activities defined in the scope of work.

c) The key mandatory management activities required to provide assurance and continuous improvement to processes and performance in line with ISO 9001 Quality Standards are as follows:

1) Scope clarification and provisional formulation of the Contracted Scope.

2) Complete submission of inspection report.

3) Report analysis and recommendation.

4) Scope of Work review (Rev.1) and Task order finalisation.

5) Issue of Scope variations and approval.

6) Well-defined and completed Quality Control Plans (QCP’s).

7) Maintenance task work instructions to sufficient level of detail to ensure quality work and prevention of re-work on complex tasks.

8) Reference of maintenance task work instruction and/or Weld Procedure Specification (WPS) numbers in the QCP’s for cross-referencing purposes.

9) Development, management and continuous improvement of sufficiently detailed work instructions for maintenance tasks of high complexity or risk.

10) Post mortem consolidation meeting.

11) Incorporation of remedial/continuous improvememt recommendations stemming from post-mortem outage meetings into future work and outage scopes.

d) Failure to provide detailed input and management of the activities, results in wasteful expenditure and performance degradation.

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4.2.4 Quality Control Documentation

The complex and multitude of verifications required to secure effective performance of the air Heaters require detailed and tightly controlled Quality Control Plans (QCP's). The following important aspects are to be incorporated into the planning and execution of QCP's:

a) Inspections are executed by the correctly skilled persons, trained on the execution procedure, required assembly lay-out, and critical points of evaluation.
b) Inspections are guided by the use of detailed check-sheets, in order to ensure all inspection items are covered and findings captured.
c) All recording-sheets are referenced on the QCP.
d) Inspection of adjustments or settings are presented for verification, with the specifications and recorded results-sheet.
e) Measured inspection results are verified, especially when recommendations based on the results require the addition of repair scope.
f) Scope activities involving the "closing-up" of an item (meaning no further witness of the internal condition is possible) shall always be a Witness Hold point intervention.
g) The method of consolidating small inspection points into one single witness hold point (with associated check-list), is considered mandatory practice.
h) All final inspections (before closing doors) shall be guided by a documented check sheet and signed-off by relevant delegated persons stipulated on the QCP. Check sheets shall cover typical items such as cleanliness, scaffold removal, door seals & latches, bolts fitted, final set-up measurement reports compiled, pinion & gearbox settings, commissioning executed, and doors closure.
i) Inspections shall comply to all Eskom safety and Permit-to-Work requirements and regulations.

4.3 DOCUMENTATION OF PROOF TESTS AND INSPECTIONS

4.3.1 Important "Proof of functioning or Compliance" tests

The following mandatory tests and verifications shall be fully documented and submitted for acceptance/approval:

a) Element pack wear measurement, analysis and trending.

b) Fire-fighting system testing.

c) Cold Seal setting verification/proof.

d) Soot-blower function and stroking.

e) Final inspection verification and sign-off.

f) Return to Service monitoring and recording of critical parameters.

g) Air Heater Leakage testing and trending.

h) Element pack differential pressure and trending ofn comparable flow/operating conditions.

4.3.2 Document acceptance requirements

The relevant Power Station shall maintain records that certify that the mandatory proof tests and inspections were completed as required. These records shall include the following information as a minimum:

a) Description of the test and inspection performed.

b) Dates of the tests and inspections.

c) Name of the person(s) who performed the test and inspections.

d) Name of the person(s) who witnessed the test and/or inspection (where required).

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e) Results of the tests and inspections.

f) Where required, wear rate predictions and projections for future outage/maintenance intervention planning.

g) Actions recommended for rectification.

5. AUTHORISATION

This document was reviewed and accepted by:

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6. REVISIONS

Date	Rev.	Compiler	Remarks
April 2020	0	N Rust	Draft under development for review
June 2020	0.1	N Rust	Final Draft for publication after comments incorporated
June 2020	1	N Rust	Final Document for Authorisation and Publication

7. DEVELOPMENT TEAM

The following people contributed towards the development and review of this document:

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8. ACKNOWLEDGEMENTS

None

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