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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. Without adequate control, plant damage can cause of number of problems.

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. PLANT PRESERVATION

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, or plant system 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 Group Technology. The scope of this guideline is as follows:

i. Air pre-heaters
ii. Boiler pressure parts, main steam pipework, and feed heaters
iii. Boiler gas and air passes, ductwork, hoppers, dampers and fans
iv. Cooling water system (main and secondary)
v. Condensate System
vi. Demineralisation plants
vii. Electric Motors
viii. Feedwater heaters
ix. Feedwater tank
x. Fire Systems
xi. Fuel oil system and burners
xii. Generator and Exciter
xiii. General Oil Systems
xiv. Precipitators, fabric filter plant
xv. Ash/Dust handling plant
xvi. PF plant and coal burners
xvii. Pumps and Valves
xviii. Turbine rotors, cylinders and condensers (steam and feedwater side)
xix. Transformers and Switchgear
xx. Emergency supplies

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The procedure excludes:

i. Mothballing of Units. A site specific works instruction is to be compiled utilising this guideline as a basis with further input from Subject Matter Experts and/or Plant Specialists
ii. Control and service air compressors
iii. H2 plant
iv. Main CW pumps
v. Boiler hydraulic testing

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 throughout Eskom Holdings Limited Generation Division.

2.2 NORMATIVE/INFORMATIVE REFERENCES

Parties using this document shall apply the most recent edition of the documents listed in the following paragraphs. In the case of any contradictions, 240-120844075 will take precedence.

2.2.1 Normative

[1] ISO 9001 Quality Management Systems.

[2] 240-120844075 Chemical Preservation of Power Plant Systems and Components Guideline

[3] 240-56361216, The Control and Management of Moisture Ingress and Leaks in Stators or Large Generators Standard

[4] 240-56535978, Management of Large Generators during Outages and Works Standard

[5] 240-56178527, Requirements for Clean Conditions and Access Control during Manufacture, Maintenance and Refurbishment of Generators Standard

[6] 240-56357281, Lay-up (Mothballing) of Generation Electrical and Process Control Equipment in Power Stations Manual

[7] 240-56358900, Sampling and Testing of Mineral Insulating Oil for Power Transformers Within Generation Division Standard

[8] 240-56358993, Standard for the Maintenance of Power Transformers

[9] 240-56062726, Intrusive Work and Oil Filling, Under Vacuum of Transformers and Reactor On Site Standard

[10] 240-56247004, Thermal Insulation Standard 2016

2.2.2 Informative

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

[12] EPRI 1006756 Fire Protection Equipment Surveillance Optimization and Maintenance Guide
[13] EPRI 1014195 Shutdown Protection of Steam Turbines Using Dehumidified Air

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[14] EPRI 1010437 Cycle Chemistry Guidelines for Shutdown, Layup, and Start-up of Combined Cycle Units with Heat Recovery Steam Generators
[15] EPRI TR-101250 Layup procedures
[16] EPRI 1004925 Cycle chemistry guidelines for fossil plants – oxygenated treatment
[17] EPRI 1011684 Ash Handling System Maintenance Guide
[18] EPRI E213676 Electrostatic Precipitator Maintenance Guide
[19] 240-56244749 FFP Operational Instruction
[20] RWE Npower TECH/PROC/ 006 Part 3 Issue 3 July 2009. The Storage of the Water/Steam Circuits of Generation Plant
[21] EPRI TR-107754 Cycling, Start-up, Shutdown, and Layup Fossil Plant Cycle Chemistry Guidelines for Operators and Chemists — Final Report, August 1998

2.3 DEFINITIONS

Definition	Description
Short-term Shutdown	Planned or Unplanned outage from hours to days to a maximum of one (1) week
Long-term Shutdown	Planned or Unplanned outage from weeks to months to years
Storage	Preservation of plant during Shutdowns

2.3.1 Disclosure Classification

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

2.4 ABBREVIATIONS

Abbreviation	Description
AVT(O)	Oxidizing all-volatile treatment
CW	Cooling water
DC	Direct current
ESP	Electrostatic Precipitator
FFP	Fabric Filter Plant
FGC	Flue Gas Conditioning (typically SO_3)
H_2	Hydrogen
HVAC	Heating, ventilation and air conditioning
OT	Oxygen treatment
PF	Pulverised fuel
SO_3	Sulphur Trioxide

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.

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The responsibility for the implementation of this guideline rests with the Chemical Services Manager, the Turbine Plant Engineering Manager, 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.

If the duration of the shutdown changes from a short duration to a longer duration, the Engineering Manager is responsible for ensuring that the plant preservation guidelines are adapted to reflect the revised plant storage risks. The Engineering Manager will co-opt any stakeholders necessary to assist with implementing the revised storage requirements.

2.7 RELATED/SUPPORTING DOCUMENTS

Not Applicable.

3. PLANT STORAGE GUIDELINE

Tables 1 to 31 below summarises the key activities before and during planned and/or forced shutdowns to preserve different plant components or systems 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 AIRHEATERS

Table 1: Airheater Plant Preservation Actions

	Short-term Shutdown (<7 days)	Long-term Shutdown (>7days)
Before shutdown	Conduct normal airheater sootblowing as late as possible before unit shutdown with dry steam unless other abnormal plant conditions prevent this (**Action** - Operating)	Conduct normal airheater sootblowing as late as possible before unit shutdown with dry steam unless other abnormal plant conditions prevent this (**Action** - Operating)
During shutdown	a) When a heater is removed from service to repair a leaking boiler tube then, if it was contaminated with wet ash. The heater must be properly washed (either high pressure or low pressure water washing depending on severity of blockage) Air heater must be 100% dry before boiler light-up. (**Action** - Maintenance, Outage b) For air heaters using a grease lubrication system (Majuba and Matimba) the grease system must be switched off when the air heaters are not rotating (**Action** - Operating).	a) When a heater is removed from service to repair a leaking boiler tube, then if it was contaminated with wet ash, the heater must be properly washed (either high pressure or low pressure water washing depending on severity of blockage). The air heater must be 100% dry before boiler light-up. (**Action** - Maintenance, Outage management).Maintain in dry condition (**Action** - Maintenance, Outage management). b) The air heater should be rotated for **30 minutes** every **2 weeks**. The lube system must be running during rotation. For horizontal shaft air heaters the heater should be positioned at 180 degrees from previous position to prevent shaft sagging. (**Action** - Operating) c) Weekly moisture measurement (maintain below 60%) (**Action** - Performance and Test) d) Check for oil contamination monthly by sampling from the bottom of the lube tank. (**Action** - Chemical Services) e) During extended shutdown of the air heaters, the lube oil systems should be switched off and only started when the air heaters are rotated (**Action** -Operating) a) For shutdowns longer than 6 months, the lube tanks should be drained and cleaned, de-rusted and refilled with clean oil before RTS. f) To avoid grease spillages it is important that the grease systems must be switched off when the air heaters are not rotating. Applicable to Majuba and Matimba) (**Action** – Operating)

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Potential storage risks which need to be mitigated	a) Stress corrosion cracking due to acidic deposits. b) General corrosion. c) Seizure d) Bearing damage (Brinelling or corrosion) Proper cleaning and drying is essential.

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3.2 FABRIC FILTER PLANT AND PRECIPITATORS

Table 2: Fabric Filter Plant and Precipitator Preservation Actions

	Short-term Shutdown (<7 days)	Long-term Shutdown (>7days)
Before shutdown	**ESPs and FFPs** a) Empty all dust hoppers before unit shutdown unless other abnormal plant conditions prevent this (**Action** - Operating) b) If dust hoppers cannot be emptied by normal operating practices, arrange for vacuuming of dust hoppers or other suitable alternative while the ash is still warm and capable of flowing (**Action** - Operating) c) Avoid de-energising outlet fields of ESP first as the fly ash will impact on the ID fan and cause erosion over time or fan overload (**Action** - Operating) d) The ash removal system should remain in operation until all hoppers are empty in order to prevent bridging and pluggage. (**Action** - Operating) e) Ash hopper heaters should remain on during and after shutdown to prevent the occurrence of condensation (**Action** - Operating) f) Inspect all dust hoppers using installed mechanisms to confirm that they have been emptied (**Action** - Operating) g) The SO3 plant should be purged using the control shut-down procedure. **Action** - Operating) h) All SO_3 plant nozzles are to be removed and cleaned (during shutdown). (**Action** - Maintenance)	**ESPs and FFPs** a) Same as for shutdown duration less than 1 week. b) For ESPs, the plant must be internally washed with high pressure water.

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Table 2: Fabric Filter Plant and Precipitator Preservation Actions (cont'd)

	Short-term Shutdown (<7 days)	Long-term Shutdown (>7days)
Before shutdown	**Electrostatic precipitators** : a) Collection and discharge system rappers and vibrator systems should remain on for two hours after system shutdown to ensure removal of dust build-up and to provide clean internals for subsequent start-up. During this time the ASH/DHP must be in service and removing the ash from the hoppers. (**Action** - Operating) b) Still air tests to be conducted before to the plant being isolated on shutdown. Result to be issued to system engineer. (**Action** - Operating and Maintenance)	**Electrostatic precipitators** : Same as for shutdown duration less than 1 week.
During shutdown	a) Inspect all dust hoppers to confirm that they have been emptied (**Action** - Operating) b) If dust hoppers cannot be emptied by normal operating practices, arrange for vacuuming of dust hoppers or other suitable alternative while the ash is still warm and capable of flowing (**Action** - Operating)	a) Inspect all dust hoppers to confirm that they have been emptied (**Action** - Operating) b) If dust hoppers cannot be emptied by normal operating practices, arrange for vacuuming of dust hoppers or other suitable alternative while the ash is still warm and capable of flowing (**Action** - Operating) Precipitator washing : a) Clean with high pressure potable water (**Action** – Maintenance) b) Increase rate of drying after washing by opening all access doors to allow natural ventilation (**Action** – Maintenance) c) Regular monitoring. (**Action** - Operating)

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Table 3: Fabric Filter Plant and Precipitator Preservation Actions (cont'd)

	Short-term Shutdown (<7 days)	Long-term Shutdown (>7days)
Before shutdown	**Fabric Filter plant** a) Purge the collector with clean (hot when necessary) dry air before allowing the gas temperature to descend below the dew point. *This is generally achieved with the boiler purge.* b) Duvha, Medupi & Kusile units fitted with bag filters should also be coated with lime at least once every 6 months in order to further protect the bags during light-up. This is normally done just before light-up	**Fabric Filter plant** Same as for shutdown duration < 1 week. Close access doors once maintenance activities have been completed to prevent moisture and rain water entering the compartments.
During shutdown	a) Inspect all dust hoppers to confirm that they have been emptied (**Action** - Operating) b) If dust hoppers cannot be emptied by normal operating practices, arrange for vacuuming of dust hoppers or other suitable alternative while the ash is still warm and capable of flowing (**Action** - Operating)	a) Inspect all dust hoppers to confirm that they have been emptied (**Action** - Operating) b) If dust hoppers cannot be emptied by normal operating practices, arrange for vacuuming of dust hoppers or other suitable alternative while the ash is still warm and capable of flowing (**Action** - Operating) Precipitator washing : a) Clean with high pressure potable water (**Action** – Maintenance) b) Increase rate of drying after washing by opening all access doors to allow natural ventilation (**Action** – Maintenance) c) Regular monitoring.
Potential storage risks which need to be mitigated	a) Corrosion due to dew point excursions or incorrect shutdowns b) Condensation which causes blinding of bags c) Over-cleaning of bags d) Dust hopper blockage e) Worn or torn bags f) Moisture or rainwater ingress	

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3.3 BOILERS

For this section, refer to 240-120844075 for more detail.

Table 4: Reheater Plant Preservation Actions

	Short-term Shutdown (<7 days)	**Long-term Shutdown (>7days)**
Before shutdown	a) Confirm shutdown duration (**Action** – Outage Management) b) Moisture evacuation via vacuum drying or forced air drying (**Action** – Operating) c) Confirm if nitrogen is available for preservation (**Action** – Operating)	a) Confirm shutdown duration (**Action** –Outage Management) b) Moisture evacuation via vacuum drying or forced air drying (**Action** – Operating) c) Confirm if nitrogen is available for preservation (**Action** – Operating)
During shutdown	**For shutdowns < 1 week** a) Wet store using 30mg/kg of ammonia solution (**Action** – Operating, Chemical Services) **OR** a) Evacuate moisture by drying reheater tubes as per local procedure and store dry (**Action** – Operating).	**For shutdowns <12 months** AND Nitrogen unavailable AND Moisture evacuation (drying) not possible : a) Wet store using 30mg/kg of ammonia solution (**Action** – Operating, Chemical Services) **OR** For shutdowns <12months AND Moisture evacuation (drying) possible a) Evacuate moisture by drying reheater tubes as per local procedure and store dry (**Action** – Operating). b) Apply hot dry using Munters drier (**Action** – Maintenance) c) Monitor humidity (**Action** – Condition Monitoring) **OR** For shutdowns <12 months AND reheater washing with wet steam not possible AND Moisture evacuation with vacuum not possible. AND nitrogen is available a) Drain the reheater (**Action** – Operating). b) Fill with nitrogen (**Action** – Operating). c) Purge to replace air (**Action** – Operating). d) Maintain nitrogen pressure (**Action** – Operating).
Potential storage risks which need to be mitigated	a) Corrosion b) Scaling c) In all cases where Nitrogen is used, cognisance must be taken of the potential for asphyxiation. A risk assessment per impacted area is required.	

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Table 5: Boiler Plant Chemical Preservation Actions

	Short-term Shutdown (<7 days)	**Long-term Shutdown (>7days)**
Before shutdown	a) Confirm shutdown duration (**Action** – Outage Management) b) Confirm if washing with steam is possible (**Action** – Operating) c) Confirm if moisture evacuation with vacuum is possible (**Action** – Operating) d) Confirm if nitrogen is available for preservation (**Action** – Operating) e) Maintain the same potential (oxidizing / reducing conditions) for shutdown, layup and start-up as during normal operation, i.e., when using AVT(O) or OT, do not add a reducing agent during shutdown. (Only when copper alloys are present in the feedwater system is it appropriate to use AVT(R); during shutdown it is necessary to maintain reducing conditions and keep air out.) a) Keep water and moisture out of steam touched components by maintaining dry conditions during shutdown by rapidly draining during shutdown and, if necessary, adding warm dehumidified air to protect the steam turbine and reheaters.	a) Confirm shutdown duration (**Action** –Outage Management) b) Confirm if washing with steam is possible (**Action** – Operating) c) Confirm if moisture evacuation with vacuum is possible (**Action** – Operating) d) Confirm if nitrogen is available for preservation (**Action** – Operating) e) Maintain the same potential (oxidizing / reducing conditions) for shutdown, layup and start-up as during normal operation, i.e., when using AVT (O) or OT, do not add a reducing agent during shutdown. (Only when copper alloys are present in the feedwater system is it appropriate to use AVT(R); during shutdown it is necessary to maintain reducing conditions and keep air out.) f) Keep water and moisture out of steam touched components by maintaining dry conditions during shutdown by rapidly draining during shutdown and, if necessary, adding warm dehumidified air to protect the steam turbine and reheaters. g) Dry layup methods are preferred for those units on OT (**Action** – Operating, Chemical Services)
During shutdown (emergency shutdown)	If unit will be brought back very quickly (i.e. < 3 days): No additional chemical measures are necessary.	If unit will <u>not</u> be brought back quickly (i.e. > 3 days): Boiler - Either drying or filling with ammonia treated water with pH > 9 Steam path plant – to be air dried (**Action** - Chemical Services)
During shutdown (serious chemistry excursion)	Chemistry excursions are caused by condenser cooling water in-leakage, makeup water contamination, condensate storage tank contamination, improper condensate polisher regeneration. Units without polishers experiencing condenser leaks, regardless of cooling water chemistry characteristics, or subject to contamination from other sources generally should be shut down to protect the evaporators and steam path components	

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	Short-term Shutdown (<7 days)	Long-term Shutdown (>7days)
	a) After a shutdown, a unit drain and clean-up using non-contaminated water treated appropriately with the boiler's chemistry treatment regime (**Action** – Operating, Chemical Services)	
During shutdown	Wet layup The use of wet layup solutions in OT units should generally be restricted to short term protection. a) Inject NH_3 to a pH of 9.5 – this should be done approximately 1 hour before shut down to ensure a homogeneous pH distribution throughout the boiler. Alternatively, for boilers without circulation pumps,, if the boiler was drained and is being refilled, continuous ammonia dosing, whilst filling the boiler, is required For shutdown duration < 5 days AND pressure will be released AND nitrogen is available a) Fill with nitrogen (**Action –** Operating) b) All instances where nitrogen preservation is applied require specific safety consideration due to the risk of asphyxiation.	For shutdown duration < 12 months AND boiler cannot be emptied a) Fill with ammonia solution containing 30mg/kg NH_3 and circulate to achieve a homogenous solution. For shutdown duration > 5 days AND boiler can be emptied AND boiler cannot be completely dried AND nitrogen is available a) Fill and purge boiler with nitrogen if maintenance requirements permit. b) All instances where nitrogen preservation is applied require specific safety consideration due to the risk of asphyxiation. For shutdown duration > 5 days AND boiler can be emptied AND boiler cannot be completely dried AND nitrogen is not available a) Use nitrite and borax as medium for wet storage if maintenance requirements permit. b) Only applicable to areas that can be flushed free of these salts prior to start-up For shutdown duration > 5 days AND boiler can be emptied AND boiler can be completely dried a) Empty boiler from highest temperature and pressure possible
Potential storage risks which need to be mitigated	a) Corrosion b) Scaling	

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3.4 BUILDINGS ROOFS AND CIVIL STRUCTURES

Table 6: Building and Civil Structure Plant Preservation Actions

	Short-term Shutdown (<7 days)	Long-term Shutdown (>7days)
Before shutdown	a) During wet weather season gutter and downpipes must be free of debris (**Action** - Maintenance)	a) During wet weather season gutter and downpipes must be free of debris (**Action** -Maintenance b) Conduct routine maintenance (**Action** -Maintenance) c) Ensure buildings are weather-proof especially during wet weather (**Action** - Maintenance) d) Monitor during each shift for rain ingress which leaks onto plant equipment (**Action** - Operating)
During shutdown	a) Conduct routine maintenance (**Action** -Maintenance) b) Ensure buildings are weather-proof especially during wet weather (**Action** - Maintenance) c) Monitor during each shift for rain ingress which leaks onto plant equipment (**Action** - Operating)	a) Conduct routine maintenance (**Action** -Maintenance) b) Ensure buildings are weather-proof especially during wet weather (**Action** - Maintenance) c) Monitor during each shift for rain ingress which leaks onto plant equipment (**Action** - Operating)
Potential storage risks which need to be mitigated	c) Moisture ingress into electrical, C&I and mechanical equipment d) Corrosion and general degradation of plant equipment	

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3.5 CONDENSER WATERSIDE, CW SYSTEM AND COOLING TOWERS

For this section, refer to 240-120844075 and to table 3.26 for Condenser steam side details.

Table 7: Condenser and Cooling Tower Preservation Actions

	Short-term Shutdown (<=7 days)	Long-term Shutdown (>7days)
Before shutdown	a. Biocide is batch dosed at cooling towers and mixed with main CW pumps (**Action** -Chemical Services) b. Where a Taprogge tube cleaning system is available, it should be used at least two hours before cooling system shut down. The system engineer will confirm the type of ball to be used (**Action** – P&T) c. Collect all Taprogge tube cleaning balls before shut down of the cooling water pumps (Action – Operating)	a. Biocide is batch dosed at cooling towers and mixed with main CW pumps (**Action** -Chemical Services) b. Where a Taprogge tube cleaning system is available, it should be used at least two hours before cooling system shut down. The system engineer will confirm the type of ball to be used (**Action** – P&T) c. Collect all Taprogge tube cleaning balls before shut down of the cooling water pumps (**Action** – Operating)
During shutdown	CW isolation is possible: a) Isolate CW system supply to unit and drain condenser waterbox (**Action** – Operating) b) Open manholes. Inspect and remove debris from tube plates (**Action** – Maintenance) c) Store with manhole covers in open position. (**Action** – Maintenance) d) Conduct condenser high level test just prior to unit return to service (**Action** – Maintenance) CW isolation is not possible: b) Inspect steam space on weekly basis (Action – Operating) c) Plan common side CW shutdown to rectify valve integrity (**Action** – Production, Maintenance, Engineering)	CW isolation is possible: a) Isolate CW system supply to unit and drain condenser waterbox (**Action** – Operating) b) Open manholes. Inspect and remove debris from tube plates (**Action** – Maintenance) c) Wash tubes with potable water within 2 days of opening CW manholes (**Action** – Maintenance) d) Store with manhole covers in open position. (**Action** – Maintenance) e) Conduct condenser high level test just prior to unit return to service (**Action** – Maintenance) CW isolation is not possible: b) Inspect steam space on a weekly basis (Action – Operating) (**Action** – Operating) c) Plan common side CW shutdown to rectify valve integrity (**Action** – Production, Maintenance, Engineering)
Potential storage risks which need to be mitigated	a) General corrosion of condensate system. b) Microbiologically induced corrosion of condenser tubes and Main CW ducts. c) Dezincification.	

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3.6 DAMPERS

Table 8 : Damper Plant Preservation Actions

	Short-term Shutdown (<7 days)	Long-term Shutdown (>7days)
Before shutdown	a) Check for operating defects (**Action** -Operating / Engineering)	b) Check for operating defects (**Action** - Operating / Engineering)
During shutdown		a) Clean (**Action** - Outage management / Operating / Maintenance) b) Clean, repair, stroke check and lubricate (**Action** - Maintenance) c) Monitor visually weekly (**Action** - Operating) d) Stroke damper if unit will be off for more than 30 days and grease damper bearings. (**Action** - Maintenance) e) Check open/close operation monthly and again just before unit start-up. (**Action** - Maintenance)
Potential storage risks which need to be mitigated	a) General corrosion b) Seizure	

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3.7 DEAERATORS AND FEEDWATER TANKS

For this section, refer to 240-120844075 for more detail.

Table 9 : Deaerator or Feedwater Tank Preservation Actions

	Short-term Shutdown (<=14 days)	Long-term Shutdown (>14 days)
Before shutdown	a) Inspect plant for defects such as leaks and malfunctioning valves (**Action** - Operating)	a) Inspect plant for defects (**Action** - Operating)
During shutdown	Wet storage: a) Visual monitoring during shift to check for leaks (**Action** - Operating)	Dry storage: a) Drain the system while hot (**Action** - Operating) b) Open all vents, drains and manholes. (**Action** - Maintenance) c) Ensure complete drainage. (**Action** - Maintenance) d) Store the system dry (**Action -** Operating)
Potential storage risks which need to be mitigated	a) General corrosion b) Pitting of deaerator or feedwater tank shell	

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3.8 DEMINERALISATION PLANTS

For this section, refer to 240-120844075 for more detail.

Table 10 : Demineralisation Plant Preservation Actions

	Short-term Shutdown (<7 days)	Long-term Shutdown (>7days)
Before shutdown	a) When new resins are stored on site and the bag or container is damaged, the resin must be re-bagged immediately. b) The outside storage (subjected to the elements) of new resins should not exceed three days to avoid damage as described in the first paragraph of this heading. c) Freezing, and sudden temperature changes, of resin must be avoided d) Resin must never be stored dry in order to avoid osmotic shock. e) Strong base resins shall be stored at a temperature below 40 °C to prevent chemical degradation and subsequent loss of strong base and total capacities.	
During shutdown	This applies to vessels that are on shutdown or repair New strong cation resins a) For storage periods exceeding 60 days the preferred option is sodium form storage. b) Rinsing of newish strong cation resin stored in the H^+ form for periods exceeding 14 days is essential in order to prevent a pronounced colour throw due to leachable short chain, low cross-linked, soluble sulfonic polystyrene polymers, when the resin is put in service. Weak cation resin a) Is equally stable in both the hydrogen and sodium forms and may be stored in either of these forms for periods exceeding 60 days	
	Weak base anion resin a) May be stored in either the chloride or hydroxide form Strong base anion resins: a) Shall be stored at a temperature below 40°C to prevent chemical degradation. Strong base anion resin that contains a large amount of silica a) It is better to regenerate the strong base resin, in order to remove silica, before storage. b) To convert the hydroxide form resin to the chloride form it is required that four bed volumes of a 5% sodium chloride solution (or 2 BV 10 % NaCl) is passed through the bed. c) Resins in units must ideally be stored in a 10 % sodium chloride solution. This will afford protection against freezing, to –6 °C, and depress micro-organism growth while ensuring that the resins are in a stable salt form. Vessels that are not on shutdown or repair must be stored wet (**Action** – Chemical Services)	
Potential storage risks which need to be mitigated	a) Osmotic shock when resin is dried. b) Freezing, and sudden temperature changes c) Micro-organism growth	

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3.9 ELECTRIC MOTORS

Table 11 : Electric Motor Preservation Actions

	Short-term Shutdown (<7 days)	Long-term Shutdown (>7days)
Before shutdown	Check for defects in SAP (**Action** -Operating / Engineering / Maintenance)	Check for defects in SAP (**Action** -Operating / Engineering / Maintenance)
During shutdown	No action required	a) Leave in situ if it is possible to maintain humidity below 50%. Otherwise remove motor from plant and store in dry, dust free area. (**Action** - Maintenance, t) b) Consider installing heaters for large motors (**Action** – Maintenance / Engineering) c) For LV motors, conduct vibration test before motor is returned to service in case brinelling of bearings has occurred (**Action** –Condition Monitoring) d) Ensure all motor heaters (where installed) remain switched on. (**Action** – Maintenance /Engineering) e) Follow the PM for motors stored in the Store area. (Action – Maintenance). f) Protect all exposed metal parts i.e. shaft extensions & exposed keyways with a suitable protective corrosion inhibitor. (Action – Maintenance) g) Touch up with paint where motors have been scratched to avoid corrosion later developing into rusting and cracking of the components normally happens during rigging. (Action – Maintenance) h) Seal all motor entry points using blanking plates (e.g. terminal boxes, air inlets, and cooler pipes) to exclude water, vermin and any foreign material ingress.(Action – Maintenance) i) Drain water from the water coolers and any residue blown out with compressed air to ensure that the unit is completely dry. Blanked off the inlet and outlet parts to prohibit the ingress of moisture and dust. Action – Operating / Maintenance) j) Maintain oil levels. (Action –

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	Short-term Shutdown (<7 days)	Long-term Shutdown (>7days)
		Maintenance / Operating) k) Ensure bearing journal are maintained with a film of lubricant. (Action – Maintenance) l) Rotate motor shaft, as per site procedure. (Action – Maintenance) m) Perform IR and PI tests. (Action – Maintenance / Engineering.
Upon return		a. Perform vibration analysis on all critical motors with roller element bearings, and action all that are flagged to have high vibrations. Action – Condition Monitoring / Maintenance / Engineering) b. Ensure all blank plates are removed. (Action – Maintenance) c. Perform IR, PI and tan delta tests. (Action – Maintenance / Engineering)
Potential storage risks which need to be mitigated	a) Moisture ingress and corrosion. b) Insulation degradation. c) Fretting d) General and pitting corrosion of cooling tubes due to aggressive deposits and high humidities. e) Bearing brinelling f) Damage during transportation g) Damage to cables; Electrical and C&I	

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3.10 FEEDWATER HEATERS

For this section, refer to 240-120844075 for more detail. **This section is applicable to all heat exchangers and** other **vessels in LP condensate and HP feedheating systems**.

Table 12 : Feedwater Heaters (Short, Medium & Long-Term Shutdown)

<table>
<tr><th colspan="3">Short-term Shutdown (<= 14 days)</th></tr>
<tr><td>Before shutdown</td><td colspan="2">Inspect plant for defects (Action - Operating)</td></tr>
<tr><td rowspan="2">During shutdown</td><td>Header heaters
Vertical Tubesheet heaters with waterbox at the top</td><td>Horizontal Tubesheet heaters
Vertical Tubesheet heaters with waterbox at bottom</td></tr>
<tr><td><u>Tubeside</u>
a) Store wet (Action -Operating)
b) Keep all vents, drains and isolation valves shut (Action - Operating)
c) Visual monitoring during shift to check for leaks (Action - Operating)</td><td><u>Tubeside</u>
a) Store wet (Action -Operating)
b) Keep all vents, drains and isolation valves shut (Action - Operating)
c) Visual monitoring during shift to check for leaks (Action - Operating)</td></tr>
<tr><td colspan="2"><u>Shell side</u>
a) Drain hot and store dry (Action - Operating)
b) Ensure complete drainage (Action - Operating)
c) Keep vents and drains open (Action - Operating)
d) Ensure Flashboxes are dry as well (Action - Operating)</td></tr>
<tr><td>Potential storage risks which need to be mitigated</td><td colspan="2">a) General corrosion
b) Pitting of feedwater heater shell and tubes.</td></tr>
<tr><th colspan="3">Medium-term Shutdown (>14 days and < 4 months)</th></tr>
<tr><td>Before shutdown</td><td colspan="2">Inspect plant for defects (Action - Operating)</td></tr>
<tr><td rowspan="3">During shutdown</td><td>Header heaters
Vertical Tubesheet heaters with waterbox at the top</td><td>Horizontal Tubesheet heaters
Vertical Tubesheet heaters with waterbox at bottom</td></tr>
<tr><td><u>Tube Side</u>
a) Increase ammonia dosing by 25% prior to shutting down (Action – Chemical Services)
b) Store wet (Action -Operating)
c) Maintain the tube side full (Action - Operating)
d) Keep all vents, drains and isolation valves shut (Action - Operating)
e) Visual monitoring during shift to check for leaks (Action - Operating)</td><td><u>Tubeside</u>
a) Drain the system while hot (Action - Operating)
b) Ensure complete drainage. (Action - Operating)
c) Keep all vents, drains and isolation valves (Action - Operating)
d) Store the system dry (Action - Operating)</td></tr>
<tr><td colspan="2"><u>Shell side</u>
a) Drain hot and store dry (Action - Operating)
b) Ensure complete drainage (Action - Operating)
c) Keep vents and drains open (Action - Operating)</td></tr>
</table>

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<table>
<tr><td></td><td colspan="2">d) Ensure Flashboxes are dry as well (Action - Operating)</td></tr>
<tr><td>Potential storage risks which need to be mitigated</td><td colspan="2">a) General corrosion
b) Pitting of feedwater heater shell and tubes.</td></tr>
<tr><td colspan="3">Long-term Shutdown (>4 months)</td></tr>
<tr><td>Before shutdown</td><td colspan="2">Inspect plant for defects (Action - Operating)</td></tr>
<tr><td rowspan="3">During shutdown</td><td>Header heaters
Vertical Tubesheet heaters with waterbox at the top</td><td>Horizontal Tubesheet heaters
Vertical Tubesheet heaters with waterbox at bottom</td></tr>
<tr><td><u>Tube Side</u>
a) Isolate water side and drain (Action - Operating)
b) Pressurise tube side and ensure that tight isolation can be obtained, refurbish valves as required and plug defective tubes (Action – Operating and Maintenance)
c) Pull vacuum to 10kPa (a) with suitable vacuum pump (Action – Maintenance)
d) Whilst under vacuum inject nitrogen to a pressure of 40kPa above atmosphere (Action – Maintenance)
e) Monitor N_2 pressure weekly and top-up as required (Action – Operating)</td><td><u>Tube Side</u>
a) Drain the system while hot (Action - Operating)
b) Ensure complete drainage. (Action - Operating)
c) Keep all vents, drains and isolation valves (Action - Operating)
d) Store the system dry (Action - Operating)</td></tr>
<tr><td colspan="2"><u>Shell side</u>
a) Drain hot and store dry (Action - Operating)
b) Ensure complete drainage (Action - Operating)
c) Keep vents and drains open (Action - Operating)
d) Ensure Flashboxes are dry as well (Action - Operating)</td></tr>
<tr><td>Potential storage risks which need to be mitigated</td><td colspan="2">a) General corrosion.
b) Pitting of feedwater heater shell and tubes.</td></tr>
</table>

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

Table 13 : Fan Preservation Actions

	Short-term Shutdown (<7 days)	Long-term Shutdown (>7days)
Before shutdown	a) Check fan vibrations (**Action** - Condition Monitoring)	a) Check fan vibrations (**Action** - Condition Monitoring)
During shutdown		a) Vane control gear - operate monthly if unit will be off for more than 30 days. (**Action** - Operating) b) Check oil samples monthly for contamination. Sample from the bottom of the lube tank. (**Action** -Chemical Services or Condition Monitoring) c) During extended shutdown of the fan, all lube oil systems should be started at least once every two weeks and run for 30 minutes to maintain an oil film on all bearing surfaces. (**Action** – Operating) d) For shutdowns longer than 6 months, the lube tanks should be drained and cleaned, de-rusted and refilled with clean oil before RTS. e) For axial fans, the impeller should be rotated a few turns monthly with lube system running to ensure proper lubrication of the bearings. (**Action** – Operating) f) For axial fans, the hydraulic pitch control system should be operated monthly to ensure proper lubrication and movement. (**Action** – Operating) g) For all centrifugal fans the impellers must be rotated a few turns and stopped with the impeller positioned 180° from previous position. This must be performed once a month to prevent shaft bending. The lube oil systems (and jacking oil systems, where applicable) must be in operation before the impellers are turned. (**Action** – Operating and maintenance) h) Prior to rotating the impellers, approximately 150ml oil should be poured into the **motor** bearing liner to prevent possible oil starvation during rotation. (**Action** – Operating and

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	Short-term Shutdown (<7 days)	Long-term Shutdown (>7days)
		maintenance) i) For all centrifugal fans with oil ring bearing lubrication, the impellers should be rotated for a minimum of 10 rotations before stopping the impeller at the 180 degree position to maintain an oil film on the journal. Prior to rotating the impellers, approximately 150ml oil should be poured onto the bearing through the bearing casing filler plug to prevent possible oil starvation during rotation start.(**Action** – Operating and maintenance) j) At the start of the shutdown, open grid couplings and ensure sufficiently lubricated to prevent corrosion. Close coupling.
Potential storage risks which need to be mitigated	a) General corrosion and seizure. b) Corrosion and distortion of shaft and journal. c) Fretting due to vibration from adjoining units.	

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3.12 FIRE SYSTEMS

For this section, refer to 240-54937454 Inspection, Testing and Maintenance of Fire Protection Systems and 240-56737654 Inspection, Testing and Maintenance of Fire Detection Systems for more details of the activities required on the fire systems.

Notes:

1. Fire Systems should not be put into preservation without full risk assessment and impairment process being followed.
2. Only in exceptional instances where all ignition ***and*** fuel sources were removed, may the system be drained and preserved; else it should remain in normal operation. Even in these exceptional cases where the fire system is deemed to be not required and then isolated, stored and preserved, additional temporary measures should be provided such as portable fire extinguishers as determined during risk assessment

Table 14 : Fire System Preservation Actions

	Short-term Shutdown (<7 days)	Long-term Shutdown (>7days)
Before shutdown	Continue routine PM's (**Action** - Maintenance, Operating).	Continue routine PM's (**Action** - Maintenance, Operating).
During shutdown	Continue routine PM's (**Action** - Maintenance, Operating). Strictly avoid the use of fire water for non-fire applications.	a) Continue routine PM's (**Action** - Maintenance, Operating). Strictly avoid the use of fire water for non-fire applications.
Potential storage risks which need to be mitigated	a) Leaving primary plant without adequate protection should be prevented by ensuring the availability of adequate fire protection at all times and not impair the system. b) If the fire system is impaired and taken out of service, it should be stored drained. Prior to returning the system to service, the control valves should be refurbished. The fire system should be fully re-commissioned when brought back into service (similar to a new installation). Re-commissioning should include flushing, pressure and leak tests, and fully flow tested to confirm functionality of the system.	

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3.13 FUEL OIL SYSTEM AND BURNERS

Table 15 : Fuel Oil System and Burner Preservation Actions

	Short-term Shutdown (<7 days)	Long-term Shutdown (>7days)
Before shutdown	a) Fuel oil heating systems kept on. (**Action** - Operating) b) Recirculate from burner to tank (**Action** - Operating)	c) Fuel oil heating systems kept on. (**Action** - Operating) a) Recirculate from burner to tank (**Action** - Operating)
During shutdown	a) Allow hot fuel oil to gravity drain from burner to bulk storage tank (**Action** - Operating)	a) Fuel oil lines to be gravity drained, flush with diesoline until clear. Where available, and on FO150 systems, flushing with diesel to be carried out. Air purge and isolate. (**Action** - Operating, Maintenance, Outage Management) b) Fuel oil heaters must be isolated when fuel oil flow is stopped (**Action** - Operating) **Extended storage > 3 months** a) Dependant on plant configuration, empty and clean bulk fuel oil tanks to avoid fuel oil quality deterioration.
Potential storage risks which need to be mitigated	a) Fuel oil quality deterioration b) Sludge build-up	

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3.14 GENERAL OIL SYSTEMS

For this section, refer to 240-120844075 for more detail.

Table 16 : General Oil System Preservation Actions

	Short-term Shutdown (<7 days)	Long-term Shutdown (>7days)
Before shutdown	Inspect plant for defects (**Action** - Operating)	Inspect plant for defects (**Action** - Operating)
During shutdown	a) Circulate oil systems (**Action** - Operating) b) Weekly monitoring for water and microbiological quality. (**Action** - Chemical Services, Condition Monitoring)	a) Circulate oil systems (**Action** - Operating) b) Weekly monitoring for water and microbiological quality. (**Action** - Chemical Services, Condition Monitoring) c) Use mobile filtering equipment and centrifuges on main turbine when required (**Action** - Maintenance) d) Circulate oil weekly to ensure maintain an oil film e) (**Action** - Operating)
Potential storage risks which need to be mitigated	a) Microbiologically induced corrosion b) General corrosion c) Fungal growth d) Leaching of additives.	

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3.15 GENERATOR AND EXCITER

For this section, refer to 240-56361216, 240-56535978, 240-56178527 & 240-120844075 for more detail.

Table 17 : Generator and Exciter Preservation Actions

	Short-term Shutdown (<7 days)	Long-term Shutdown (>7days)
Before shutdown	Inspect plant for defects (**Action** - Operating)	Inspect plant for defects (**Action** - Operating)
During shutdown	Air cooled generators a) If electrical space heaters are fitted: Ensure space heaters are switched on for the duration of the shutdown. If electrical space heaters are not fitted: Supply or circulation of hot dried air at temperature above the dewpoint within the generator (**Action** - Maintenance, Outage Management) Hydrogen cooled generators b) For shutdown periods < 60 days with start-up readiness at any time, hydrogen gas pressure must be maintained above alarm value, gas purity and dew point is monitored as for running plant and partial gas flow drying is carried out using a gas dryer with an additional gas recirculation fan. If a gas dryer with additional circulation fan is not installed, frequent venting of gas below acceptable dew point is required followed by topping up with dry gas. (**Action –** Operating, Maintenance) c) Generators with hydrogen cooling and direct water cooling shall be treated in accordance with these methods; however the primary water system shall remain in operation and stator coolant chemistry monitored and controlled as is done as for running plant. (**Action –** Operating)	Air cooled generators a) Supply or circulation of hot dried air at temperature above the dewpoint within the generator. Dew point/humidity must be monitored and driers checked daily. (**Action** - Maintenance, Outage Management) Hydrogen cooled generators b) For shutdown periods < 60 days with start-up readiness at any time, hydrogen gas pressure must be maintained above alarm value, gas purity and dew point is monitored as for running plant and partial gas flow drying is carried out using a gas dryer with an additional gas recirculation fan. If a gas dryer with additional circulation fan is not installed, frequent venting of gas below acceptable dew point is required followed by topping up with dry gas. (**Action –** Operating, Maintenance) c) For shutdown periods >60 days without immediate start-up readiness the hydrogen shall be removed from the generator and the generator shall be preserved with a continuous feed of dry air. (**Action –** Operating, Maintenance) d) Generators with hydrogen cooling and direct water cooling shall be treated in accordance with these methods; however the primary water system shall remain in operation as long as hydrogen gas pressure is maintained. Hydrogen gas pressure shall be maintained at normal working pressure while the stator coolant system is in service. If the hydrogen gas

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	Short-term Shutdown (<7 days)	**Long-term Shutdown (>7days)**
	Exciter a) The exciter set shall be protected against temperature below dew points by means of dry warm air circulation such as a Munters drier. (**Action –** Operating, Maintenance**)** b) Coolers shall never be subjected to stagnant conditions for long periods. The normal analytical surveillance shall be maintained during shutdowns.	pressure is dropped below alarm value and/or the stator coolant system is taken out of service for more than 15 days, the stator coolant must be drained from the stator winding and vacuum dry-out initiated to preserve the stator winding cooling circuit. A generator shall not be left with stagnant cooling water for more than 30 days. (**Action –** Operating**)** e) Bearing oil and sealing oil supply on degassed units shall be operated once a week with switched-on turning gear operation (**Action –** Operating**)** Hydrogen or air coolers f) The coolers shall be drained flushed and dried or further operated with cooling water. (**Action –** Operating**)** g) Maintain the dewpoint of the gas at 10°C below the minimum cooling water temperature anticipated. (**Action –** Operating**)** Exciter h) The exciter set shall be protected against a temperature below dew points by means of dry warm air circulation such as a Munters drier. (**Action –** Operating, Maintenance) Coolers i) Coolers shall never be subjected to stagnant conditions for long periods. The normal analytical surveillance shall be maintained during shutdowns. (**Action –** Operating, Maintenance)
Potential storage risks which need to be mitigated	a) General corrosion. b) Insulation degradation. c) Hydrogen-cooled systems - corrosion of end bells and rotors. d) Corrosion of water cooled stator bar internals leading to gas into coolant leaks causing cooling water flow starvation or plugging of small water cooling passages, both leading to overheating and subsequent electrical insulation failure.	

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3.16 GENERATOR STATOR COOLANT

Table 18 : Generator Stator Coolant Chemistry Preservation Actions

	Short-term Shutdown (<7 days)	**Long-term Shutdown (>7days)**
Before shutdown	Inspect plant for defects (**Action** - Operating)	Inspect plant for defects (**Action** - Operating)
During shutdown	For shutdowns < 5 days, without coolant drainage a) Maintain system to normal working level (**Action** – Operating) b) Monitor plant conditions (**Action** – Operating) c) Maintain circulation (**Action** – Operating) d) Maintain surveillance (**Action** – Operating) For shutdowns < 5 days, with coolant drainage due to maintenance scope a) Drain the system (**Action** – Operating) b) Remove and replace resins if necessary (**Action** – Maintenance, Chemical Services, Engineering) c) Complete maintenance and refill system (**Action** – Maintenance) d) Maintain surveillance (**Action** – Operating) e) Maintain chemical surveillance (**Action** – Chemical Services)	For shutdowns > 5 days, without coolant drainage a) Maintain system to normal working level (**Action** – Operating) b) Monitor plant conditions (**Action** – Operating) c) Maintain circulation (**Action** – Operating) d) Maintain surveillance (**Action** – Operating) For shutdowns > 5 days, with coolant drainage a) Drain the system (**Action** – Operating) b) Remove and replace resins if necessary (**Action** – Maintenance, Chemical Services, Engineering) c) Complete maintenance and refill system (**Action** – Maintenance) d) Maintain surveillance (**Action** – Operating) e) Maintain chemical surveillance (**Action** – Chemical Services)
Potential storage risks which need to be mitigated	a) General corrosion. b) Insulation degradation. c) Corrosion and plugging of stator bar internal cooling channels leading to generator overheating.	

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3.17 LAGGING

Refer 32-303 & 240-56247004 for more detail

Table 19 : Lagging Preservation Actions

	Short-term Shutdown (<7 days)	**Long-term Shutdown (>7days)**
Before shutdown	Survey boiler (including air and gas ducts) and turbine plant visually and defect areas of moist, damaged or missing which will be repaired during shutdowns (**Action** - Operating, Maintenance, Outage Management)	Survey boiler (including air and gas ducts) and turbine plant visually and defect areas of moist, damaged or missing insulation which will be repaired during shutdowns (**Action** - Operating, Maintenance, Outage Management)
During shutdown	a. Remove any wet lagging and inspect metal surfaces for corrosion or damage. Attend to areas of local deterioration. Maintain in a dry condition. In the case of asbestos lagging, de-lag in accordance with the Eskom procedure and protect exposed metal surface (**Action** -Maintenance, Operating) b. Monitoring of the condition of the metal surfaces beneath lagging to be implemented. (**Action** - Maintenance)	a. In the case of asbestos lagging, de-lag in accordance with the Eskom procedure and protect exposed metal surface by means of a coating system. For other lagging materials dry out completely and maintain in a dry condition. Where dry conditions cannot be maintained, de-lag and protect exposed metal surfaces. (**Action** -Maintenance, Operating) b. Monitoring of condition of metal surface beneath lagging to be implemented (**Action** - Maintenance)
Potential storage risks which need to be mitigated	i. Asbestos Lagging – manage in accordance to Eskom's asbestos standard (32-303) ii. Retention of Moisture causing: a. lagging break-up b. accelerated corrosion of metal surfaces.	

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3.18 PF PLANT AND COAL BURNERS

Table 20 : PF Plant and Coal Burners

	Short-term Shutdown (<7 days)	Long-term Shutdown (>7days)
Before shutdown	a) Mills to be emptied (**Action** - Operating) b) Bunkers to be run empty (**Action** - Operating)	a) Remove all coal and PF from bunkers, feeders, PF pipes, mills, burners etc. **If barring is done, this is not required** (**Action** - Operating)
During shutdown	a) Visual monitoring per shift (**Action** -Operating)	a) Lubricate all moving parts (**Action** -Maintenance) b) Pneumatic systems to be verified for the presence of moisture and blown down accordingly (**Action** – Operating and Maintenance) c) Bar periodically – Tube mills only (**Action** -Operating) d) Visual monitoring per shift (**Action** -Operating)
Potential storage risks which need to be mitigated	a) Fire hazard due to coal b) General corrosion c) Seizure d) Fretting due to vibrations from adjoining units e) Compaction and moisture seepage of coal in mill bunkers reducing coal flow Lock charge of balls in tube mills (due to moisture)	

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3.19 TRANSFORMERS AND SWITCHGEAR

For this section, refer to 240-56062726, 240-56358993, 240-56358900 for more detail.

Table 21 : Transformer and Switchgear Preservation Actions

	Short-term Shutdown (<7 days)	Long-term Shutdown (>7days)
Before shutdown	a) Maintain oil sampling routine on transformers (**Action** – Chemical Services, Condition Monitoring) b) Monitor online gas analyser for signs of high temperature gases (**Action** – Operating, Engineering) c) Check plant for alarms (**Action** – Operating)	a) Maintain oil sampling routine on transformers (**Action** – Chemical Services, Condition Monitoring) b) Monitor online gas analyser for signs of high temperature gases (**Action** – Operating, Engineering) c) Monitor plant for alarms (**Action** – Operating)
During shutdown	a) Monitor plant for alarms (**Action** – Operating) b) Check silica gel breathers regularly (**Action –** Maintenance**)**. c) Keep heaters energised. (**Action –** Operating) d) Maintain oil sampling routine on transformers (**Action** – Chemical services, Condition Monitoring) e) Monitor online gas analyser for signs of high temperature gases (**Action** – Operating, Engineering)	a) Monitor plant for alarms (**Action** – Operating) b) Check silica gel breathers regularly (**Action –** Maintenance**)**. c) Keep heaters energised. (**Action –** Operating) d) Maintain oil sampling routine on transformers (**Action** – Chemical services, Condition Monitoring) e) Monitor online gas analyser for signs of high temperature gases (**Action** – Operating, Engineering) Switchgear f) Rack breakers out and lock out on all power circuits that are not required to be in service. (**Action** - Operating) g) Ensure that all fire doors in cable tunnels and cable spreading basements remain closed. (**Action** – Maintenance) h) Ensure that the forced ventilation systems on cable tunnel surface venting shafts remain in service. (**Action** – Operating & Maintenance) i) Ensure that all leaks to the substation are fixed. (**Action** – Operating, Maintenance)
Potential storage risks which need to be mitigated	a) Moisture ingress and corrosion. b) Insulation degradation. c) Fire spreading d) Gas accumulation in tunnels	

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3.20 EMERGENCY SUPPLIES

Table 22 : Emergency Supplies

	Short-term Shutdown (<7 days)	Long-term Shutdown (>7days)
During shutdown	a) Ensure that power supplies to battery chargers remain on. b) Monitor all alarms and act thereon as if the unit is in full production.	a) Ensure that power supplies to battery chargers remain on. (**Action** – Operating) b) Monitor all alarms and act thereon as if the unit is in full production. (**Action** – Operating) c) Continue with the test running routines of the diesel generators. (**Action** – Operating) d) Maintain diesel levels as if the unit is in normal production. (**Action** – Operating) e) Continue to execute standby / running checks. (**Action** – Operating) f) Continue with normal PMs. (**Action** – Maintenance) g) Ensure that ventilation fans at battery rooms and enclosed diesel storage areas remain in service. (**Action** – Operating)
Potential storage risks which need to be mitigated	a) Protection systems inactive b) Indication and alarm systems inactive c) Not being able to maintain batteries	

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3.21 GENERATOR CIRCUIT BREAKER AND BUS DUCTING

Table 23 : Generator Circuit Breaker and Bus Ducting Preservation

	Short-term Shutdown (<7 days)	Long-term Shutdown (>7days)
During shutdown		a) Disable breaker from closing and lock it out. (**Action** – Maintenance) b) Maintain cooling water system in service and continue with chemistry monitoring. (**Action** – Maintenance & Chemical Services) c) Isolate pressurised air system from the common range, and drain the air from the unitised system. (**Action** – Maintenance) d) Close busbar earthing switches and lock in closed position. (**Action** – Operating) e) Ensure busbar ducting pressurisation fan remains in service. (**Action** – Maintenance) f) Top-up SF6 to nominal value. (**Action** – Maintenance) g) Test quality of SF6 gas. (**Action** – Maintenance)
Upon return		a) Open and visually inspect busbar ducting system for ingress of water – close afterwards. (**Action** – Maintenance) b) Open earthing switches. (**Action** – Operating) c) Inspect earthing switches for water ingress. (**Action** – Maintenance) d) Inspect VT cubicles for water ingress. (**Action** – Maintenance) e) Conduct a full circuit breaker test to verify all opening and closing times. (**Action** – Maintenance) f) Conduct thermography scans on the entire ducting. (**Action** – Maintenance)
Potential storage risks which need to be mitigated	a) Inadvertent closing of generator circuit breaker b) Electrical faults due to water / dust ingress	

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3.22 UNITIZED H_2

Table 24 : Hydrogen Plant Preservation Actions

	Short-term Shutdown (<7 days)	Long-term Shutdown (>7days)
During shutdown		a) Remove all H_2 bottles from unit H_2 bottle filling point. b) Once a week vent one inert gas bottle (e.g. N_2) through the unitized H_2 piping. (**Action** - Operating
Upon return		a) Verify analyser accuracy. (**Action** – Engineering, Chemical Services) b) Verify dew point analyser meter accuracy. (**Action** – Engineering, Chemical Services c) Install Hydrogen cylinders. (**Action** – Operating) d) Replace all CO2 cylinders after air purge before. (**Action** Operating) e) Hydrogen is introduced into the generator, to ensure that 2x generator CO2 purge can be performed. (**Action** – Maintenance, Engineering)
Potential storage risks which need to be mitigated	a) Corrosion b) H_2 fire / explosion	

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3.23 SECONDARY PLANT

Table 25 : Secondary Electrical Plant Preservation Actions

	Short-term Shutdown (<7 days)	Long-term Shutdown (>7days)
During shutdown	a) Ensure all protection schemes remain in service. (**Action** – Maintenance) b) Ensure that the remote back-up protection is never switched off. (**Action** – Maintenance) c) Continue to monitor all alarms and act on alarms. (**Action** – Operating) d) Ensure that the generator fault recorders remain active and ready at all times. (**Action** – Maintenance) Ensure all Transmission interfaces are reviewed. (**Action** – Maintenance and Engineering)	a) Ensure all protection schemes remain in service. (**Action** – Maintenance) b) Ensure that the remote back-up protection is never switched off. (**Action** – Maintenance) c) Continue to monitor all alarms and act on alarms. (**Action** – Operating) d) Ensure that the generator fault recorders remain active and ready at all times. (**Action** – Maintenance) e) Ensure all Transmission interfaces are reviewed. (**Action** – Maintenance and Engineering)
Potential storage risks which need to be mitigated	a) Inactive protection b) Inability to record disturbances	

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3.24 LIGHTING

Table 26 : Station Lighting Preservation Actions

	Short-term Shutdown (<7 days)	Long-term Shutdown (>7days)
During shutdown		a) Continue with normal maintenance and PMs. (**Action** – Maintenance) b) Ensure that the emergency lighting and essential lighting remains working through regular testing. (**Action** – Maintenance)
Upon return		a) Ensure that the IP rating of all lighting in hazardous locations is correct.(**Action** – Maintenance)
Potential storage risks which need to be mitigated	a) Unavailable lighting b) Cable damage	

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3.25 HVAC

Table 27 : HVAC Preservation Actions

	Short-term Shutdown (<7 days)	Long-term Shutdown (>7days)
During shutdown		a) Ensure that turbine hall ventilation system remain in service. (**Action** – Operating and Maintenance) b) Ensure that venting fans remain in service in all areas unless motivated with a risk assessment. (**Action** - Operating and Maintenance) c) Ensure that the air conditioning systems to all equipment and control rooms remain in service at all times. (**Action** – Operating) d) Continue to monitor and act on equipment room temperature alarms. (**Action** – Operating) e) Regularly test smoke extraction fans.(**Action** – Operating) f) Ensure that cooling fans for dry-type transformers remain in service. (**Action** – Maintenance) g) Ensure that pressurisation fans remain in service for all applications. (**Action** – Maintenance) h) Remove and clean filters on standby plant (**Action** – Maintenance)
Potential storage risks which need to be mitigated	a) Poor quality air b) Damage to C&I equipment c) Dust / moisture ingress	

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3.26 TURBINE ROTORS, CYLINDERS AND CONDENSERS (STEAM SIDE)

Warm dehumidified air is the protection medium of choice for the steam turbine and other steam circuits. Dry preservation is particularly recommended for OT units.
Refer to table 3.5 for Condenser cooling water side actions.

Table 28 : Turbine Steam Side Preservation Actions

	Short-term Shutdown (<7 days)	Long-term Shutdown (>7days)
Before shutdown		
During shutdown	For shutdown duration <7 days : a) Use residual heat and vacuum to facilitate drying (**Action** - Operating)	a) Use residual heat and vacuum to facilitate drying (**Action** - Operating) b) Where applicable, supply dehumidified air to steam spaces on a continuous basis using air driers. Maintain relative humidity < 30%. Hot dry air flows in reverse from LP turbines via reheaters, HP turbine, boiler and FW pumps to vent at FW tank. (**Action** - Maintenance, Outage Management) a) Monitor humidity levels daily (**Action** -Performance and Testing) b) Monitoring to verify that dehumidifier is in service (**Action** -Operating) c) Rotor barring using the jacking oil system shall be done once a week and the rotor turned one and a quarter turns (**Action** - Operating) d) Take weekly lube oil samples to check for contamination (**Action** -Chemical Services) e) Turbine oil purifier to kept in service to maximise the heat in the oil (**Action** - Operating) f) Operate all bled steam valves once a month (**Action** - Operating)
Potential storage risks which need to be mitigated	a) Stress corrosion cracking. b) Rotor distortion. c) General corrosion d) Corrosion fatigue.	

The system utilized to supply dry air to the various components of the feedwater, steam and boiler circuits may be customized to adapt to various heat cycle configurations. One example is the flow diagram depicted in Figure A. Another variation is shown in Figure B.

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According to the dehumidification equipment manufacturer, the dry air circulation systems are then sized to provide

i. Ten air changes per hour for water/steam-side components,
ii. One air change per hour for flue gas-side components, and
iii. Five to ten air changes per hour for generating equipment.

The flow path for Figure A can be described as follows:

Dry air is discharged from the dehumidifier (DH) into the hotwell, and then flows through the low pressure turbine and continues through all turbine sections to the boiler, backward with respect to steam flow. Dry air flows through the feedwater side of the heaters and is discharged out of the system, back to the DH. Condensate pumps receive dry air from the hotwell and discharge it back to the DH from the discharge check valves. Extractions are left open so dry air can reach the feedwater heaters, from which air is returned to the DH.

The relative humidity is below 60% in less than 20 hours and less than 30% in 36 hours. To ensure effective dehumidification, the boiler is flash drained at 1.7 MPa drum pressure. Draining at 1.7 MPa pressure prevents condensation in the secondary superheater and reheater U-bends in the hanging pendant sections.

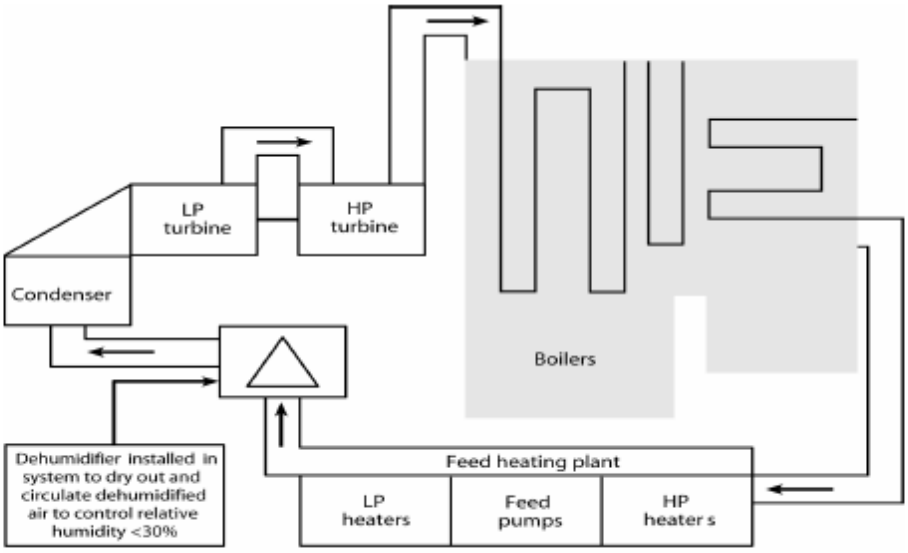

Figure 1: Option 1 - Block Diagram of Dehumidifier Steam/Feed Cycle

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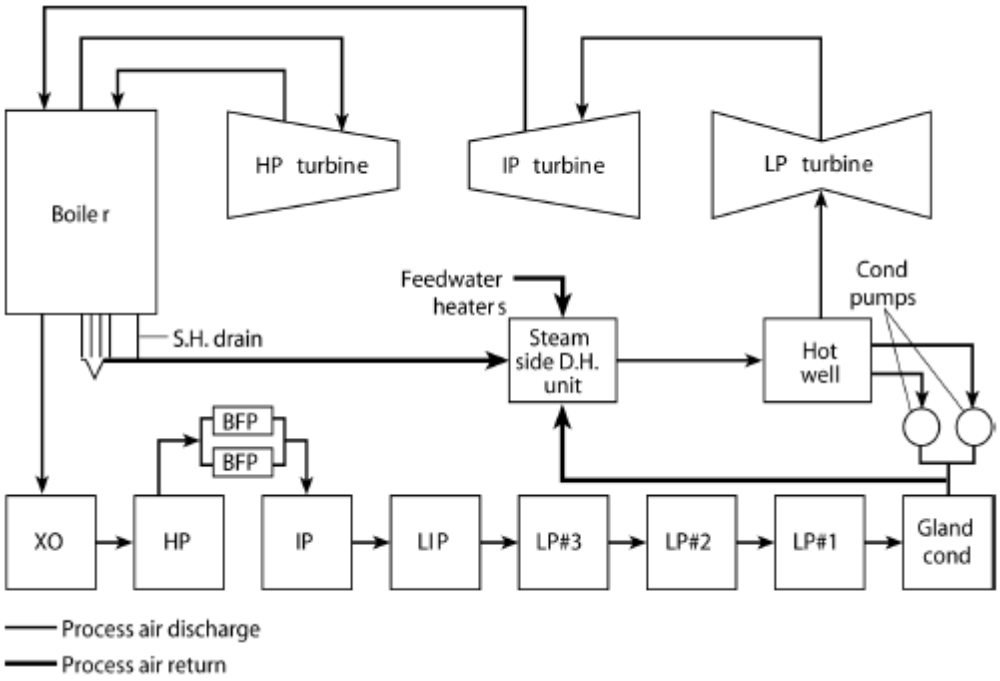

Figure 2: Option 2 - Steamside Dehumidification Flow

Air moisture levels should be checked as air enters and as it exits the reheat section. It is difficult to dry a system with “hanging” superheaters (vertical tubes with bends) by the use of dehumidified air circulation. The same difficulty is noted for non-drainable headers or connecting lines. The following drying procedure was recommended for these instances:

Dehumidified air is discharged into the LP turbine as soon as the boiler steam drum reaches atmospheric pressure. All turbine valves necessary to allow air flow through the turbine steam cycle are opened. Low pressure turbine extraction piping and heaters are dehumidified through the normal extraction piping, in the normal direction of steam flow. Low point drains on the shell sides of the heaters are opened to facilitate air flow.

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3.27 TURBINE OIL SYSTEMS, BEARINGS, GOVERNOR AND BARRING GEAR

Table 29 : Turbine Oil System Preservation Actions

	Short-term Shutdown (<7 days)	Long-term Shutdown (>7days)
Before shutdown	Inspect plant for defects (**Action** - Operating)	Inspect plant for defects (**Action** - Operating)
During shutdown	a) Run oil systems and operate valve gear and bar shaft daily (**Action** - Operating) b) Monitor oil systems for signs of leakage (**Action** - Operating)	a) Run oil systems weekly (**Action** - Operating) b) Conduct regular barring (**Action** - Operating) c) Weekly oil Analysis (**Action** - Chemical services) d) Monitor oil systems for signs of leakage (**Action** - Operating) e) Drain condensation as required from oil coalescers (**Action** -Operating, Maintenance) f) Regular drainage of water in main oil tanks (**Action** -Operating, Maintenance)
Potential storage risks which need to be mitigated	a) General corrosion. b) Fretting. c) Seizure due to lack of lubrication or bacterial degradation of lubricant - regular drainage of water from main oil tanks has improved microbiological quality of oil. d) Creep of white metal bearing. e) Galvanic corrosion between dissimilar metals.	

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3.28 DUCTINGS – PRIMARY AIR, SECONDARY AIR AND FLUE GAS

Table 30 : Ducting Preservation Actions

	Short-term Shutdown (<7 days)	Long-term Shutdown (>7days)
Before shutdown	Inspect plant for defects (**Action** - Operating)	Inspect plant for defects (**Action** - Operating)
During shutdown	a) Inspect ducts internally for signs of wet ash build-up, especially at expansion bellows. Clean ducts and bellows as required b) (**Action** - Operating)	a) Inspect ducts internally for signs of ash build-up (wet and dry), especially at expansion bellows. Clean ducts and bellows as required (**Action** – Maintenance) b) Maintain in dry condition (Action - Maintenance, Outage management).
Potential storage risks which need to be mitigated	a) General corrosion. b) Perishing of supple joint expansion bellows c) Failures of ducts due to limited allowance for thermal expansion during start-up and operation, as a result of fouled expansion bellows	

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4. AUTHORISATION

This document has been seen and accepted by:

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5. REVISIONS

Date	Rev.	Compiler	Remarks
March 2013	0.0	Pravin Moodley	Need identified for creating new plant preservation guideline during planned shutdowns to ensure unit returns in reliable condition
April 2013	0.1	Pravin Moodley	First Draft for Comments Review as Prepared by Document Centre
May 2013	0.2	Pravin Moodley	Second draft based on comments received from subject matter experts for all plant areas
May 2013	1	Pravin Moodley	Final Document for Authorisation and Publication
November 2016	1.1-1.4	Pravin Moodley	First draft post first review cycle. Sent out for comments
November 2016	1.5	Pravin Moodley	Final Draft Document for Comments Review
December 2016	2	Pravin Moodley	Final Document for Authorisation and Publication
January 2017	2.1	Pravin Moodley	Update of Feedwater systems
January 2017	3	Pravin Moodley	Final Document for Authorisation and Publication (Rev 3)

6. DEVELOPMENT TEAM

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7. ACKNOWLEDGEMENTS

- Not Applicable.

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