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1. INTRODUCTION

Infrastructure associated with power plant generation equipment is complex and expensive. Protecting this infrastructure from destructive corrosion and other failure modes during system lay-up is a critical concern for future reliability.

Of principal concern are mechanical, electrical, water handling systems and the combination of materials associated with these systems all of which require a concise approach to predict and control the failure mode. Failure of these components occurs for a number of reasons within an idle plant. In an idle condition, plants and associated equipment are subject to temperature fluctuations, water condensation and other conditions that cause failure to occur. Under certain combinations of conditions, deterioration can be very rapid. Adequate control is therefore required to prevent any problems from occurring on the plant.

The preservation measures required for each storage period can differ significantly and it is therefore of vital importance to determine the storage period before following a storage regime. In addition, should the situation change and, for example, a unit that originally was placed in cold-reserve is required to be preserved / stored then the relevant measures must be re-initiated.

No matter which type of storage method is selected, a certain amount of financial outlay will be required.

2. SUPPORTING CLAUSES

2.1 SCOPE

It is expected that, for any given unit(s) being placed in preservation, a detailed procedure shall be compiled by the power station engineering team. This procedure should be designed for each specific unit and it's associated draught plant based on an evaluation of the considerations detailed in Section 3.

Should the power station team require assistance in compiling these procedures, this will be provided by PEI Draught Plant. The scope of this guideline is as follows:

i. Air pre-heaters
ii. Draught Group gas and air passes, ductwork, hoppers, dampers and fans
iii. Draught Group associated electric motors

Where possible, reference to existing Eskom documents will be made.

2.1.1 Purpose

The prime reason for preserving power plant is to conserve existing assets, with a view to using them in the future. These assets must be preserved in an operating condition otherwise the plant will deteriorate thereby increasing life cycle costs. In order to achieve cost-effective preservation of plant, the protective measures to be taken must be determined by the length of the storage period.

2.1.2 Applicability

This document shall apply to all Eskom Holdings Limited Generation Division Fossil Fired Power Stations Draught Groups.

2.2 NORMATIVE/INFORMATIVE REFERENCES

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

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2.2.1 Normative

[1] ISO 9001 Quality Management Systems.

[2] 240-57127944 - Preservation of Power Plants During Shutdowns Guideline

2.2.2 Informative

[1] TRR/S97/126 Plant Storage Methodologies.

2.3 DEFINITIONS

Definition	Description
Approved by	The accountability of the Approver of the document is equivalent to the specified role of Functional Responsible/Owner as identified in 240-53114186 and 32-6 for Documents and Records Management.

2.3.1 Disclosure Classification

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

2.4 ABBREVIATIONS

Abbreviation	Description
PA Fan	Primary Air Fan
FD Fan	Forced Draught Fan
ID Fan	Induced Draught Fan
PEI	Production Engineering Integration

2.5 ROLES AND RESPONSIBILITIES

The Power Station Manager is accountable for assigning roles and responsibilities at his/her station.

The Engineering Manager is responsible for ensuring that the technical guidelines outlined in this document are adapted to include site specific plant design information. The Engineering Manager is responsible for overseeing the long term plant health practices at each power station.

The responsibility for the implementation of this guideline rests with the Boiler Plant Engineering Manager, the Outage Manager, the Maintenance Manager and the Operating staff (or equivalent future designations) at each power station.

2.6 PROCESS FOR MONITORING

The Technical Plant Manager, Outage Manager, the Engineering Manager, the Maintenance Manager and the Operating Manager are responsible for ensuring that station controls are implemented to ensure that the practices outlined in this guideline are incorporated into station specific plant preservation procedures.

The Engineering Manager will co-opt any stakeholders necessary to assist with implementing the revised storage requirements.

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2.7 RELATED/SUPPORTING DOCUMENTS

Not Applicable.

3. DRAUGHT PLANT PRESERVATION STANDARD

Tables 1 to 3 below summarises the key activities before and during planned and/or forced shutdowns to preserve the different plant components associated with the Draught Plant to maximise the long term plant health and to minimise the risk of delays or plant damage during the subsequent return to service.

This guideline should also be implemented during planned shutdowns on plant components and systems that can be suitably preserved whilst not affecting or being impacted by maintenance activities.

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3.1 AIR PREHEATERS

Table 1: Air Preheater Plant Preservation Actions

Air Heater Preservation			Action Time Line									
			Shut Down		Short/Medium Term Shutdown - 3 Months	Long Term/Mothballing Longer than 3 Months after Shutdown						
Equipment	Description	Action	Once Before Shutdown	Once Directly After Shutdown	Monthly	Once After 3 Months	Monthly	Every 3 Months (2200 hrs)	Every 6 Months (4500 hrs)	Every 12 Months (9000 hrs)	Maintained During Storage	Basic Return To Service Actions
All Air Heaters												
	APPLICABLE TO ALL REGENERATIVE AIRHEATERS	A storage log book must be generated for each air heater, containing all relevant data & included the log for periodic checks during storage	X								X	Review log book by Engineering
		Sootblow air heaters continuously with the boiler on load for at least 6hrs before final shutdown steam must be dry	X									
		Subject to engineering assessment regarding ash deposits, fouling etc. If necessary HP water wash the air heater matrix in keeping with standard practice, duration etc.		X								
		If water washing is applicable, dry air heater by running the draught groups for 48 hrs Perform atmospheric moisture tests Continue drying if necessary		X								
		Element plate mass loss & life cycle analysis to be performed		X								

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Equipment	Description	Action	Once Before Shutdown	Once Directly After Shutdown	Monthly	Once After 3 Months	Monthly	Every 3 Months (2200 hrs)	Every 6 Months (4500 hrs)	Every 12 Months (9000 hrs)	Maintained During Storage	Basic Return To Service Actions
Rotating Hood (Rothemuhle) Air Heaters												
	Seal frame assembly hot end	Tighten all spring pin nuts & lift seal frame away from the stator so that there is 5mm clearance between shoes & stator				X						Re-set spring pin assemblies per standard practice
	Seal frame assembly cold end	Leave in original position		X								Re-set spring pin assemblies per standard practice
	Collar seal assemblies, hot & cold end	Release spring tension				X						Re-set spring pin assemblies per standard practice
	Lubrication system	Run lube set for 4hrs Where two electrical pumps are fitted alternate between main & standby Alternate between duplex filters			X							
		Run lube system for 4 hours Take oil sample and analyse Drain lube tanks & store oil Clean lube tanks per standard practice Refill tank with new or stored oil dependant on oil analysis result Replace filters Re-commission lube set & run for 4hrs				X						Drain lube tanks & dispose of storage oil Replace filters Clean lube tanks per standard practice Refill tank with new oil Re-commission lube set per standard procedure including filter change
		Run lube set for 4hrs Where two electrical pumps are fitted alternate between main & standby Alternate between duplex filters					X					
		Replace filters								X		
		Take oil sample & check moisture content after running lub system (replace oil if contaminated)						X				
	Lube oil coolers	Flush water circuit on units with open cooling water systems		X								
		Isolate from CW & oil supply Bypass oil circuit with flexible adaptor pipe Dry cooler & store indoors to OEM requirements				X						Pressure test cooler Reinstate in original position & connect oil & water supply
	Gearbox drive	Grease the exposed drive shaft rolling element bearings until grease escapes				X						Refurbish gearbox and replace gearbox oil
		Re-grease drive shaft bearings							X			
		Check gearbox oil levels			X							
		Check gearbox oil levels					X					
		Take oil sample off gearbox oil & check moisture content						X				

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Equipment	Description	Action	Once Before Shutdown	Once Directly After Shutdown	Monthly	Once After 3 Months	Monthly	Every 3 Months (2200 hrs)	Every 6 Months (4500 hrs)	Every 12 Months (9000 hrs)	Maintained During Storage	Basic Return To Service Actions
		Change gearbox oil								X		
	Sootblower devices (all types)	Isolate from steam supply after final usage Open drains/blow down Ensure free movement				X						Ensure free movement Re-connect steam supply
	Water washing & fire protection devices (all types)	Isolate from water supply after final usage Open drains in lower transition duct				X						Ensure free movement (if applicable) Replace bursting disks Re-connect water supply Close drains
	Routine activity	Start lube set & run until normal oil temperature is reached Rotate air heater hoods & ensure there is no seal contact at any point Minimum 5mm running clearance at HE hub Run air heater for 4 hours					X					
Rotating Matrix (Howden - Ljungstrom) Air Heaters												
	Lube system & bearing lubrication	Run lube set for 4hrs Where two electrical pumps are fitted alternate between main & standby Alternate between duplex filters			X							
		Run lube system for 4 hours Drain lube tanks & discard oil Drain oil from final spur gear housing Clean lube tanks per standard practice Clean final spur gear housing Refill tank and final spur gear housing with new oil Replace filters Re-commission lube set & run for 4hrs				X						Drain lube tanks and final spur gear housing & dispose of storage oil Replace filters Clean lube tanks per standard practice Refill tank and final spur gear housing with new oil Re-commission lube set per standard procedure including filter change
		Run lube set for 4hrs Where two electrical pumps are fitted alternate between main & standby Alternate between duplex filters					X					
		Replace lub oil filters								X		
		Take oil sample & check moisture content						X				

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Equipment	Description	Action	Once Before Shutdown	Once Directly After Shutdown	Monthly	Once After 3 Months	Monthly	Every 3 Months (2200 hrs)	Every 6 Months (4500 hrs)	Every 12 Months (9000 hrs)	Maintained During Storage	Basic Return To Service Actions
	Lube oil coolers	Flush water circuit on units with open cooling water systems		X								
		Isolate from CW & oil supply Bypass oil circuit with flexible adaptor pipe Dry cooler & store indoors to OEM requirements				X						Pressure test cooler Reinstate in original position & connect oil & water supply
	Sootblower devices (all types)	Isolate from steam supply after final usage Open drains/blow down Ensure free movement if design requires				X						Ensure free movement Inspect sootblower for corrosion/erosion damage and replace if required Re-connect steam supply
	Water washing & fire protection devices (all types)	Isolate from water supply after final usage Open drains in lower transition duct Ensure that the fire protection valves are sealing properly				X						Ensure free movement (if applicable) Replace bursting disks Re-connect water supply
	Gearbox drive & coupling	Open coupling & re-grease				X						Refurbish gearbox and replace gearbox oil
		Open coupling & re-grease								X		Replace coupling
		Check gearbox for leaks & oil level (top up oil if required)			X							
		Check gearbox for leaks & oil level (top up oil if required)					X					
	Routine activity	Start lube set Check gearbox oil levels Rotate air heater & ensure there is no seal contact at any point Run air heater for 4 hours			X							
		Start lube set Check gearbox oil levels Rotate air heater & ensure there is no seal contact at any point Run air heater for 4 hours					X					
	Horizontal shaft air heaters	Start lube set Check gearbox oil levels Rotate airheater & ensure there is no seal contact at any point Mark a reference point on rotor and casing Run air heater for 4 hours Stop air heater and sequentially change position with 180 degrees			X							
		Start lube set Check gearbox oil levels Rotate air heater & ensure there is no seal contact at any point Mark a reference point on rotor and casing Run air heater for 4 hours Stop air heater and sequentially change position with 180 degrees					X					

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3.2 FANS (APPLICABLE TO PA, FD AND ID FANS)

Table 2: Fan Preservation Actions

Boiler Fan Preservation			Action Time Line											
			Shut Down		Short/Medium Term Shutdown - 3 Months	Long Term/Mothballing Longer than 3 Months after Shutdown								
Equipment	Description	Action	Once Before Shutdown	Once Directly After Shutdown	Monthly	Once After 3 Months	Weekly	Every 2 Weeks	Monthly	Every 3 Months (2200 hrs)	Every 6 Months (4500 hrs)	Every 12 Months (9000 hrs)	Maintained During Storage	Basic Return To Service Actions
All Boiler Fans														
	APPLICABLE TO ALL BOILER FANS	A storage log book must be generated for each fan, containing all relevant data & including the log for periodic checks during storage	X										X	Review log book by Engineering
		During the last stages of operation the fan DE & NDE vibration signatures must be recorded & stored in the equipment log book	X											Review log book by Engineering
		If the impellers, RVC's etc. have accumulated deposits, these must be removed by sand blasting per standard procedure		X										Review log book by Engineering
		All boiler fans should be routinely subject to full MPI of all exposed welds. Irrespective of records to-date, an MPI base-line must be re-established & the report stored in the log book. Existing test records not older than 18 months, 14000 running hours or 45 starts may be used for the data book.		X										Review log book by Engineering
Centrifugal Fans (PA, FD and ID)														
Couplings														
	Direct drive couplings	Spray all multi discs with aerosol lubricant		X										
		Spray all multi discs with aerosol lubricant			X									
		Remove coupling per standard procedure including match-marking of parts Clean all parts & coat with tectyle or similar preservative coating Store indoors in a labelled packing box Protect exposed fan and motor shaft ends with preservative tape				X								Clean all parts & inspect Replace per standard procedure Re-alignment per standard procedure

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Equipment	Description	Action	Once Before Shutdown	Once Directly After Shutdown	Monthly	Once After 3 Months	Weekly	Every 2 Weeks	Monthly	Every 3 Months (2200 hrs)	Every 6 Months (4500 hrs)	Every 12 Months (9000 hrs)	Maintained During Storage	Basic Return To Service Actions
		Holset Couplings – Remove rubber blocks and preserve as per requirement for rubber including the split" turnol" limited end float rings and the fitted coupling bolts. Marked correctly per fan and location on each individual coupling . All metal surfaces relevant to both the fan and motor coupling (includes the coupling internals voids)protected with tectyle coating.												
		Replace preservative tape on exposed fan and motor shaft ends									X			
		Clean & re-coat coupling parts										X		
	Fluid drive & Jolly-type couplings	Turn both motor and fan connected parts of the coupling a few turns			X									
		Drain oil per standard procedure remove coupling per standard procedure store indoors per OEM requirement				X								Replace per standard procedure Replenish with new oil Realignment per standard procedure
	Fluid drive coupling coolers	Flush and clean water side off cooler if station is using open cooling water system		X										
		Isolate from CW & oil supply dry cooler & store indoors to OEM requirements				X								Reconnect to oil & CW supply
Rotating Assembly														
	Rotating assemblies inside casing, resting on bearings	Unlock and rotate a few turns for pressure fed bearings with lube system running and at least 10 turns for oil ring fed bearings and then lock 180 degrees from current position and relock (locking devices to be designed)			X									Remove locking device
		Unlock and rotate at few turns and then lock 180 degrees from current position and relock (locking devices to be designed)								X				
Casing														
	Fan casing doors	Leave closed				X								
Actuators														
	Actuators	Leave installed to operate controls during first 3 months		X										
		electrically isolate & remove, send to C&I store				X								Replace & re-connect by C&I and re-stroke limits
Flow Control System														
	RVC's	Inspect all moving parts and ensure they are clean & free to move fully open and close to check free movement and leave fully open		X										

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Equipment	Description	Action	Once Before Shutdown	Once Directly After Shutdown	Monthly	Once After 3 Months	Weekly	Every 2 Weeks	Monthly	Every 3 Months (2200 hrs)	Every 6 Months (4500 hrs)	Every 12 Months (9000 hrs)	Maintained During Storage	Basic Return To Service Actions
		Run through full mechanical stroke & return to fully open position during first 3 months			X									
		Apply aerosol lubricant to all internal moving parts fully run open and closed mechanically & lock in full open								X				De-grease all moving parts, Inspect RVC for wear and replace parts as required Full mechanical stroke & calibration with actuator position
	ILD's	Inspect all moving parts and ensure they are clean & free to move fully open and close to check free movement and leave fully open		X										
		Run through full mechanical stroke & return to fully open position during first 3 months			X									
		Apply aerosol lubricant to all internal moving parts fully run open and closed mechanically & lock in full open								X				De-grease all moving parts, inspect ILD for wear and replace parts as required Full mechanical stroke & calibration with actuator position
	RVC & ILD cross shafts & pull rods	Inject all bearings & ball-joints with grease until the grease leaks out				X								
		Inject all bearings & ball-joints with grease until the grease leaks out									X			Clean all bearings and ball joints and re-grease for operation
Fan Bearings														
	All oil pressure fed bearings with white metal sleeves preservation of shaft journal & spherical seat (all white metal surfaces will be considered as expendable)	Jack shaft to unload lower sleeve half & remove sleeves Clean shaft journal & thrust collars & smear with grease Clean white metal surfaces & smear with grease Grease spherical seats Replace sleeves Allow shaft to re-settle on lower sleeve				X								Clean all surfaces Fit new bearing sleeves as per procedure Fill with new oil Inspect oil rings and replace if required
		Jack shaft to unload lower sleeve half & remove sleeves Clean shaft journal & thrust collars & smear with grease Clean white metal surfaces & smear with grease Grease spherical seats Replace sleeves Allow shaft to re-settle on lower sleeve									X			

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	All oil ring lubricated bearings with white metal sleeves	Remove bearing cover and pour 250ml of oil at a slow steady rate into bearing at each oil ring at the top. Drain excess oil from bearing bottom housing sump to maintain correct oil level in bearing Carry out action just before impeller rotation			X									
		Isolate & disconnect cooling water supply Plug CW supply pipes Flush bearing cooling jacket with clean water Jack shaft to unload lower sleeve half & remove sleeves Clean shaft journal & thrust collars & smear with grease Clean white metal surfaces & smear with grease Grease spherical seats Replace sleeves Allow shaft to re-settle on lower sleeve Fit see-through standpipes with sealed cap to CW inlet & outlet Completely fill cooling jacket with corrosion inhibited fluid (100% antifreeze) Mark standpipe levels				X								
		Drain anti freeze Jack shaft to unload lower sleeve half & remove sleeves Clean shaft journal & thrust collars & smear with grease Clean white metal surfaces & smear with grease Grease spherical seats Replace sleeves Allow shaft to re-settle on lower sleeve Refill with antifreeze 100% solution to correct level									X			Remove anti freeze and standpipes Clean all surfaces Replace bearing sleeves as per procedure Inspect oil rings and replace if required Refill with oil Reconnect cooling water pipes
		Check fluid level of antifreeze in standpipe							X					
	Rolling element bearings in oil bath (Wide Range type)	Drain oil, dispose off accordingly and replace oil per standard procedure		X										
		Drain oil, dispose off accordingly and replace oil fill oil level to just below shaft seal				X								
		Drain oil, dispose off accordingly and replace oil fill oil level to just below shaft seal										X		Dismantle bearing assembly, clean & re-assemble Replenish new oil to standard procedure

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	Grease lubricated rolling element bearings	Strip, clean & re-pack with grease per standard procedure		X										
		Strip, clean & re-pack with grease per standard procedure									X			Strip, clean & re-pack with grease per standard procedure
Lubrication Oil Systems														
	All pressure fed lube oil systems (assumes power is available for lube set)	Replace filters		X										
		Replace filters										X		
		Re-start & run lube set on electrical pump for 4hrs Where two electrical pumps are fitted alternate between main & standby pumps Alternate on duplex filters			X									
		Detach oil supply & return pipes from bearings & connect supply pipe directly to the oil tank return line with flexible pipe & adaptor pieces Plug all open connections on the bearings with plastic adapters Re-commission lube set & run for 4hrs				X								Reconnect supply & drain pipes Re-install mechanical oil pump, remove needle valve and replace foot valve and NRV Drain lube tanks & dispose of storage oil Replace filters Clean lube tanks per standard practice Refill tank with flushing oil Re-commission lube set & run for 4hrs Fill with new oil
		Re-start & run lube set on electrical pump for 4hrs Where two electrical pumps are fitted alternate between main & standby pumps Alternate on duplex filters							X					
		Take oil sample & check moisture content								X				
	Mechanical lube oil pumps	Disconnect oil feed & discharge pipes & connect together with a flexible pipe & adaptor pieces Remove suction line foot valve inside tank Remove mechanical pump side discharge non return valve and Replace with needle valve Run electrical pump and set needle valve to ensure flow through both bearings and mechanical pump line back to tank Remove oil pump & store with coupling				X								

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	Lube oil coolers	Isolate from CW & oil supply Bypass oil circuit with flexible adaptor pipe Dry out cooler with dry compressed air & store indoors to OEM requirements				X								Pressure test cooler Replace cooler & reconnect pipes
	Jacking oil pumps	Run jacking oil pumps for 4 hours			X									
		Run jacking oil pumps for 4 hours (KRIEL) connect supply pipe into main lube return line												
Motors														
	Drive motors	Release motor holding bolts Remove motor per standard practice & transfer to Eskom Elec. Store Recommend bearings are treated as per fan bearings				X								Replace per standard practice Re-alignment per standard practice
		Wrap or grease exposed threads that remain on pedestal				X								
		Clean and re-grease/tape pedestal threads								X				
		Install denso tape to cover all open machines surfaces on bases ie motor feet, coupling feet etc. install a cover plate over the denso tape and bolt down				X								
		Remove covers on machined pedestal surfaces. clean all surfaces. Inspect all surfaces for damage and rust and replace denso tape. Re-install cover plates									X			
		Recommend bearings are treated per fan bearings of that type or as per motor OEM specifications				X								

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AXIAL FLOW FANS (FD & ID FANS)														
	Couplings	Apply aerosol lubricant to multi-disks		X										
		Apply aerosol lubricant to multi-disks			X					X				
	Rotating assemblies inside casing, resting on bearings after preservation measures (see below)	Run fan for 4 hrs with all auxiliary systems fully operational blade pitch control set to 10 %			X				X					
	Drive motors	Per prescribed procedure for in-situ storage motor must remain in an operational state												
	Fan casing doors	Lock open & reclose for periodic fan runs			X				X					
	Actuators	Blade pitch control actuator to remain in position & fully functional												
	Blade pitch control pull rods, linkages etc.	Inject all bearings & ball-joints with grease until the grease leaks out		X							X			
	Hydraulic blade pitch control system	Operate pitch control from fully closed to fully open with fan stationary			X				X					
	Bearing lubrication unit	Run lube system for 4 hours			X				X					
	Bearing chamber seal air fans	Run seal air fans for 4 hours			X				X					

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3.3 DUCTING AND DAMPERS

Table 3: Ducting And Damper Preservation Actions

Ducting And Damper Preservation			Action Time Line									
			Shut Down		Short/Medium Term Shutdown - 3 Months	Long Term/Mothballing Longer than 3 Months after Shutdown						
Equipment	Description	Action	Once Before Shutdown	Once Directly After Shutdown	Monthly	Once After 3 Months	Monthly	Every 3 Months (2200 hrs)	Every 6 Months (4500 hrs)	Every 12 Months (9000 hrs)	Maintained During Storage	Basic Return To Service Actions
All Dampers												
		Check for all operating defects	X									
		Clean all dampers		X								
		Repair all defects		X								
		Open and close dampers through full stroke			X							Lubricate and stroke check. Ensure any identified defects are repaired
		Open and close dampers through full stroke					X					Lubricate and stroke check. Ensure any identified defects are repaired
		Visual inspection			X							
		Visual inspection					X					
		Re-lubricate dampers and link arm ball joints							X			
All Ducting												
		Remove ash deposits from the ducting and flues, the walls and floors should be swept with a broom		X								
		Inspect ducting and flues for damage		X								Repair damage
		Inspect for moisture and corrosion						X				Repair damage

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4. AUTHORISATION

This document has been seen and accepted by:

Name & Surname	Designation
Yokesh Singh	Senior Manager PEI
Balin Naicker	Senior Manager PEI Boilers
All	Draught Plant Care Group Members
All	All Fossil Fired Power Station Managers
All	All Fossil Fired Power Station Engineering Managers
All	All Fossil Fired Power Station Boiler Engineering Managers
All	All Fossil Fired Power Station System Engineers

5. REVISIONS

Date	Rev.	Compiler	Remarks
Nov 2017	0.1	NA Rust	Draft Document for review
February 2018	0.2	NA Rust	Document for Formal Business Review Process
April 2018	0.3	NA Rust	Updated Final Draft after Review Process
April 2018	1	NA Rust	Final Document for Authorisation and Publication

6. DEVELOPMENT TEAM

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

- Mike Lander
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- Willy Garnett-Bennett
- Nico Rust

7. ACKNOWLEDGEMENTS

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CONTROLLED DISCLOSURE

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