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CONTENTS

Page

EXECUTIVE SUMMARY **5**

1. INTRODUCTION **6**

2. SUPPORTING CLAUSES **6**

2.1 SCOPE 6
2.1.1 Purpose 6
2.1.2 Applicability 6
2.2 NORMATIVE/INFORMATIVE REFERENCES 6
2.2.1 Normative 6
2.2.2 Informative 6
2.3 DEFINITIONS 7
2.3.1 Disclosure Classification 7
2.4 ABBREVIATIONS 7
2.5 ROLES AND RESPONSIBILITIES 8
2.6 PROCESS FOR MONITORING 8
2.7 RECORDS 8

3. MAINTENANCE REQUIREMENTS **9**

3.1 AIR HEATER SYSTEMS BREAKDOWN AND DEFINITION 9
3.1.1 Stator (Casing) and Heat transfer elements 9
3.1.2 Rotating hoods 9
3.1.3 Drive mechanism 9
3.1.4 Shaft, Bearings and lubrication system 9
3.1.5 Hood Seal and seal-setting system 9
3.1.6 Throat Sealing system (Collar Seal) 9
3.1.7 Soot-blower system 9
3.1.8 Fire Detection and Protection systems 10
3.1.9 Erosion protection 10
3.1.10 Instrumentation 10
3.2 STATOR (CASING) AND HEAT TRANSFER ELEMENTS 10
3.2.1 Stator structure and supports 10
3.2.2 Radial- and Divisional plate sealing surface 11
3.2.3 Element packs, support and condition monitoring 11
3.2.4 Element pack washing and drying 12
3.2.5 Casing Transition ducting and access doors 14
3.3 ROTATING HOODS 14
3.3.1 Hood alignment 14
3.3.2 Shaft alignment 15
3.3.3 Hood erosion damage and monitoring 15
3.3.4 Hood doors 15
3.3.5 Turning vanes 16
3.3.6 Hood mounting interface for sleeve compensator 16
3.4 DRIVE MECHANISM 16
3.4.1 Main drive motor and coupling 16
3.4.2 Main drive Gearbox 16
3.4.3 Auxiliary drive motor and coupling (Matimba & Majuba) 17
3.4.4 Gearbox output shaft and support bearing assembly 17
3.4.5 Main drive coupling 17
3.4.6 Drive Pinion 17
3.4.7 Drive Pin-rack 18
3.5 SHAFT, BEARINGS AND LUBRICATION SYSTEM 19
3.5.1 Bearing compartment and access door 19

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3.5.2 Shaft and alignment 20
3.5.3 Top/Bottom locating bearing 20
3.5.4 Main Support bearing 21
3.5.5 Oil lubrication system 22
3.5.6 Grease lubrication system (MJ, MT) 22
3.6 HOOD SEAL AND SETTING SYSTEM 22
3.6.1 Sealing frame 22
3.6.2 Stainless steel sleeve compensator 23
3.6.3 Cast Iron Wear Seals 23
3.6.4 Articulation joints 24
3.6.5 Thermal compensating rods and crank-levers 25
3.6.6 TOP Seal setting rods and springs 25
3.6.7 BOTTOM Seal setting rods and springs 26
3.6.8 Drag-links, Centre-pots and Nudging-pins 27
3.6.9 Manual seal setting mechanism (MT, MJ) 27
3.7 THROAT SEAL SYSTEM (COLLAR SEALS) 28
3.7.1 Collar seal housing 28
3.7.2 Tangential seal tensioning system (MT, MJ) 28
3.7.3 Individual seal tensioning system (DV, TT, KR, HD, GV) 29
3.7.4 Primary throat (Collar) seals (DV & TT) - notes 29
3.7.5 Static ducting and seal wear liner (rubbing) ring 29
3.8 SOOT-BLOWER SYSTEM 30
3.8.1 Steam supply piping 30
3.8.2 Steam supply piping in-line thermal compensator 30
3.8.3 Steam supply piping centre (rotating) thermal compensator 31
3.8.4 Indexing actuator and striker-plate support/control arm 31
3.8.5 Indexer valve system (GV, TT, MT, MJ) 32
3.8.6 Reciprocating system (HD, KR, DV) 32
3.8.7 Low pressure washing facility 33
3.9 FIRE DETECTION AND PROTECTION SYSTEMS 33
3.9.1 Fire detection system 33
3.9.2 Fire-fighting water supply piping 33
3.9.3 Fire water: air-side distribution piping 33
3.9.4 Fire water: gas-side distribution piping 34
3.9.5 Casing drainage for fire-fighting water 34
3.9.6 Fire-fighting system hardware testing - notes 34
3.9.7 Fire-fighting procedure and system 35
3.10 EROSION PROTECTION 35
3.10.1 Identification and control of erosion areas 35
3.10.2 Repair of eroded areas 35
3.10.3 Minimum reference list of known repair areas 36
3.11 INSTRUMENTATION 36
3.11.1 Process and Protection Instrumentation 36
3.11.2 Condition monitoring instrumentation 37
3.12 SPARES AND MANAGEMENT OF SPARES BOM 37

4. INSPECTION AND TESTING 37

4.1 ONLINE INSPECTION 37
4.1.1 Plant-walk verification 37
4.1.2 Operational assessment and incidents 38
4.1.3 Contractors documentation 39
4.2 OUTAGE CONDITION AND SOW INSPECTION DOCUMENTATION 39
4.2.1 Preventative replacement SOW 39
4.2.2 Compulsory Inspection/assessment 39
4.2.3 Scope of Work management 41
4.2.4 Quality Control Documentation 42
4.3 DOCUMENTATION OF PROOF TESTS AND INSPECTIONS 42

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4.3.1 Important “proof of functioning or compliance” tests 42
4.3.2 Document acceptance requirements 42

5. AUTHORISATION 43

6. REVISIONS 43

7. DEVELOPMENT TEAM 43

8. ACKNOWLEDGEMENTS 43

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EXECUTIVE SUMMARY

The Rotating Hood type Air Heater – generally referred to the Rothemuhle design – is a complex machine, and inherent to it's 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 element blockage, Soot-blower malfunction, sealing failures, etc. will result in the accumulation and exaggeration of damage to components with severe consequences of 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 hood (Rothemuhle) type Air Heaters is 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 is obtained between repair intervals.

2.1.2 Applicability

This Specification applies to all Rotating hood (Rothemuhle) 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 (Rev 1)

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 in quantities over and above the retained-ash, through regenerative cycles and as result of settling in element spaces with low flow distribution 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 manipulation of 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

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 of 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.

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.

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

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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 with 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 Stator (Casing) and Heat transfer elements

The Stator/structure containing the inserted heat transfer element packs, incorporating the thermal expansion supports with supporting steel-structure.

3.1.2 Rotating hoods

The Rotating hoods, refers to the internal ducting guiding the air inlet- and outlet path, excluding the sealing frame, which is covered as the Sealing System.

3.1.3 Drive mechanism

The Drive mechanism refers to the drive, motor, gearbox, pillar-box, coupling, pinion and pin-rack system. 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 hoods, Thrust/support- and locating bearings with an auxiliary system for lubrication. Two different concepts of bearing and lubrication systems are in use – Cylindrical roller bearings with oil lubrication, and sleeve/pad bearings with grease lubrication.

3.1.5 Hood Seal and seal-setting system

The sealing system covers a complex assembly of components starting with the Cast Iron Wear Seals, seal frame, compensator with clamping attachments. The frame is controlled by numerous elements like springs, rods, thermal compensators, and positioning attachments. Some units are not fitted with Thermal compensators

3.1.6 Throat Sealing system (Collar Seal)

The throat/collar seal is located between the rotating hood and the stationery ducts, and is presented in two formats – Individually tensioned rods/seals (DV, TT, KR, HD, GV),and tangentially tensioned segments (MT, MJ). Stations with twin-flow functionality (DV, TT) have Collar seals on both the outer Secondary duct and inner Primary duct.

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 – Rotary valve (MT, MJ, TT, GV), and the reciprocating manifold (KR, DV, HD 1-5), and a spider wheel design (AN 1). The control actuators & instrumentation with minor piping is external to the casing.

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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.

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 inner hub temperature monitoring.

3.2 STATOR (CASING) AND HEAT TRANSFER ELEMENTS

3.2.1 Stator structure and supports

a) The Air Heater casing (stator) with (up to) quantity 6 supporting columns, with spherical & sliding mechanisms is relatively maintenance-free, but any abnormality noted with inspection of the low-friction sliding-mechanism must prompt further investigation.
b) The internal circumferential surface of the stator – forming the top/bottom sealing surface is monitored on GO-intervals for variation/changes in elevation. Abnormal variation in excess of 3 mm must prompt further investigation.
c) The water-gauge measurement must distinguish between elevation changes and surface wear – thus caution where the exact measuring locations are.
d) Excessive loss of flatness of the periphery surface can be caused through sealing-wear friction and erosive wear. Erosive wear is exaggerated by incorrect setting or malfunction of the seals and require extensive repairs based on condition monitoring. Wear cavities or un-even sealing surface in excess of 8 mm must prompt the scheduling of a repair task during a future outage of sufficient duration.
e) The peripheral stator sealing surface can be repaired with the addition of a new 10 mm liner-plate, which is fully welded-in and surveyed to re-instate a flat sealing-surface.
f) The raised sealing surface is matched in conjunction with the repair or the ‘re-surfacing’ of every radial-rib of the stator to align in turn with the hub sealing-surface.
g) The repairs to the stator sealing-surface is best executed during element pack-changes, as the addition of the radial sealing surface must be removed to facilitate the element-pack removal.
h) Similar wear-damage to the hub sealing-surface must be repaired during the same opportunity.
i) The attachment-welds of radial ribs onto both the periphery flange, as well as the hub-section must be inspected and reported for cracking. Cracking in these areas is promoted through repeated heat-expansion and distortion.
j) The lubrication tunnel is routed through the Cold-end side of the stator structure and must be inspected for erosive wear on the top & sides during GO shut-downs, and especially with element pack replacement opportunities.
k) It is compulsory to add additional 10 mm plate-liners to the lube-tunnel casing when repaired during element pack-changes.
l) CAUTION: The Cold-end element pack sizing must be arranged in order to facilitate the size of the lube-tunnel in the applicable routing-segment.

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3.2.2 Radial- and Divisional plate sealing surface

a) In conjunction with the above-mentioned total 'sealing surface' condition, the Stator Radial ribs are to be evaluated on 3-yearly intervals, as it is subject to more severe erosive wear as well as Soot-blower wear for both the HE and CE-side.
b) Minor damage (max 4 mm deep by 50 mm lengths on each radial/divisional crossing) to the radial and divisional sealing surface can be repaired by means of welding build-up, while cautioning the evaluation-comparison of cost between the weld build-up and the addition of flat-bar seals.
c) Repair of severe wear to the radial sealing-surface is best achieved by the addition of radial flat-bars, weld-attached to the sides of the worn radial plates, and aligned to form a flat sealing-surface with both the stator periphery and hubs.
d) Former repair to the radial- and divisional plates was executed through the fitting of costly u-channel lengths, which are now being replaced by simple 10 mm thick x 60 mm wide (approx.) mild-steel flat-bar strips. The strips are weld-attached with a full seal-weld on the flow-exposed side, and 50x150 space-weld on the under-side.
e) The re-instatement of damaged radial plates must also prompt the condition and alignment of the divisional plates (plates/ribs between the structure rings), to form a complete and flat sealing surface, surrounding each individual element segment/pack.

3.2.3 Element packs, support and condition monitoring

a) The aspects for monitoring and reporting on the condition of the Element packs on 3 yearly intervals are as follows:
   1) Element pack **Wear rate** (sampling).
   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** is executed through 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 plate-pair is used for engineering analysis through mass-loss comparison with new plates of similar size.
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.
   4) A wear report approaching 28% mass-loss must prompt for replacement during the next outage within 3 years, as a 36% mass-loss is considered as depleted-life.
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 corrected – especially if the machine was subjected to prolonged operation with blocked elements and excessive bypass flow.
f) Inspection and reporting must comprise of a layout matrix of rings and segments in order to ensure that a 100% of the elements are covered, reported and repaired.
g) Element pack **Gap-sealing** is performed 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:**
   1) The target with element pack sizing and specification should be to avoid out-of-specification gaps of larger than 6 mm all-round.

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2) The use of a gap-closing mechanism, attached to the element pack surrounding “cage” is preferred.
3) Flat-bar cover-strips of 6x25 mm mild steel can be pre-cut to match the rotor structure, and is weld-attached with 30 x 100 space welding and the strip positioned to overlap flush with the elements.
4) The reduction of excessive bypass-flow gaps with cover-strips is applicable for both hot-end and Cold-end.
5) It is accepted practice on the Cold-end for the cover-strips to facilitate a dual-purpose of element pack supporting, with added attachment welding strength.

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 and reporting of Air/Gas pressure drop trends.
2) Implement monthly monitoring, logging and reporting of Air 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.
4) Implement Combined Back-end Temperature 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.
j) The Soot-blower system’s ability to counter severe dew-point blockage is limited, and prolonged failure 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:
1) Lost or insufficient compression on element packs
2) Soot-blower/system failure with continuous blowing on localised areas.
3) Large preference-flow areas through element packs causing flow-induced vibrations and plate-fatigue.

3.2.4 Element pack washing and drying

a) Station layout with the boiler water economiser (heat exchange tube-bank) located directly above the Air Heater elements are subject to extreme risk to contaminate the Air Heater elements with excessive amounts of ash. This type of contamination must prompt for low pressure flushing with care to ensure proper drying of the elements.
b) Low pressure water flushing is mostly executed through water connections into the soot-blowing system - also refer to the Soot-blower system for details.
c) Most Air Heaters operated in the South African context are subject to hardened ash on the Cold-End element packs and require high pressure washing water to dislodge and flush-out hardened ash deposits.
d) 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.
e) The following aspects are important to manage with the execution of **high pressure washing**:
1) Over and above the Contractors procedure for the control of the high pressure washing exercise, the Station needs to register 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

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- Water disposal control
- 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.

f) An arrangement is to be made with the executing contractor for the provision and installation of traversing equipment covering the entire heat-exchange surface.

g) The provision of high pressure washing equipment that complies to requirements stated in the Eskom washing procedure.

h) Prior to HP-washing, perform effective sealing and/or screening of plant that could be affected by the water and drainage. Affected plant could be:
- Bearing compartment and compartment access doors/hatches.
- Cold-end Soot-blower nozzles facing into the down-flushing water/waste.
- Immediate area instruments.
- Fans and lubrication system located below the Air Heaters.
- Upward-flow ducting with thermal compensators.

i) CAUTION: As noted above, it is important to screen and prevent the deposit of washing-sludge into the Cold-End soot-blower system nozzles.

j) Hourly monitoring and logging of sustained water pressure above minimum 450 bar and healthy nozzle conditions.

k) Inspection on 24 hour intervals to evaluate cleanliness and to establish focus areas and/or a revised water pressure application.

l) Condition monitoring: Water samples are to be taken for evaluation of exit/waste-water acidity and turbidity. Neutral acidity is considered between 6 and 8 pH, and acceptable turbidity gain below 100 NTS is an indication that no further ash-deposits are released to the water.

m) Post-washing activities must be stipulated and generally, the typical focus areas are to be inspected and conditions re-instated:
- Air Heater bearing compartment and instrumentation.
- Air Heater Cold-End Collar seals.
- Fans and lubrication systems.
- Fan casing drain-points.
- Ducting compensators that are able to accumulate the down-flow of waste-water.
- Downstream ducting pressure tapping points and instrumentation.

n) Inspection and cleaning of the CE-side Collar seal is important for seal-functioning, due to the flushing of ‘mud’ into the seal housing – this phenomena cannot be avoided.

o) 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 also 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 Draughts with moderate (<50% MCR) flow velocities.
3) Washing of Boiler economisers which are located in the gas-path above the Air Heater is compulsory for prevention of re-blockage.
4) Drip-drying – even after a period of 4 days is not effective as the only means of drying.
5) Cold-air purging with uncontaminated air for 6 hours is a minimum – with air heater hoods rotating.
6) Added heat to combustion/cooling air can shorten the drying period.
7) Drying with the use of the Air-pass only, thereby avoiding any gas-exit flow, mitigates risks of dirty-boiler ash carry-over – thus air is 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 a low-flow draught, combined with a single low firing burner level, can shorten the drying cycle to approximately 3 hours.

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3.2.5 Casing Transition ducting and access doors

a) The Transition ducting is joined to the main structure by means of an angle-iron flange, which is subject to severe erosion for both HE and less severe CE-sides.
b) Remedy for the wear is to re-instate the flange welding in order to prevent ingress-flow over a 3-year period of operation – thus forming part of the 3-yearly inspection requirement.
c) The weld-repair to the flange is further protected by the addition of a rolled mild-steel flat-bar of size 10 mm thick by 20 mm high, with full seal-weld attached in front of the transition duct flange, to deflect erosive flow away from the flange.
d) The deflected erosive flow is transferred to the transition duct vertical side-wall, for which erosion wear is countered with the addition of a curved liner plate, fitted all-round the peripheral wall of mild-steel and of size 6 mm thick and 300 mm wide.
e) In a similar way, the Main access door is subject to erosive wear, and should be covered with replaceable liner plates up to 1.2 meter in height.
f) CAUTION: Excessive periphery seal-gaps result in accelerated wear of the side-walls and liner plates, and must be avoided.
g) The Secondary-air ducting leading the heated air towards the boiler/burners, is ducted through the incoming gas-flow area. Erosion-wear of the ducting facing the gas-flow path, is subject to wear, and must be inspected for wear (wall-thickness). A repair is activated for wall-thickness less than 3 mm.
h) The main top & bottom access doors provides the means for easy access to large equipment and frequent or high volume personnel access, and is opened to facilitate major maintenance activities. Closure requires the full bolting and replacement of sealing material.
i) External smaller quick-access hatches are require seal replacement on 6 yearly GO-basis.
j) Air- or Gas-flow guiding vanes (Turning vanes) must be inspected and maintained to the original design – refer also to the applicable section on ducting/hoods below.
k) Gas-side Casing (Transition ducting) drains – used for element pack washing-water and fire-fighting water, are to be maintained and any deficiencies that would avoid successful drainage must be eliminated.
l) It is the responsibility of Air Heater maintenance team to confirm that Gas-exit ducting compensators are maintained to full functionality. Failing thermal compensators could cause thermal distortion of CE secondary air ducts and collar seal housings.

3.3 ROTATING HOODS

3.3.1 Hood alignment

a) The checking/verification of Hood alignment – as a method to detect any possible changes to the operational condition – is performed on 3 yearly basis, as follows:
    1) A vertical measurement from a selected fixed point on all 4 of the hood corners down to the stator periphery, while cautioning to consider an un-worn or un-sagged location onto the stator periphery (measuring points are normally located on the supporting feet).
    2) The shaft/hoods are turned through 90 degrees and the repeat measuring/recording of the vertical distance on the quantity 4 hood corners.
    3) A variation of more than 20 mm on the hood corners, justifies a decision for re-alignment of the hoods.
    4) Consistency of the variation through the 90-degree repeat measurements confirms the hood alignment, and inconsistent repeat measurements points to shaft alignment deficiency.
b) The evaluation and decision for executing hood alignment is subject to the verification, recording and correction of shaft alignment. Refer to the section dealing with the ‘Shaft’.
c) Excessive misalignment of the hoods results in over/under compression of the Stainless Steel sleeve-type thermal compensator or reaching adjusting limits on the spring-rods.
d) The hood attachment bolts on the hub must be inspected for secureness.

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3.3.2 Shaft alignment

a) The shaft alignment is evaluated together with any observed misalignment on the hoods and is covered under the appropriate section for the ‘Shaft”.

3.3.3 Hood erosion damage and monitoring

a) The hoods can experience several modes of failure, and is to be comprehensively inspected and repaired on 3 yearly intervals:

   1) Leading-edge erosion on the outer top & side surface – verify erosive thinning of wall by thickness testing and repair where necessary.

   2) Leading-edge erosion on the inner side, following the flow-path of the (entrained) ash-contaminated air – identify damage trail and repair where necessary.

   3) Soot-blower Steam-pipe protrusion through the hood and/or steam leaks result in damage to the hoods – identify and seal to prevent leakage.

b) Each damage area is comprehensively listed on a “Protection Inspection check-sheet”, and the protection elements consist mainly of replaceable screening plates – refer to the applicable section on erosion protection.

c) Leakage on the steam-pipe protrusions through hoods is sealed with the use of pre-formed cover plates over the hole and seal-welded. In cases where the steam-piping protrusion through the hood is subject to thermal expansion, a compression-gland sealing method must be used.

d) Hoods are carefully inspected and reported for signs of cracking and leakage – especially around hood attachment points and stay-mountings.

3.3.4 Hood doors

a) Hood doors generally do not require maintenance except for the 3-yearly renewal of the internal door seals.

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

c) Most hood doors are designed for the fitting of a double-seal – one in the doorframe, and one in the hood frame – and the correct fitting of correctly sized gaskets must be enforced. Sluggish fitting allows leakage with resultant erosion damage.

d) Erosion damage requiring more than 50% repairs to the hood/door frames, should prompt for the complete cut-out and replacement of the door and frame.

e) Repeated extensive in-situ repairs to door seals must prompt investigation for incorrect repair practice. The double-lip sealing edges are required to be centralised and forming a flat surface to interface with each gutter seal.

f) The correct sealing material is selected for the Hot End heat resistance. Incorrect material result in decay and is the start of leakage erosion on the doorframes.

g) CAUTION: Closure of hood doors must be verified, Witnessed, and recorded, in order to prevent severe leakage and resultant load losses following which a unit shut-down would be required to close doors.

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3.3.5 Turning vanes

a) Turning vanes located inside the CE and HE hoods must be inspected for cracking and loose bolts on 3-yearly intervals, reported, and repaired as per reported defects.

b) It is important to maintain and retain installed flow-distributing vanes (do not remove). Incorrect distribution of flow contributes to temperature variations, blockage and high erosion areas.

3.3.6 Hood mounting interface for sleeve compensator.

c) The bottom surface of the hoods accommodates the bolt-on surface (sealing bar) for the Stainless Steel (sleeve) compensator.

d) The Seal bar forms the seating surface for the compensator clamping devices, and it is therefore important to maintain it with a flat/smooth surface.

e) Sealing bar gaps on articulation joints must be minimised and sealed with the use of a high temperature silicon.

f) It is to be noted that the clamping positions of the sleeve-compensator are carefully selected in order to ensure free movement of the compensator – not on connecting (articulation) joints. Clamps with positions are fixed (tack welded) and do not change with compensator replacements – refer also to “Sealing system”

3.4 DRIVE MECHANISM

3.4.1 Main drive motor and coupling

a) Main drive motors are designed to operate for 18+ years, but 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) Following maintenance intervention on motors, it is compulsory to verify the correct direction of rotation with Mechanical Control personnel as Witness.
d) 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.
e) 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.

3.4.2 Main drive Gearbox

a) The gearboxes are generally designed to operate for 15+ years without maintenance, but may vary between stations.
b) Stations need to consider, thus execute other supporting tests, for condition information, such as oil samples, oil leaks, oil level, and vibration monitoring on set periodic intervals.
c) It is cautioned that incorrectly sampled oil does not detect settled contamination, and gearboxes do not have an oil circulation filtration system – a situation that requires consideration for scheduled 6 yearly oil replacements.
d) Gearboxes with externally fitted oil pumps like Matimba & Majuba require a 6-yearly replacement of the oil pump coupling.
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.
g) The main drive motor coupling must be inspected for healthy condition on 6-yearly intervals.

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h) The gearbox mountings and adjusting mechanisms must be monitored and kept in good functioning condition. Gearbox adjustments are important to achieve requirements for both vertical and horizontal settings.

3.4.3 Auxiliary drive motor and coupling (Matimba & Majuba)

a) The auxiliary drive is a maintenance facility, and essential to be kept in good working order to execute maintenance.
b) Maintenance Rotation of Air Heaters must always be facilitated in the correct/normal operating direction. Following some maintenance intervention on motors, it is compulsory to verify the direction of rotation with Mechanical Control personnel as Witness.
c) In extreme case – with pin-rack replacements, the need exists to counter rotate the hoods for accurate positioning of the rack in line with the removal door – this manipulation requires a reversal function which can be facilitated with the fitting of an external control panel interfaced with the auxiliary drive motor. Reverse manipulation can also be achieved by a manual rigging facility.
d) Machines that are not equipped with an Aux-drive function are manually rotated by means of a pneumatic (pony) drive interfaced directly onto the main drive motor coupling.
e) CAUTION: Extreme care and access control is to be implemented when hoods are to be rotated. An additional warning siren with red-flashing lights are displayed when hoods are turned.

3.4.4 Gearbox output shaft and support bearing assembly

a) The gearbox output shaft seal must be kept clean and monitored/reported for health.
b) The output shaft/bearing pillar boxes are fitted with lubrication points for each of the top and bottom locating bearings and must be kept clean and monitored/reported for health.
c) Greasing points are serviced on monthly intervals.

3.4.5 Main drive coupling

a) The Main gearbox couplings used are mostly the pin and rubber bush type, for which the pin & bushes require some visual inspection on 6-yearly intervals, and a detailed stripped inspection on 12-yearly intervals when gearbox is removed for servicing.
b) Air Heater rotation monitoring instrumentation must be mounted on the Pinion-side coupling half (thus NOT on the drive-side coupling half).
c) Note: an excessive gap between coupling halves is an indication of change or abnormal conditions, and must be investigated/monitored.

3.4.6 Drive Pinion

a) Pinions are designed as reversible, and used for a normal service life of minimum 3 years per working side.
b) Pinion wear shall be monitored on-line (subjective report), as well as objective measurement with the use of a gear-profile templet and feeler gauge during 18-monthly outage inspection/reports.
c) Reduced wear-life is caused by:
    1) Incorrect meshing conditions (penetration depth).
    2) Incorrect 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.
d) Reduced pinion wear-life shall be reported, investigated, and corrective actions implemented.
    1) This must be a new paragraph point (e) – please HELP
    2) The Pinion and Pin-rack meshing depth shall be controlled and reported to specification with all change of installations. For most machines the pin-to-root gap should be 19 mm. CAUTION: Measurements are recorded on the average Pin-rack radial run-out.

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e) The pinion and pin-rack axial alignment shall be controlled and reported to 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 'capping movement' of the stator and hood assemblies.
f) Pinions are provided with accurately positioned pre-drilled mounting holes, and mismatch of bolt-holes must be corrected on the hub. Back-marking to the hub with site-drilling is not a standard and is to be phased out.
g) Pinion locating mounting bolts are closely fitted bolts (with minimum clearance), thus holes are NOT to be flame cut, but accurately positioned and drilled.
h) Pinion mounting bolts (size generally M30) are of a higher grade (Gr 8.8) from Standard industrial supply may be used and are used in conjunction with a special locking-nut (cleave lock) – Note: Ny-lock nuts are not resistant to the operational heat.
i) CAUTION: With the insertion and tightening of bolts it must be ensured that the seating areas are clear of any debris, in order to secure a proper wet torque of 700 Nm. Most pinions have an additional 4 mounting points (M24), which is mainly used for fitting-rigging of the pinion, nevertheless bolts are to be adequately tightened.
j) Pinion mounting bolts can be re-used when turning for the use of the alternative side. Bolts must be replaced with new pinions.

3.4.7 Drive Pin-rack

a) Pin-racks are designed as reversible, and used for a normal service life of minimum 6 years per side.
b) 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.
c) Reduced Pin-rack wear-life shall be reported, investigated, and corrective actions implemented.
d) 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.
e) Reduced service life is considered if a wear-measurement of 2.5 mm is noted on 3-year inspection.
f) 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 reported to specification during installation. Radial alignment is adjusted within 3 mm TIR, Axial alignment 6 mm TIR.
    3) For shaft with sleeve-bearing applications: The Pin-rack radial & axial alignment shall be controlled and reported to specification during installation. Radial alignment is adjusted within 5 mm TIR, Axial alignment 8 mm TIR.
    4) 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.
g) 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.
h) NOTE: For turn/swop activities, the previous installation tolerances are to be evaluated. Installations with out-of-specification tolerances are to be analysed by Engineering in order to establish new installation mean PCD's.
i) Pin-rack mounting is performed with utmost attention and care with particular attention to the following:
    1) Mounting pads split between racks.
    2) No welding is allowed across/near pins.
    3) Full welding all-round on the plate to rack interface.

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4) Placement position and length of the mounting plate.
5) Full top/bottom welding of the mounting plate onto the hood/frame interface.

j) Pin-rack mounting plates are best replaced with each turn/replace and correct lengths are cut from standard 16x100 mm flat-bar lengths. Guillotine cropping of plates is less desirable and cause distortion that affect mounting accuracy. Laser-cutting or flame-cutting of plates is preferred.

3.5 SHAFT, BEARINGS AND LUBRICATION SYSTEM

3.5.1 Bearing compartment and access door

a) The compartment access door hatch is opened with every Inspection and Outage and CAUTION is to be applied where the hatch is placed when removed, and also that closure of the hatch is controlled (signed-off) with final inspection. Generally the hatch is not sealed, but it is recommended when water-washing is to be executed, in order to prevent water ingress.
b) The Matimba & Majuba Air Heater compartments are also equipped with a bearing/pad removal door located on the compartment roof, or stator hub and must be serviced/sealed to prevent erosion-leakage or water ingress during washing.
c) The Bearing compartment Structural welds are to be inspected for cracking on 6-yearly cycles.
d) The locating bearing housing mounting bolts, located on the roof of the compartment is an inspection point, and is dealt with under the section for Bearing maintenance. (Specifically sensitive for Duvha & Tutuka).
e) Most machines are fitted with top locating bearing welded stops in order to prevent movement of the housing after alignment, and is to be inspected for deficiency with regular intervals.
f) The Compartment is cladded with Thermal insulation material to limit the transfer of conducted heat from the element packs, and must be monitored and maintained.
g) The sleeve-bearing wear indicator monitors excessive bearing wear, and is linked to a switch with alarm when wear has reached the recommended/set 4 mm level (Matimba & Majuba). The striker mechanism must be serviced on 3 yearly intervals, while observing not to affect the original adjustment. The switch and termination box must be cleaned and sealed with the same maintenance intervention.
h) The Bearing compartment temperature is monitored via a fitted temperature measuring connection for the purpose of detecting unhealthy operating conditions and to activate/control the cooling-flow. The thermocouple is mounted inside the compartment, in a way to detect the atmosphere temperature, and not the temperature of the steel structure.
i) For the Oil lubricated machines: (DV, TT, KR, HD, GV)
   1) Cooling is mainly achieved by guiding some of the FD Fan flow through the bearing compartment, with a secondary mechanism of an externally cooled lubricant (where applicable).
   2) Lubricating flow is gravity fed from the top locating bearing to the main support bearing and connecting pipes must be inspected and passed with zero-defect.
   3) Observe correct installation and venting (to atmosphere) of the oil bath cavity, in order to prevent pressurisation of the bearing.
j) For the grease-lubricated machines (MT, MJ)
   1) Partial flow from the FD Fan is ducted through the compartment during Fan-in-operation (on-load) periods.
   2) Machines are fitted with a Hub Cooling Fan, which delivers cooling flow to the central bearing compartment during shut-down periods.
   3) The greased system is equipped with a hub-cooling fan and ducting with a non-return flap-type damper for which operation is to be observed and maintained.
k) The correct cooling-air flow-path is to be observed and maintained, with inlet cavities via the bottom locating bearing and support bearing into the compartment. Outflow is guided through cavities at the top locating bearing.
l) The lubrication tube guiding lube-piping through the element matrix is cooled via the pressurised flow inside the compartment, and exit restriction should be observed and avoided.

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3.5.2 Shaft and alignment

a) The shaft generally requires no maintenance, unless some damage is caused due to labyrinth seal or bearing failure.
b) The checking/verification of Shaft alignment – as a method to detect any possible changes to the operational condition – is performed on 3 yearly basis, as follows:
   1) A vertical measurement from a fixed point on any of the hood corners down to the stator periphery, while cautioning to consider an un-worn or un-sagged location onto the stator periphery. The measurement is normally taken by parking the hood corner in line with each of the external casing supporting feet.
   2) The shaft/hoods are turned through one rotation, while measuring and recording the vertical dimension at each of the quantity 6 air heater main support positions.
   3) A variation of more than 5 mm on the measurements must prompt for further investigation with review of the measurements by Engineering and with a possible recommendation for adjustment.
c) A decision to adjust the shaft alignment must be combined with the verification of the following:
   1) Top locating bearing fixed/gagged position – these are bolts and/or stop-blocks to prevent dis-location on bearing/housing.
   2) Top locating bearing wear-condition – ensure that a worn bearing does not result in a false misalignment report due to a rocking-of-the-hood.
d) The evaluation and decision for executing shaft alignment is combined with the verification and recording of hood alignment. Refer to the section dealing with the ‘Hoods’.
e) Some machines with oil lubrication on the main bearing will be fitted with a shaft protection sleeve, as landing for the oil/labyrinth/felt seal, which is to be inspected/repaired if damaged. If no wear-sleeve is fitted, damage-repairs by means of an epoxy has been executed successfully, providing that a concentric finish is obtained.

3.5.3 Top/Bottom locating 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 hood sealing system.
b) The tightness of the locating Bearing housing attachment bolts and anti-movement stops is an important inspection prompt, in order to prevent undesired movement of the housings.
c) Two prominent locating bearing types are in use on Eskom Power Stations – Rolling element bearings and Sleeve-type bearings:
d) 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, and is to be inspected for condition and cleanliness on 3-yearly intervals.
   2) Bearings are subject to compulsory replacement on 12 yearly cycles – after which the bearings can be re-certified or discarded if rejected for re-use.
   3) The locating bearing oil-bath level overflows towards the Support bearing oil bath via connecting pipework, which is to be inspected for healthy condition.
   4) Some stations have been fitted with flexible connecting piping between the locating and support bearing, which requires a cautious inspection and replacement decision.
   5) The support bearing is fitted with a lubrication breather pipeline, in order to prevent pressurisation of the system via the pressurised compartment. These pipes should be checked for blockages in every GO.
   6) A cautious approach towards the inspection and execution of maintenance is required, as the leakage of lubricant has been the cause for a multiple of Air Heater fires.
e) Sleeve locating bearings:
   1) The bearings are grease-lubricated and are subject to ash ingress & wear and are inspected on 3 yearly IR/GO intervals.
   2) Replacement is based on the wear-evaluation of two components – Bearing sleeve and shaft protection sleeve, which is stripped, inspected and sizes recorded for evaluation.

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3) The bearing/sleeve diametrical clearance is approximately 1.5 mm in the new condition, and a maximum wear clearance of maximum 3 mm is recommended.
4) The bearing and sleeve report with measured sizes is analysed by the Contractor's Engineer, in order to recommend replacement.
5) During servicing, the inspection and cleaning of lubrication grooves, pre-greasing of the bearing and testing for continuation of grease feed is of utmost importance to prolong bearing life.
6) Accurate assessment and the cleanliness of servicing/installation is the key element to prolong bearing life and requires the deployment of trained personnel for maintenance execution.
7) The lubrication systems for each respective bearing type is dealt with in the appropriate sections below.

3.5.4 Main Support bearing

a) The inspection and condition monitoring of the Support/Thrust bearing is important to ensure that no adverse condition develops that would affect and damage the hood sealing system.
b) Two prominent Support bearing types are in use on Eskom Power Stations – Rolling element bearings and Sleeve-type bearings:
c) Rolling element support bearings:
   1) The taper cylindrical roller bearing is oil lubricated and must be inspected on 6 yearly intervals with compulsory replacements on 12 yearly intervals.
   2) Bearing inspections must deploy the expert intervention to detect signs of debris, scoring damage, discoloration or cracking of bearing races or cylindrical rollers.
   3) Bearing replacement requires the expert verification of seating surface health, sleeve-tensioning and installation cleanliness.
   4) Correct sealing set-up and cleanliness of the sealing system (labyrinth seals) must be observed.
d) Flat pad-type support bearings:
   1) The bearing-pads are grease lubricated and must be inspected and cleaned on 3-yearly intervals.
   2) The cleaning requires the clearance of all grease-feed and rejection grooves, and pre-greasing by complete re-filling of all grooves of the bearing followed by the testing for continuation of grease feed on all ports is of utmost importance to prolong bearing life.
      a. Note: Omission to fill grease-rejection grooves allow ash-ingress with resulting blockage of the groove and accelerated wear.
   3) The bearing upper thrust-collar must be cleaned and inspected for scoring.
   4) Caution: Evidence of hard deposits in the grooves, and scoring marks on the wear surface is reason for reporting and further investigation.
   5) The pads are removed for consistency of thickness evaluation, and a report with thickness variation of more than 0.3 mm is an indication of deficiency which will contribute to high start-up friction.
   6) The operational performance of all pad-type Support bearings must be checked – a large rise in the drive motor Amps after a standstill period is indicative of stress on the bearing, and should prompt for further evaluation and/or replacement.
   7) Bearing-stress is generally caused through lubrication failure or excessive temperature during operation.
   8) The grease-rejection grooves of the bearing tends to plug on the outer-ends towards the grease-tray, resulting in all grease being rejected towards the inner-ends and settling on the bottom locating bearing. Note that a modification is available for partially restricting flow to the inner rejection groove, and forcing flow to the outer grease tray.
   9) Bearing replacement is motivated by Normal wear of the bearing up to 4 mm, and/or surface damage with thickness variation as stipulated above.
e) The respective bearing type lubrication systems is dealt with in the appropriate sections below.

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3.5.5 Oil lubrication system

a) Oil-lubricated systems are serviced through reservoir inspection and oil cleaning on 3 yearly intervals.
b) Control system filter, pump, pressure & flow set-up and cooler requires health verification with re-commissioning after each cleaning intervention, guided by a dedicated procedure and check-list.
c) Caution: inadequate sealing of the bearing compartment during element pack washing interventions can result in water-ingress to the oil system – this condition must be verified and the clean-up servicing is best scheduled after washing.

3.5.6 Grease lubrication system (MJ, MT)

a) The Grease-lubrication system is a total supply to waste system, thus the maintenance cleaning of waste-grease trays are required on 18 monthly intervals – top, bottom and support bearing trays.
b) The correct grease-reservoir re-filling as well as the adjustment and maintenance of the metered supply system requires expert/skilled attention.
c) Tampering with the built-in failure warning systems can result in bearing damage:
    1) Change-over pressure setting and rise to be observed and reported.
    2) Change-over valve solenoid (qty 1) failure to alarm a fault.
    3) Line-metering solenoids (qty 17) failure to alarm a fault.
    4) Empty grease reservoir failure to alarm a fault.
d) CAUTION: While greasing failure is not immediately evident on either temperature of motor amps, starvation of lubricant results in damage to the support-bearing. Immediate action for manual greasing is required on each line every two hours until the fault of the supply-control system is functional.
e) The cleaning of grease-waste trays must be performed against an approved procedure, cautioning the correct cleaning of the air-flow paths – cleaning is required beyond the obvious grease-trays. Air-flow paths provide cooling to the bearing compartment during operational periods.
f) The leakage and continuation of each grease line between the supply system and the inner-compartment is to be inspected through withdrawal and verification of the lines in the lube-tunnel. The continuation of grease supply is to be tested up to the bearing contact surface after every 3-yearly maintenance intervention.

3.6 HOOD SEAL AND SETTING SYSTEM

3.6.1 Sealing frame

a) The Hot-End (top) leading edge sealing frame is the most susceptible to erosion damage and replacement frequencies could be as short as 12-yearly. Erosion damage is accelerated through the incorrect repair management of Articulation joints, or incorrect installation of the Cast Iron Wear Seals.
b) The Cold-End (bottom) seal frames reveal a longer life-cycle of up to 18 years providing proper management of peripheral components maintenance is performed.
c) The bottom-side seal frame and articulation joints only function during initial and possibly subsequent setting – thus it is not thermally compensated during operation.
d) Note: The use of “solid-frame technology” (eliminates the use of articulations) is reliably promoted for the CE, whereas this application for the HE is still in a development phase. System Engineers and Maintainers must recommend Scope of Work to enhance installations to solid-frame technology.
e) Meticulous management of articulation joint leakage, and with joint replacements, can preserve the life best possible Partial replacement is acceptable
f) Any attachment or joints on the sealing frames must be performed with utmost care to prevent any source of air leakage, which would result into severe erosion damage.
g) During repairs and installation, the flatness of the seal-frame on the CIWS interface, shall be proven within a 2 mm tolerance.

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h) CAUTION: For the complete replacement/installation of Seal Frames ,the verification of pre-matched positions of the various sections must be done. Sealing frames are manufactured and surveyed and matched sets. Forced partial replacements must prompt for additional flatness verifications.
i) The CIWS attachment interface with the Seal-frame is a critical inspection verification for sealing and the quality of attaching bolt threads/tappings.
j) CAUTION: The sealing frame suspension on setting rods/springs must be tested by forced vertical movement in order to confirm looseness for expansion.
k) Correctly installed seal-frames are secured and retained in the correct position with several links – refer to the section covering Center-pots, Nudging pins and Drag-links below.

3.6.2 Stainless steel sleeve compensator

a) The compensator facilitates movement of the sealing frame, and is sensitive to correct sealing installation, weld-arc damage, articulation joint failure and erosion damage particularly on the periphery of the hoods. The compensator has a reliable expected life of 6 years providing that the correct installation and peripheral component maintenance is thoroughly performed.
b) Seal frame or installation deficiencies could require up to 50% replacement/repairs on 3-yearly intervals. It is advisable to conduct detailed inspections during 18-monthly inspection interventions.
c) The stainless steel is critically inspected, reported and cautiously repaired, depending on the failure mode.
d) Typical failure modes to be identified (and potential repair/remedies) are:
    1) Ash erosion as a result of normal gas-side flow, resulting in the “thinning” of the 0.7 mm thick material. Chronic localised erosion of this type can also be treated with an increase of material thickness or flow deflector plates. This failure mode is prone to the periphery sections.
    2) Localised erosion as a result of articulation joint leakage/failure. Chronic localised erosion of this type can be treated under emergency by overlapping an add-on insert on the INSIDE of the compensator and sealed with high temperature silicone. Longer opportunities require replacement of the damaged sections.
    3) Localised erosion as a result of incorrect penetration on the joints. This is an installation defect and must be addressed/prevented by means of training and quality inspection.
    4) Localised cracking as a result of fatigue cracking due to incorrect clamping that limits expansion of the compensator joints on the seal frame articulations. This failure mode must be addressed with a review of the clamping positions.
    5) Clamps are available in two possible designs, and the L-plate (one-bolt) design should be preferred to the flat-plated (two-bolt) design.
e) The compensator is clamped onto the seal frame with a webbing-seal interface which is to be properly secured to each respective frame by gluing with contact adhesive.
f) Clamping position is secured by allowing joint-movement on the articulation joints.
g) Penetration on the sleeve-compensator joints is to be a minimum of 30 mm with inspection verification required.
h) Fitting of the correct joints and lengths to drawing is mandatory in order to reduce probability of failure.
i) CAUTION: The correct application of articulation joint erosion protection covers must be completed prior to fitting the Stainless Steel compensator.

3.6.3 Cast Iron Wear Seals

a) Wear monitoring and expected wear life of seals is normally in excess of 6 years, providing that seal setting and Operational conditions are correctly optimised/managed. Localised erosion on the leading edge periphery require replacement on 3-yearly intervals and damage to seals in the articulation joints area will also require some repair remedy or replacement on 3-yearly intervals.
b) CAUTION: Wear life of the sealing-frame leading edge seals is drastically reduced due to incorrect setting-gaps and erosion.

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c) Seals reaching a wear-condition below 15 mm is to be recommended for replacement. The minimum thickness is determined as a function of i) threaded attachment integrity and ii) approximately 50% of original thickness.
d) Generally, partial replacement of damaged seals should be avoided, and when necessary due to failure, it requires the control of stepped increases of maximum 3 mm in thickness to adjacent seals.
e) The Sealing-frame flatness (mounting interface) is to be controlled during the replacement/fitting of CIWS, in accordance to norms stipulated under the Sealing frame section.
f) The CIWS interface with the Seal-frame is adequately sealed with a high temperature sealant and the correct bolting configuration.
g) CIWS element installation gaps are set to ZERO, except on articulation joints. The gaps between seals on articulation joints are to be set as follows:
    1) Important: Installed gaps on CIWS are controlled and reported on the inner (hood) and outer (gas) sides.
    2) Hub-joint 1 to 2 mm
    3) Intermediate joint 2 to 3 mm
    4) Outer joint 3 to 4 mm
    5) For sealing frames with only two articulations, the intermediate setting is eliminated.
    6) Set gaps are verified and recorded as a quality measure.
h) Seals for leading edges are installed with a machined chamfer facing the leading contact surface and must be verified correct.
i) CAUTION: Leading & Trailing edge seals are generally secured to the sealing frame by a qty 6 attachment points. Attachment points and fitting/tightening of bolts are to be verified and reported as a quality control measure.

3.6.4 Articulation joints

a) The purpose of the joints is to allow the sealing frame to be adjusted according to the changing curvature of the stator due to the “capping-phenomena”.
b) Articulation joints are the weakest link in the wear-life of the seal-frame and must be maintained on 3 yearly basis. Premature failure of joints must prompt for correction to incorrect maintenance practice.
c) The use of bolt-in articulation joints is advised for 3 yearly replacement. Joint replacement must be accompanied with the fitting of the correctly designed erosion protection cover plates.
d) Incorrect gaps on the seal frame clamping pad (for attachment of the Stainless compensator), result in accelerated leakage-wear of the compensator. For the HE-side (moving) seal frame, the tolerated gaps are to be minimised as the joint is located on the opposite side of the articulation hinge and would only be subject to “opening”. All gaps are to be sealed with high-temperature silicone.
e) Articulation joints are re-sealed by means of carefully designed and positioned cover-plates for inside and outside of the hoods, and potential leakage gaps are sealed with high-temperature silicone. Accurate/correct installation must be guided by authorised procedure/drawing and trained personnel.
f) There is a high tendency for air leakage on the articulation joint, and in combination with ash on the leading edge, result in rapid wear-deterioration. Joints are to facilitate the insertion of a repair cover plate on the CIWS interface to close enlarged erosion gaps on the seals.
g) Note: Maintenance Engineers are to observe the recommendation on the Sealing-frame section for the elimination of articulation joints on the sealing frames, and if cautious about the expansion control for the HE-side, the solid beam seal frame should most certainly be installed on the CE-side
h) CAUTION 1: The fitting of articulation joints require the correct linear alignment of the seal frame on the leading/trailing edges in order to allow free movement (prevention for “hinge” to lock-up).
i) CAUTION 2: The fitting of articulation joints require the correct vertical alignment in order to obtain a neutral gap (to facilitate hinge movement). The alignment is secured with the correct fitting of Nudging pins and must be proven/recorded with inspection interventions.

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3.6.5 Thermal compensating rods and crank-levers

a) The HE-mounted Thermal compensators operate to facilitate auto seal adjustment with stator/element capping during operation and must be inspected carefully.
b) Thermal compensators do not malfunction, and can last for the full life-cycle of the machine, unless the individual components are damaged due to erosive operational conditions or incorrect installation.
c) The verification of correct installation of crank-levers due to multiple rod-connecting holes is required under the following circumstances:
    i. Erratic behaviour with CIWS wear,
    ii. New/replacement installations.
d) With re-active forces acting on the rod-assembly, damage due to erosion of the mounting attachment must not compromise the attachment. Firm mounting of thermal compensators onto the hood, in accordance with drawings is required and must be verified/reported.
e) With ash-erosion as the biggest cause for damage, attention to detail and care is required to apply effective methods to prevent component damage. It is required to compile a comprehensive plan for protection of rod-ends, vertical down erosion and hood leading edge swirl. Generally, the expansion-rod connecting-ends and the length of the surrounding tube is erosion-protected.
f) Damage replacements could constitute only the surrounding tube and spares should be stocked as such.
g) CAUTION: Machines fitted with Thermal compensators require more intensive review when abnormal operating conditions occur, as the de-capping of the stator under hot conditions with hoods rotating will result in accelerated CIWS wear. Specific conditions must be logged and the mode of operation reviewed:
    1) A hot Unit trip will result in stator heat-soaking and de-capping and should prompt to minimise hood rotation.
    2) Single Draught capability operation will result in the stationery heater heat-soaking especially if the flue gas discharge dampers are not maintained correctly and promote excessive heat-flow. This situation should prompt to minimise hood-rotation.
h) A lack of record of abnormal operational conditions makes it difficult to analyse and interpret seal wear and re-setting requirements. It is therefore important for the maintaining team to monitor and log operating excursions such as elevated temperatures, rotation failures and extended periods of rotation against seal pressure.

3.6.6 TOP Seal setting rods and springs

a) The Top Seals are set to make contact with the stator with a small (3 mm) wear-in (seating) allowance and are set against a calculated seal-setting schedule, considering the following affected components and parameters that are recorded for inspection:
    1) Spring length – measured length excluding the spring seats.
    2) Seal gap – physical gap between the seal and undamaged/straight stator surface.
    3) Nut gap – allowance for spring-rod travel or to ‘seat’ and to compensate where no thermal compensation is available.
    4) Seal wear – to interpret the effect of previous adjustment and/or operating conditions.

b) The execution of any work on the Setting of springs require a review with both Contractor and Eskom Engineering on the latest configuration of the setting schedule available from the Employer Draught Plant System Engineer.
c) Seal setting rods and springs could last for the life of the machine, if not damaged by ash-erosion. The HE Spring tension have not been found to collapse under normal operating conditions, but can be scheduled for confirmation on 12 yearly cycles.
d) Springs/rods must be monitored for erosion damage and replaced if evident.
e) Root-cause analysis and remedial action is required when springs/rods are damaged by erosion.

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f) Spring rods extending through air hoods (primarily on the hood outer periphery) are fitted with a sealing mechanism, and the seal must be maintained on 3-yearly intervals to prevent leakage-erosion in this area.
g) Spring rods must be aligned with protrusion cavities in mounting brackets in order to prevent rubbing-contact that could foul normal movement.
h) Spring rods must be locked in position to prevent in-operation changes of setting by positive verification of tightened lock-nuts and correctly secured R-clips.
i) Setting or re-setting of Seals and Rods must be accompanied by an “as-set” recording sheet and require a 100% quality verification.
j) NOTE: It is not standard practice for Seals/springs to be re-adjusted after an operating period. Nut gaps on the spring rods actually blocks the downward movement of the seal frame, thereby preventing any wear more than the bedding-in allowance of 3 mm. Obvious signs of exaggerated wear require further investigation and contributing factors to abnormal wear are as follows:
    1) Incorrect initial setting – not adhering to the setting and verification requirement.
    2) Malfunction of components - such as articulation joint lock-up, which is a consequence of incorrect installation.
    3) Inadequate gaps on articulation joints – incorrect installation.
    4) Abnormal operating conditions – temperature excursions with boiler outlet temperatures could add up to 5 mm additional capping towards the bottom (fixed) seals, with the obvious consequence of seals wearing down and a large peripheral gap will remain even after re-instating the boiler operating temperatures.
    5) Abnormal operating periods during start-up and Single Draught Capability operation – The Engineer with maintenance team should be sensitive to such occurrences, and take action to monitor and adapt seal frame settings.
k) CAUTION: Any re-setting of seals after an operational period must be approached with appropriate analysis and care:
    1) Analysis of wear or failure condition with a written engineering instruction for re-adjustment.
    2) Analysis must incorporate the verification of correct installation of articulation joints, thermal compensator operation, previous nut-gap allowances, abnormal operational conditions.
    3) Normal wear re-adjustment should ONLY require a re-seating allowance – thus a 3 mm re-adjustment of the nut-gaps.
    4) Note: Consistent or repeated wear patterns must be analysed and lead to a review of the Seal-setting schedule. It should however be noted that most abnormal wear conditions are the result of incorrect installation and setting.

3.6.7 BOTTOM Seal setting rods and springs

a) The Bottom Seals are set with a large gap between seals and stator with a calculated allowance for the stator to cap “into” the seals to form a tight seal during 97% (MCR) load conditions. The minimum requirements for monitoring of settings are:
    1) Spring length – measured excluding the spring seats.
    2) Seal gap – physical gap between the seal and undamaged/straight stator surface.
    3) Nut gap – Zero, thus no allowance required.
    4) Seal wear – to interpret the effect of previous adjustment and/or operating conditions.

b) The execution of any work on the Springs and Setting require a review with Engineering on the latest configuration of the setting schedule.
c) Seal setting rods and springs could last for the life of the machine, if not damaged by ash-erosion. No CE deficiencies on Spring tension have been found under normal operating conditions, but can be scheduled for confirmation on 24 yearly cycles.
d) All other conditions and requirements stipulated under the section for the TOP Springs and Setting-rods above shall apply to the BOTTOM Springs and Setting-rods.

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3.6.8 Drag-links, Centre-pots and Nudging-pins

a) Drag links keep the periphery sealing frame in position relative to the hoods, while ensuring that the peripheral sealing frame up/down movement is facilitated.
b) The **Drag-links** can fail in several modes:
   1) gas/ash seizure of the swivel connection,
   2) incorrect fitting,
   3) damaged by mechanical force.
c) Drag links are inspected 3 yearly for free movement, and bush/pin joint can be cleaned-up to remove seizure.
d) Ensure to increase the bush/pin clearance to 1 mm to provide a longer seize-free operation.
e) **Centre-pots** are positioned around the hub, and keeps the hub sealing frame in position (aligned) and ensures up/down movement of the hub sealing frame.
f) The function of the centre-pot is reliable but can fail in several modes:
   1) seizure due to extreme dirt ingress
   2) damaged by mechanical force.
g) The condition of centre-pots are inspected and reported for contact or seizure – visible/measured defects are contact on the inside pot surface or a variation in height between the two seal-frame sides, or the seal frame not seating on the stator.
h) **Nudging-pins** are positioned along the leading & trailing edges of the sealing frame, and keeps the seal-frame in position/alignment during rotational movement of the hoods. Misalignment of the seal-frame can result in the locking-up of the articulation joints.
i) Nudging pins do not fail, except by mechanical force, or incorrect installation.
j) Nudging pin gaps to the seal-frame are inspected and reported before and after the execution of work, and if a loss of contact with the seal frame is reported, it must be investigated and the seal-frame alignment re-assessed.
k) CAUTION 1: Nudging stop misalignment can be caused with turning the hoods in the incorrect direction, thus any positioning of stops or gap-assessment with the seal frame must be performed after turning the hoods in the operating direction.
l) CAUTION 2: Seal frame replacements must prompt for the correct positioning and recording of the stop gaps.

3.6.9 Manual seal setting mechanism (MT, MJ)

a) The purpose of the manual seal setting device is to correct abnormal (large) seal gaps on the Cold-End periphery seals. Execution of adjustments must be reported to the Employer and Contractor Engineers for investigation and recording. The need to perform on-line adjustment is a possible resultant of the following factors:
   1) Incorrect cold setting.
   2) Abnormal gas/air temperatures (caused due to a lack of Boiler soot-blowing or Furnace combustion conditions), and resulting in over-capping of the Air Heater Stator. These conditions should obviously be avoided and reported for taking action on the seal-setting.
b) CAUTION: The Manual seal-setting device must not be activated by unauthorised persons and without procedure. The mechanism should be locked, and only authorised with Engineering intervention. Setting is only performed when the unit is on full load, with capping-gaps minimised.
c) The setting mechanism must be properly cleaned/serviced with every 3-year shutdown. The fibre compensators on the screw mechanism can be replaced on 6-yearly intervals or if damaged, replace with the 3-yearly service.
d) Premature failure of either the mechanism or fibre compensator must be flagged as incorrect maintenance practice or incorrect fibre-compensator material specification.
e) Dry graphite lubricant must be used on the internal screw-gear servicing.
f) The installation of an erosion protection plate/screen, fitted between the mechanism cavity and the gas-flow chamber, prevents gas/ash exposure and prolongs the life of the device.

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g) Cold-End (bottom) seal setting or replacement must prompt the servicing and correct setting of the hood adjusting mechanism (ball and arm), and adjusted to the mid-position of 45 degrees.
h) Good practice is to activate and adjust the bottom seals during the seal-setting exercise before a unit's Return to Service.
i) The activating ramp has a replaceable impact wear-block, which could wear due to frequent operation, or incorrect operation. While frequent operation is abnormal, incorrect operation is more likely due to the operator's failure to return the ramp to the mid-position after performing peripheral seal setting.
j) The activating ramp hinge point is inspected for free movement or damage – damage would only occur due to foreign mechanical obstruction/striking.

3.7 THROAT SEAL SYSTEM (COLLAR SEALS)

3.7.1 Collar seal housing

a) The collar seal housing condition is to be monitored during every 3 yearly outage – for erosion damage and concentricity/ovality.
b) The collar seal housing concentricity and ovality is monitored and recorded by means of static and rotational TIR.
c) For the housing, the new installation TIR specification is 4 mm Axial & Radial. For installations in operation, conditions beyond 6 mm Axial and 8 mm Radial should be reported for correction.
d) Excessive TIR measurements must flag an investigation into the root-cause – which is either incorrect installation or normally a restraint on the transition duct thermal expansion joint, which should be investigated, reported and rectified.
e) The housing is subject to erosion due to the Hot Secondary Air outlet ducting not adequately maintained, or in case of bolt-on flange leaks, and should be avoided by repair of the noted areas.
f) Collar seal housing replacement should only be necessary after 24 years if the appropriate care for adjacent equipment was executed.
g) The replacement/installation of complete collar seal housings shall be installed within acceptable/pre-defined concentricity, eccentricity and axial specifications, and installation parameters must be recorded and QC approved.
h) CAUTION: The directional positioning of tensioning devices shall be verified/reported as additional check-point.
i) Housing cover attachment bolts are installed with thread/nut facing away from the erosive gas flow. Bolts/nuts are preserved with a high temperature anti-seize lubricant and can be re-used, if not damaged.

3.7.2 Tangential seal tensioning system (MT, MJ)

a) The sealing elements (seals/shoes) are manufactured from Cast-Iron, which contain an inherent 'dry lubricant', and have been designed for a service life of minimum 3 years to replacement.
b) Reduced seal wear-life shall be reported, investigated, and corrective actions implemented, and is generally caused by:
    1) Excessive eccentricity of the contact surface (rubbing ring/liner) during rotation.
    2) Leakage erosion due to stuck seals.
    3) Incorrect installation of wear stop pins in the housing cover.
    4) Incorrect setting of the tensioning device.
    5) Incorrect material specification for the seal-element.
c) Extended wear life (seals not making contact), is a sign of abnormal condition and leakage. Lack of seal contact shall be reported, investigated, and corrective actions implemented.
    1) Soiling of the seals housing due to element pack high pressure washing.
    2) Incorrect installation, including the set-up of the wear stop pins.

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d) The tangential tensioning system shall be scheduled for re-setting to the specified tension on 18 monthly maintenance interventions.
e) The initial opening of seal covers is essential to Inspect, Witness and report defects on the condition and operation of the sealing system.
f) The remnant life of sealing element shall be monitored and reported by measurement on the minimum size, and can be re-used if above minimum size. The decision for re-use of seals is to be evaluated by Engineering, as the combination of worn seals with new seals result in a stepped joint on the joining-plates. Seals with a remaining thickness of 55 mm could be re-cycled for re-use
g) The final installation of replacement seals and connections shall be monitored with a Quality intervention Hold Point to verify correct assembly. A Quality Check-sheet detailing important verifications shall be used to guide the Witnessed Inspection.
h) Before cover closure inspections shall be conducted with the check-sheet prompting for critical points such as:
    1) Fixed and sliding seal connections.
    2) Use of assembly bolts to grade 8.8.
    3) Correct positioning of anchor points.
    4) Positioning of wear-limiter pins on the covers.
    5) Fixing of tangential connecting rods.
    6) Cleanliness
i) Post closure of covers shall prompt for a verification of gaps between the moving seals and cover-penetrating wear-limiting pins.
j) The correct setting-length of the tangential rod/spring and spring tensioning shall be verified and recorded.
k) Tensioning spring cover-tubes shall be erosion-protected – refer to applicable section for erosion protection.
l) Cover attachment-bolts shall be installed in a way to conceal the bolt-threads from ash-erosion.

3.7.3 Individual seal tensioning system (DV, TT, KR, HD, GV)

a) Design wear-life replacement intervals for the individually tensioned sealing elements are similar to the tangential designs, on 3 years.
b) Individually tensioned systems are subject to similar quality interventions than systems installed on single air-sector designs.
c) The re-tensioning (re-setting) intervals are similar to the tangential designs, on 18 months.
d) Opening and pre-closing Quality inspection requirements are similar to the guide stipulated for the tangential systems as noted above.

3.7.4 Primary throat (Collar) seals (DV & TT) - notes

a) Primary throat seals are maintained with greater frequency and care due to the higher operating pressure.
b) Individually tensioned seal-springs are individually adjusted to the applicable plant specification.
c) Spring stops are adjusted in accordance to the housing location, in order to prevent seal wear beyond the acceptable limit.

3.7.5 Static ducting and seal wear liner (rubbing) ring

a) The rubbing ring is a replaceable ‘hardwearing’ liner to protect the ducting, and forms part of the sealing surface and contact with the Seal and should render an acceptable wear-life of 6 years.
b) Wear of the liner, without sharp steps can be tolerated up to 3 mm deep.
c) The condition of the rubbing ring is monitored and reported for:
    1) Wear – depth measurement.
    2) Housing eccentricity and alignment – which is performed by taking 8 equi-spaced distance measurements (radial & axial) from a fixed point on wear-ring to the housing while rotating the ring.

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3) Wear ring radial concentricity and alignment – which is performed by taking 8 equi-spaced distance measurements (radial & axial) from a fixed point on the housing to the rotating ring.
4) A static gap-assessment is made to ensure that the eccentricity of the mating wear surfaces do not exceed 24 mm, in order to prevent excessively worn seals from entering the gap.
5) Each of the above aspects are to be measured, reported and corrected to specification for the applicable plant.

d) Rubbing ring segments are installed with maximum 1 mm gaps between segments, or seal welded and flush-ground to bridge larger gaps. Replacement ring-segments shall be sized to avoid welded joints.
e) Attachment bolts penetrating the liner from the inside of the ducting, shall be of the standard-grade.

3.8 SOOT-BLOWER SYSTEM

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

The different types are described as follows:

a) Rotary valve system with multiple nozzle/headers.

b) Reciprocating system with variations on Steam supply and indexing lay-out.

3.8.1 Steam supply piping

a) The steam supply piping, passing through the gas-path is protected with erosion-prevention liners and should not require any maintenance if correctly protected.
b) Specific attention is required on the steam-pipe entry point on the casing, which is angled and subject to leakage if not properly sealed. Seal welding approached from both the inner and outer casing wall is strongly recommended.
c) Steam piping thermal-expansion is facilitated through the secondary-duct wall with the fitting of a thermal compensator between the pipe fixed points.
d) Thermal movement of the steam-pipe penetrating through static ducting is fitted with a sealing gland, while ensuring any erosive wear on the pipe is repaired with a replacement pipe-section.
e) Steam piping penetrating through the fixed outer casing shall be monitored for sound seal-welding that prevent ingress-air erosion on the pipe/casing.
f) The maintenance of the in-line thermal compensators are dealt with in the following sections.

3.8.2 Steam supply piping in-line thermal compensator

a) Linear (In-line) operating thermal compensators can be of steel-bellows type and require a replacement philosophy of 3 up to a maximum of 6 years, providing that installation lengths and alignment is done to the compensator specifications.
    1) The clear identification of fatigue in the bellows-type compensator is difficult, and a 3-yearly scheduled replacement philosophy is recommended to avoid un-timely failures of the soot-blower system.
b) Installation parameters are monitored and reported.
c) The thermal compensators can be of special – piston & ring design with superior 6-year life-expectation, but reliable and precise installation alignment is required in order to secure the operating life:
    1) Centerline alignment of the connecting pipe-sections within 1 mm.
    2) Fitting of an alignment/support bracket to secure the alignment.
    3) Control of the operating length of the compensator.
d) The use of a good quality heat-resistance and high pressure flange-gasket will secure 6-yearly maintenance-free operation of the system.
e) Flange connecting-bolts on high temperature soot-blower systems are verified as higher grade (Gr 8.8).

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f) Supply-steam pipework for the Cold-End side of the Air Heater is fitted with condensate drains and maintenance of the drain control valves must be verified by the Air Heater maintenance team.
g) Some Stations are fitted with a purge-facility on the CE-side Steam Supply pipeline in order to ensure the CE-side steam piping remains hot & dry in order to reduce condensation.
h) The purge-facility is fed with hot air tapped from the Hot Secondary Air ducting, and guided into the CE-side Steam supply pipe-line and is fitted with a Non Return Valve that is shut when the steam-blowing cycle is operated.
i) Typical maintenance points and intervals that are to be managed are as follows:
    1) Cleaning/servicing of the Non Return Valve – 3 yearly inspection.
    2) Pipe-line inspection for erosion or perforation – 3 yearly pressure test.
    3) For the gas-path exposed pipeline, erosion protection channel is to be fitted.

3.8.3 Steam supply piping centre (rotating) thermal compensator

a) Rotating thermal compensators are applicable on the Top/Bottom centre-distribution support column, and can be of the steel-bellows type that require a replacement philosophy of 3 up to a maximum of 6 years, providing that installation lengths and alignment is done to the compensator specifications.
b) Acceptable alignment is to be verified and reported with installation, and should not be more than 5 mm TIR.
c) The clear identification of fatigue in the bellows-type compensator is difficult, and a scheduled 3-yearly replacement philosophy is recommended to avoid un-timely failures of the soot-blower system.
d) The thermal compensators can be of a special – piston & sleeve design with superior 6-year life-expectation, but reliable and exact installation is required in order to secure the operating life:
    1) Alignment of the connecting pipe-sections within 5 mm TIR accuracy.
    2) Control of the operating length of the compensator and adjustment of connecting flanges to secure piston penetration within suppliers drawing specification.
    3) 3 yearly inspection on the condition of sealing/sliding-rings as well as piston rings.
e) The use of a good quality heat-resistance and high pressure flange gasket will secure 6-yearly maintenance-free operation of the system.
f) Flange connecting-bolts on high temperature soot-blower systems are verified as higher grade (Gr 8.8).
g) Alignment adjustment is facilitated by means of shimming the centre support column bolt-interface to the main shaft.
    The centre-compensator is combined with a water-distribution manifold, installed directly below the compensator, and maintenance activities must be integrated (eg. stripping of the “manifold” requires removal of the compensator) – refer to the fire protection system for details on the Manifold maintenance.

3.8.4 Indexing actuator and striker-plate support/control arm

a) The external components are inspected for wear and abnormal condition, with daily plant inspections.
b) It is essential to monitor and report on the system – while in operation - on a monthly basis, for deficiencies and includes the following aspects:
    1) Positive engagement and movement to the stops.
    2) Abnormal noise emission with stop/start cut-off of the supply steam.
    3) Verification and recording of the correct steam supply pressure.
    4) Abnormal movement (kick-back) of the actuating rod.
    5) Condition of shaft-protecting compensators/boots.
    6) Verification of switching to individual soot-blower headers.
    7) Timing alignment of the indexer valve spool with housing ports.
c) The internal components are inspected for wear and abnormal condition, on 18-monthly intervals, with expected repairs generally scheduled on 3-yearly intervals.

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1) Condition and setting verification is required on the following components:
2) Control push/pull rod free movement or damage.
3) Striker plate support mechanism with hinge pins.
4) Striker plate wear-condition and overlap adjustment with the Indexer valve drive-sprocket.

d) Electric actuator stroking is verified and executed by C&I department, and facilitated with the complete and correct mechanical adjustment/location of external mechanical stops.

3.8.5 Indexer valve system (GV, TT, MT, MJ)

a) Specific installation on one Unit (2) at Duvha was installed on a test-basis.
b) Steam is provided through the aforementioned components into the Rotating indexer valve.
c) Indexer valves and steam distribution pipes with header/nozzles are maintenance intensive on 3 yearly basis as damage is caused through leaking steam, rotating/sliding wear and ash-erosion. The monitored and reporting aspects are as follows:
   1) Paddle to Sprocket alignment and wear.
   2) Rotating sprocket, and steam plug mounting with slide-bearings – free movement.
   3) Steam plug (spool) labyrinth seal – leakage and erosion damage.
   4) Valve steam-outlets with flange–gaskets and erosion protection.
   5) Steam supply pipes to nozzle headers with supports, erosion protection and flange gaskets.
   6) Steam headers and nozzles – nozzle damage, erosion and fitting alignment.
d) Indexer valve mechanical stroking is required internally and is set up before start-up with the following specific verifications required:
   1) The correct location for position indicators, and to be visible for on-line monitoring.
   2) Adjustment of the drive-sprocket bolting slots in order to align the parking position of the drive-sprocket with each indexing rotation.
   3) Synchronisation with the 40 mm striker plate overlap on the drive sprocket (paddle wheel), and external stops.
e) Completed Mechanical stroking facilitates C&I adjustment of the controlling actuator from the outside with the external stops as guide. The Mechanical contractor must ensure that the internal overlap, and external tops are set-up and provides a clear indication where stop limits must be adjusted.
f) Clean working conditions are to be secured and verified when reverting to in-situ inspections and/or replacement of the steam supply piping/components.
g) The condition Assessment and Refurbishment of the Indexer valve components shall be documented, in order to ensure that the appropriate repair-aspects are identified and controlled. The following critical areas shall be included:
   1) Body & flange erosion and steam-blow damage.
   2) Body top face mounting interface for bearing/bonnet – bolt-tapping damage.
   3) Correct application of bonnet attachment studs.
   4) Labyrinth seal damage and replacement.
   5) Wear ring (bearing) condition and replacement.
   6) Spool (plug) damage on body, wear rings and stub-shaft.

3.8.6 Reciprocating system (HD, KR, DV)

a) The swivel – bush and pin – components facilitating the reciprocating movement is inspected and repaired on 3-yearly basis, and the same applies to the activating sprocket (Spider wheel).
b) The internal activating paddle (striker plate) with supporting column is subject to the same maintenance and checks as for the Rotary valve system.
c) The steam supply piping with swivel (moveable) functionality is facilitated through various designs, and the following aspects require verification and maintenance on 18-monthly intervals:
   1) Flexible hose design requires replacement.
   2) A bush and swivel arm system requires inspection and worn bush replacement.
   3) Correct alignment of the system, that considers the effects of thermal expansion.
   4) All system lay-outs require accurate alignment with the Striker-plate column.

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d) Steam-supply piping, penetrating through the rotating hood wall is guided with minimal clearance in order to eliminate air-leakage erosion of piping.
e) Reciprocating nozzles are inspected and replaced when worn. Designs incorporating weld-on nozzles are reviewed, and recommended for screw-on replacements.

3.8.7 Low pressure washing facility

a) Some plant is fitted with a low pressure water washing facility for the element packs – Matimba & Majuba.

b) The facility incorporates a connection of fire-water supply into the Soot-blower steam supply piping.

c) The system must be utilised for effective “wetting” of element packs to prepare for high-pressure washing or where “flushing” of the element packs is required in the case where Boiler economiser tubes are located in the gas path above the Air Heater and is subject to ash deposits into the elements.

3.9 FIRE DETECTION AND PROTECTION SYSTEMS

3.9.1 Fire detection system

a) Internal to Air Heater components are the temperature measuring thermocouples with erosion protection shields, requiring 3-yearly maintenance.
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 too elaborate as to shield the thermocouple from sensing the heat with limited delay. An up-stream screen with “open” downstream thermocouple shield ensures sufficient exposure.
   2) The length of the erosion/protection tube must be co-ordinated with the standard installation protrusion in order to ensure maximum wear-life for the probe.
d) Systems with “local” temperature indications are monitored for functionality of measurement accuracy and alarm-activating relays on 18-monthly intervals.
e) In terms of Air Heater Fire Protection requirements, the Unit start-up temperature deviations must be incorporated into alarming functions and requires intensive monitoring.

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 but it remains the responsibility of the Air Heater maintenance team to ensure correct functionality is tested and declared.
b) External water supply pressure Control and Isolation valves are subject to failure (leakage) and such incident occurring during Unit/Air Heater operation can be undetected. The fitting of a leakage tell-tale valve – downstream from the main valves – is to be recommended, and is to be monitored during operation on a daily basis.
c) Internal water supply piping is guided through the Gas-flow ducting and must be inspected for erosion, and protected if erosion is evident.

3.9.3 Fire water: air-side distribution piping

a) Water reticulation piping into the Hot-End Air-path is guided through the centre column – shaft extension.

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b) Water is transferred from the stationery supply-piping to the Rotating hoods via a Centre-casting (manifold), which is subject to wear and replacement at 6 yearly intervals, providing correct installation is followed. Controlling aspects are as follows:
   1) Allowance on installation for approximately 30 mm of main shaft thermal movement.
   2) The Centre-casting is sealed and seated on a shaft-collar and subject to wear – wear is limited through correct installation. Any obstruction in the installation to follow the thermal movement of the main shaft will result in accelerated wear of the casting.
   3) The centre casting bolt-on interfaces are mirrored, thus it can be turned to operate on the opposite side (similar to the drive pinion that is turned for a “second wear-life”), providing that the wear on the seat was limited to a 10 mm depth.
   4) The centre-casting rotation is driven through externally mounted brackets, and installation of the drive must be verified to facilitate the upward movement (due to shaft expansion) of the casting.
   5) Water supply piping attached to the Centre-casting must facilitate unconstrained upward movement of the casting through flexible compensators or alternative means.
   6) If fitted with thermal compensators – the replacement interval of 12 years is recommended, pending correct installation.
   7) The stripping and replacement maintenance of the Centre-casting is coordinated with inspection and replacement of the Soot-blower system Centre compensator, as it has to be stripped-out for centre-casting removal.
c) The internal to Hood Piping and Nozzles are inspected and reported for erosion (especially close to the leading edge of the hoods).
d) Bi-sector Air Heaters with an internal Primary sector (Duvha & Tutuka) is fitted with a flow-leakage prevention Rupture disc. The rupture disc prevents air-flow through the water piping due to the higher pressure in the Primary sector, and must be removed/installed when system testing is performed.

3.9.4 Fire water: gas-side distribution piping

a) Water reticulation piping in the Hot-End Gas-path is subject to “directional” erosion. Erosion patterns must be analysed and protection screening must be fitted and maintained on 3 yearly intervals.
b) Erosion protection design will be repeatable between units and must be recorded on the erosion protection drawings for materials planning and implementation – refer to the applicable section on Erosion protection.
c) Nozzles blockage is normal on the gas-side, and must be cleared frequently on 18 monthly intervals.

3.9.5 Casing drainage for fire-fighting water

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

b) Observation of a tendency of drains to block must be reported for rectification of the design.

3.9.6 Fire-fighting system hardware testing - notes

a) Functional testing of the Fire-fighting system is mandatory and is facilitated during element pack washing events or if washing is not executed, minimum 6 yearly testing must be scheduled.
b) During testing, the following aspects are specifically verified:
   1) Internal inspection for missed points of leakage.
   2) Exercising of isolating valves.
   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 with outage SOW.

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3.9.7 Fire-fighting procedure and system

a) Each individual Station must possess of a dedicated Fire-fighting procedure, identifying reporting, management and activating points
b) Maintenance crews are to familiarise themselves with the content, specifically on reporting 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, and the exact recording of the existence, wear-condition and effectiveness of protecting elements, and replacement recommendation.
c) Visual inspection is executed during the initial walkthrough assessment, with a follow-up thickness verification where applicable, in order to table a complete scope of work during the Scope review meeting.

3.10.2 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, and where possible (more desirable) for 6-yearly interventions.
b) The designed/proven repair methods and recommended materials are documented on drawings. 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 gets damaged anyway with rapid depletion of width.
    5) High erosion rates are countered with the use of thicker materials rather than exotic materials if the desired wear-life can be achieved.
    6) Overlay (patch) repairs are used for repeatable erosion patterns, requiring frequently replaceable protection layers.
    7) Insert (window) repairs are used when the original structure was damaged, either through slow undetected erosion or failure of delayed repairs to overlay protection.
    8) As far as possible – leakage erosion is not only addressed through protection elements but through route cause analysis and elimination of source.
c) Drawings 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:
    1) Weld quality is managed to the required standard, and weld quantity is established to prevent detachment through erosion.
    2) Direct welding onto protected members is preferred with weld-position such that welds are not subject to erosion.
    3) As opposing/contradicting requirement – welds are not positioned to 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.

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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 – in order to reduce the chance of dislodging eroded sections.

3.10.3 Minimum reference list of known repair areas

a) Transition duct peripheral casing liner.
b) Transition duct peripheral flange (top & bottom).
c) Transition duct flange periphery flat bar (top & bottom).
d) Secondary Air ducting facing inlet gas-flow area.
e) Steam supply pipe in flue gas transition duct (top &bottom).
f) Fire water supply pipe in flue gas transition duct.
g) Fire water supply ring in flue gas transition duct.
h) Fire water downpipes to nozzle.
i) Soot-blower piping in flue gas transition duct.
j) Soot-blower piping on reticulation to steam header/nozzles.
k) Soot-blower piping bends internal erosion.
l) Indexer valve outlets.
m) Soot-blower headers.
n) Inside hood leading edge areas/stays.
o) Seal frame articulation joint leakage gaps protecting the stainless Steel sleeve compensators.
p) Top hood areas.
q) Thermal compensators and threaded rod-ends.
r) Hood periphery spring pins penetrating through hoods.
s) Fire detection thermocouples and leakage monitoring instruments.

3.11 INSTRUMENTATION

Reference is made to the Draught Plant “Minimum Protection Requirements” applicable to Air Heaters.

The purpose with listing the critical instrumentation is to:

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

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

Air Heater maintenance personnel are prompted for deliberate actions to test and verify the accurate functioning of instrumentation in order to facilitate the condition and performance assessment of the machine.

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 asset to verify and maintain, as it is used in conjunction with the outlet Oxygen increase measurement, in order 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 cautiously verified for stable performance, as the heavy mechanical maintenance works can damage critical instrumentation.

c) Fire detection thermocouples – erosion protection details were stipulated with re-commissioning care to verify correct installation and operation accuracy is required.

d) Bearing wear is only applicable to Pad-type bearings and functionality is to be proven especially after heavy maintenance works and water washing. On-load correction I not possible.

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e) Bearing temperature measurement housed in the bearing compartments justifies critical verification of functionality before closing the bearing compartment and hood doors. On-load replacement is not possible.

f) Lubrication system pressure/flow/temperature – inherent critical verification is required to prevent spurious trips or possible component damage.

g) Dew-point control is dependent on Condition monitoring temperature instrumentation. Erosion protection and accuracy verification is important – incorrect dew-point control plant and instrumentation presents no direct load-loss but is a “silent killer” until air Heater blockage surfaces with major load-loss costs.

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.

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 element packs cause major life-affecting damage to element packs and Rotor structure and must be avoided.

d. Outlet oxygen measurement – This is the verification of “on-line” leakage, and affects analysis of root-cause for process changes.

3.12 SPARES AND MANAGEMENT OF SPARES BOM

a) Management of Spares requires the dedicated effort of continual improvement of the details, in order to secure effective execution of Maintenance.

b) Spares lists are to be structured in accordance to plant layout 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, resulting from operational changes, prolonged operational periods, and the interrelated effect of failures, Spares-holding 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 extreme exaggeration of 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 list, and to confirm the spares BOM, after evaluating the Scope submission.

4. INSPECTION AND TESTING

4.1 ONLINE INSPECTION

4.1.1 Plant-walk verification

The aspects to be monitored with daily/weekly plant walks are important reporting points to flag failure, detect early signs of failure and the monitoring of changing process conditions and are summarised as noted below:

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Recording and reporting of observations is made to Maintenance personnel, and load-affecting deficiencies are elevated to the System Engineer.

a) Sealing gaps evaluation and feedback is recorded

   1) Sealing gaps are assessed and act as feedback for the Seal Setting Schedule optimisation

   2) Seal wear – drastic changes in seal thickness is reported and are direct signs of sealing/setting malfunction or indication of process anomalies.

   3) Broken seals are detected with evident severe leakage and reported for performance analysis and urgent repair actions.

   4) Nut gaps are normally stipulated to allow for additional sealing frame movement or the bedding-in of newly set seals. Deviation from zero nut gaps must be reported.

   5) Severe increase of periphery leakage is evident of failure on Stainless steel compensators and must be reported for repair intervention planning.

b) 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

   3) Seal rubbing noises or internal “thumping” noises are clearly audible and should prompt for further investigation.

c) Motor drive-amps recorded and reported for variation.

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

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

f) Drive system vibrations are not specifically monitored on any system, but subjective observation is reported for further investigation.

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

4.1.2 Operational assessment and incidents

Some machines are adversely affected when exposed to process of system excursions.

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

Inspections are also aimed at identifying, recording and reporting of plant-affecting incidents.

a) Operational assessment

   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 provides an irreversible upward spiralling of plant damage if left unchecked.

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

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4) All of the above aspects are early identifiers of performance affecting 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 from the start-up condition and therefor justifies intensive observation and 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 of seal wear.

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

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

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, containing effective reporting for trending, and flagging of anomalies of critical failures.

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

c) A comprehensive 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 handover to Eskom at termination.

4.2 OUTAGE CONDITION AND SOW INSPECTION DOCUMENTATION

4.2.1 Preventative replacement SOW

a) The Employer System Engineer compiles and submits the basic Scope of Work, based on known life-cycles 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 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 scope, thus requiring some verification and update of the actual scope after the inspection phase.

4.2.2 Compulsory Inspection/assessment

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

1) The Contractor’s key experienced personnel conducts and reports on inspections.

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2) The initial visual walk-through inspection is performed with the involvement of the Employers 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.

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 and documented by the Contractor.

5) The inspection is guided by a pre-formulated document, ensuring that all possible visual damage is assessed and reported in walkthrough 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, detailing what is measured, measured results, reference specification, and recommended actions.

3) Complex inspection results (such as shaft or hood alignments), requiring an increase of Scope is analysed by the Contractors 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 Scope of Work – Referred to 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 and Quality Control documentation.

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

1) Stator level, shaft- and hood alignment.

2) Seal frame incorporating expansion joints, articulation joints, control rods and the cast iron wear seal fixing point & condition with appropriate gaps & thickness.

3) Measured collar seal, and rubbing ring condition, incorporating hood and seal-housing alignments.

4) Measured seal setting springs, rods, nuts, and thermal compensator status with proposed setting adjustment.

5) Measured Drive pinion and pin-rack installation and wear condition.

6) Main and auxiliary drive couplings, gearbox external and output pinion bearings.

7) Bearing compartment, including bearings, lubrication system, bearing wear limit indicator (where applicable) and insulation.

8) Fire-fighting system, incorporating internal reticulation, water supply line compensators and nozzles.

9) Soot-blower system, incorporating pipeline wall-thickness survey, compensators, distribution mechanism/valve visual with headers/nozzles, activation mechanism (striker), and pipeline purge system.

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10) Erosion wear condition with check-sheet covering all areas requiring repair and protection. The purpose of the erosion protection approach shall be to prevent erosion damage to structural- and other components.

11) Stator and element-pack condition, incorporating pack supports, radial plates, periphery flange, and element pack sampling to establish the wear condition/remnant life, and general condition of element packs and support system.

12) Casing condition incorporating external casing, internal hoods, access platforms & ladders, doors, and door seals, turning vanes, structure supports.

13) External lubrication system incorporating the supply & return piping.

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 as follows:

- Bearing wear condition.
- Piston-type compensators.
- Element pack wear sampling.

2) The condition and recommended replacement 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 is a key element with providing the assurance of reliable RTS performance.

b) The following aspects are designed for implementing continuous improvement to processes and performance (ISO 9001).

c) 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.

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

e) The key mandatory management activities to provide the above assurance 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) Post mortem consolidation meeting.

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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 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.
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 intervention.
g) The method of consolidating small inspection points into one witness (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.

4.3 DOCUMENTATION OF PROOF TESTS AND INSPECTIONS

4.3.1 Important "proof of functioning or compliance" tests

The mandatory tests and verifications are documented and submitted for acceptance/approval are as follows:

a) Element pack wear analysis and trending.

b) Fire-fighting system testing.

c) Cold Seal setting verification/proof.

d) Soot-blower function and stroking.

e) Final inspection, inner door closing verification and sign-off.

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

g) Hot seal setting verification and review of setting.

h) Air Heater Leakage testing and trending.

i) Element pack differential pressure and trending on comparable flow/operating conditions.

4.3.2 Document acceptance requirements

The relevant Power Station shall maintain records that certify that 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) Results of the tests and inspections.

e) Actions recommended for rectification.

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5. AUTHORISATION

This document was reviewed and accepted by:

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6. REVISIONS

Date	Rev.	Compiler	Remarks
March 2019	0	W. Garnett-Bennett	Defined the minimum Boiler “Rotating hood” type Air Heater Maintenance requirements for fossil fired boilers in Eskom
September 2019	0.1	W. Garnett-Bennett	Draft under development for review
April 2020	0.2	W. Garnett-Bennett	Final Draft version for implementation
April 2020	1	W. Garnett-Bennett	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

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