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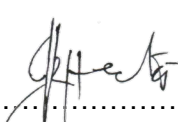
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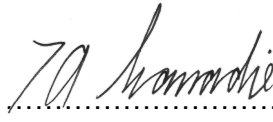
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1. INTRODUCTION

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 modes. Failure of these components occur for several reasons within an idle plant. In an idle condition, plants and associated equipment are subjected 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 numerous problems.

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

No matter which types 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 Generation Engineering.

The guideline 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. Main CW pumps
- iv. 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. 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.

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2.2.1 Normative

- [1] ISO 9001 Quality Management Systems.
- [2] 240-120844075 Chemical Preservation of Power Plant Systems and Components Guideline
- [3] 559-577251846 Turbine Centreline Preservation During Shutdown Period
- [4] 240-56361216, The Control and Management of Moisture Ingress and Leaks in Stators or Large Generators Standard
- [5] 240-56535978, Management of Large Generators during Outages and Works Standard
- [6] 240-56178527, Requirements for Clean Conditions and Access Control during Manufacture, Maintenance and Refurbishment of Generators Standard
- [7] 240-56357281, Lay-up (Mothballing) of Generation Electrical and Process Control Equipment in Power Stations Manual
- [8] 240-56358900, Sampling and Testing of Mineral Insulating Oil for Power Transformers Within Generation Division Standard
- [9] 240-56358993, Standard for the Maintenance of Power Transformers
- [10] 240-56062726, Intrusive Work and Oil Filling, Under Vacuum of Transformers and Reactor on-site Standard
- [11] 240-56247004, Thermal Insulation Standard 2016
- [12] 240-56360387 Storage of Power Station Electric Motors Standard.
- [13] 240-131963944 Draught Group Preservation Standard
- [14] 474-12740 Generation Boiler Reheater Drying Position Paper

2.2.2 Informative

- [15] TRR/S97/126 Plant Storage Methodologies
- [16] EPRI 1006756 Fire Protection Equipment Surveillance Optimization and Maintenance Guide
- [17] EPRI 1014195 Shutdown Protection of Steam Turbines Using Dehumidified Air
- [18] EPRI TR-101250. Palo Alto, CA: 2009 Cycling, Startup, Shutdown, and Layup Fossil Plant Cycle Chemistry Guidelines for Operators and Chemists
- [19] EPRI, Palo Alto, CA: 2020.3002016985 Comprehensive Cycle Chemistry Guidelines for Fossil Plants
- [20] EPRI 1011684 Ash Handling System Maintenance Guide
- [21] EPRI E213676 Electrostatic Precipitator Maintenance Guide
- [22] 240-56244749 FFP Operational Instruction
- [23] RWE Npower TECH/PROC/ 006 Part 3 Issue 3 July 2009. The Storage of the Water/Steam Circuits of Generation Plant

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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)
GM	General manager
H ₂	Hydrogen
HVAC	Heating, ventilation, and air conditioning
IR	Insulation Resistance
MPa	Mega Pascal
OT	Oxygen treatment
PF	Pulverised fuel
PI	Polarisation Index
PM	Planned Maintenance
SO ₃	Sulphur Trioxide

2.5 ROLES AND RESPONSIBILITIES

The **Power Station General 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 **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.

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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.

2.6 PROCESS FOR MONITORING

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.

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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.

3.1 AIRHEATERS

Table 1: Air heater Plant Preservation Actions

For information refer to Guideline 240-131963944 Draught Group Preservation Standard

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 to prevent bridging and blocking. (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 SO₃ 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) Gas Load Secondary V-I curves readings to be recorded before the plant is 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 2: 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. <i>This is generally achieved with the boiler purge.</i> 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 rainwater 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 Guideline 240-120844075 *Chemical Preservation of Power Plant Systems and Components* for more detail.

For draught group fans, See Guideline 240-131963944 Draught Group Preservation Standard

3.3.1 Boiler Plant Chemical Preservation Actions

The station must develop and implement a station specific Boiler Pressure Parts Preservation Procedure. This procedure should specify and not be limited to:

3.3.1.1 General requirements:

- a) Ensure that existing Operating Procedures and maintenance philosophies ensure proper drainage of all pressure parts, water / steam touched components as well as maintaining adequate drainage slopes. It should include assurance that drainage systems are properly functioning (functioning of drain and vent valves need to be devoid of any blockages)
- b) Specify requirements pertaining to, and confirmation of, expected off-load duration
- c) Specify requirements pertaining to, and confirmation if, washing with steam is possible.
- d) Specify requirements pertaining to and confirm if it will be either wet or dry storage of the unit.
- e) Specify the Operating requirements prior to boiler shut down.
- f) Note that dry storage is the default and preferred preservation technique.

3.3.1.2 Specific requirements related to Dry Storage:

- a) Note that dry storage is the default and preferred preservation technique.
- b) Specify procedure of drainage of the boiler while hot and under reduced water/ steam pressure (The maximum pressure limits should be properly designed and clearly specified) effectively facilitate the removal of all water from the boiler.
- c) In the event where relevant systems are available, specify requirements in terms of evacuation of the moisture in the boiler tubes by either using the residual furnace heat and turbine condenser vacuum of the Unit when the Unit is shutdown, or by using forced air drying (steam evacuation) during the shutdown process.
- d) Refer to **Generation Boiler Reheater Drying Position Paper [474-12740]** for more information pertaining to RH Drying best practices.
- e) In the case where a unit was taken off load or tripped and the boiler has cooled down and pressure reduced to a point where forced draining and / or RH Drying is not a possibility:
 - i. The station specific procedure should specify the requirements to reheat the boiler to achieve adequate conditions to effect RH Drying and / or Forced Draining.
 - ii. In the event where it was found that the boiler cannot be reheated, station should have a

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procedure to cover this scenario to mitigate the risk of damage to the plant.

3.3.1.3 Specific requirements related to Wet Water Storage (when no maintenance interventions are planned):

- a) In the case where the boiler could not be adequately drained and dried on shutdown of the Unit, and the boiler cannot be reheated for draining and drying, the station may consider wet storage for preservation of the boiler. This technique can however only be applied if no maintenance is planned on the boiler pressure part envelope. In the consideration of this option, it is important to take account of the additional weight of the water in the boiler which may be beyond the boiler support design limits.
- b) In the case where the station intent to put a unit on short term wet storage during which no maintenance is planned on the boiler pressure part envelope, a specific preservation procedure should be developed. This can be done in two ways:

3.3.1.3.1 Short term wet storage:

- a) Short-term wet storage can be considered on components that can be completely drained, if there is certainty that the Unit will be returned to service within 3 days, and if there is certainty that no work will be done on the component. (**Action** – Chemical Services)
- b) Short-term wet storage cannot be applied when the boiler chemistry was out-of-specification prior to the shutdown, as this will lead to accelerated pitting corrosion while the boiler is standing. In this situation, the boiler must be completely drained, even if it cannot be drained while hot (**Action** – Chemical Services)
- c) When applying short-term wet storage, maintain the same potential (oxidizing / reducing conditions) for shutdown as during normal operation, i.e., when using AVT(O) or OT, do not add a reducing agent during shutdown. (**Action** – Chemical Services)
- d) For short-term wet storage, increase the pH to 9.5 approximately 1 hour before shutting down to ensure a homogeneous pH distribution throughout the boiler. Confirm that the required pH has been attained.
- e) Alternatively, for boilers without circulation pumps, if the boiler was drained and is being refilled, continuous ammonia dosing, whilst filling the boiler, is required. (**Action** – Chemical Services)

3.3.1.3.2 Long Term Wet Storage

- a) If adequate dry storage of the boiler could not be implemented, long-term wet storage can be considered on components that can be completely drained, where no work will be done. (**Action** – Chemical Services)
- b) If the boiler chemistry was out-of-specification prior to the shutdown, the boiler must first be completely drained, even if it cannot be drained while hot, to prevent accelerated pitting corrosion. (**Action** – Operating, Chemical Services)
- c) Long-term wet storage can only be considered if the boiler water can be circulated, if dosing of ammonia can be conducted and if chemistry monitoring of the boiler water can be done throughout the long-term wet storage.
- d) When applying long-term wet storage, maintain the same potential (oxidizing / reducing conditions) for shutdown as during normal operation, i.e., when using AVT(O) or OT, do not add a reducing agent during shutdown. (**Action** – Chemical Services)
- e) For long-term wet storage, maintain the pH at 9.5 by dosing ammonia and circulating the water to obtain homogeneous pH distribution throughout the boiler.
- f) Periodically monitor the boiler pH and dose ammonia as required to maintain the pH at the required level. (**Action** – Chemical Services)

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3.3.1.4 Specific requirements related to storage using nitrogen (when no maintenance interventions are planned)

- a) In case this option is selected for the specific site, a site-specific Nitrogen Blanketing procedure need to be developed in support of preservation The development of such a procedure and equipping the plant to effect it will take a long period. The design and preparation of this should thus be done well in advance. (**Action** – Boiler Engineering)
- b) All instances where nitrogen preservation is applied require specific safety consideration due to the risk of asphyxiation.

3.3.1.5 Specific requirements when filling a boiler for leak testing at the end of an outage:

- a) It frequently occurs that at the end of planned outages, boilers are filled with water for leak testing. The boiler must be filled with ammoniated water to reduce the corrosion risk. Once the leak test is completed, the boiler must be returned to service as quickly as possible. If delays in returning the Unit to service are experienced, this will result in the boiler being left in a wet condition for an extended period without being able to affect drying, which may increase the corrosion risk. To manage this, Outage Management should schedule this activity as late as possible during the outage. The Boiler should not be filled if there is known risk which will cause delays to the RTS.
- b) Boiler Engineering and the relevant maintenance and inspection personnel should be present during the leak testing process to ensure that the water temperature is correct, the boiler pressure ramp rates are always adhered to and ensure that there are no leaks on the boiler. If no leaks are evident, the boiler should be returned to service as soon as possible after the boiler leak test.

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3.4 BUILDINGS ROOFS AND CIVIL STRUCTURES

Table 3: 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) a) 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	a) Moisture ingress into electrical, C&I and mechanical equipment b) 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 28 for Condenser steam side details.

Table 4: 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 shutting down 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 shutting down the cooling water pumps (Action – Operating)
During shutdown	CW isolation is possible: a) Isolate CW system supply to unit and drain condenser water box. (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: a) Inspect steam space on weekly basis (Action – Operating) b) 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 water box. (Action – Operating) b) Open manholes. Inspect and remove debris from tube plates (Action – Maintenance) c) Wash tubes with potable water or Fire hydrant 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: a) Inspect steam space on a weekly basis. (Action – Operating) b) 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 5 : 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	

3.7 DEAERATORS AND FEEDWATER TANKS

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

Table 6 : Deaerator or Feedwater Tank Preservation Actions

	Short-term Shutdown (<=21 days)	Long-term Shutdown (>21 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 7 : 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 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 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, 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 8 : 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) 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 developing into rusting and cracking later. This 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 keep out water, vermin, and any foreign material. (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. Blank off the inlet and outlet parts to prohibit the ingress of moisture and dust. Action – Operating / Maintenance) j) Maintain oil levels. (Action – Maintenance / Operating) k) Ensure bearing journals are maintained with a film of lubricant. (Action – Maintenance) l) Rotate motor shafts as per site procedure. (Action – Maintenance) m) Perform IR and PI tests. (Action – Maintenance / Engineering.

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	Short-term Shutdown (<7 days)	Long-term Shutdown (>7days)
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 blanking 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 humidity. 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 feed heating systems.

Table 9 : Feedwater Heaters (Short, Medium & Long-Term Shutdown)

Short-term Shutdown (<= 14 days)		
Before shutdown	Inspect plant for defects (Action - Operating)	
During shutdown	Header heaters Vertical Tube sheet heaters with water box at the top	Horizontal Tube sheet heaters Vertical Tube sheet heaters with water box at bottom
	<u>Tube side</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)	<u>Tube side</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)
	<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 Flash boxes are dry as well (Action - Operating)	
Potential storage risks which need to be mitigated	a) General corrosion b) Pitting of feedwater heater shell and tubes.	
Medium-term Shutdown (>14 days and < 4 months)		
Before shutdown	Inspect plant for defects (Action - Operating)	
During shutdown	Header heaters Vertical Tube sheet heaters with Water box at the top	Horizontal Tube sheet heaters Vertical Tube sheet heaters with water box at bottom
	<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)	<u>Tube side</u> a) Drain the system while hot (Action - Operating) b) On horizontal heaters, blow-through the tubes with compressed air, using lances (Action – Maintenance) c) Ensure complete drainage. (Action - Operating) d) Keep all vents, drains and isolation valves open (Action - Operating) e) Store the system dry (Action - Operating)
	<u>Shell side</u> a) Drain hot and store dry (Action - Operating)	

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	b) Ensure complete drainage (Action - Operating) c) Keep vents and drains open (Action - Operating) d) Ensure Flash boxes are dry as well (Action - Operating)	
Potential storage risks which need to be mitigated	a) General corrosion b) Pitting of feedwater heater shell and tubes.	
Long-term Shutdown (>4 months)		
Before shutdown	Inspect plant for defects (Action - Operating)	
During shutdown	Header heaters Vertical Tube sheet heaters with water box at the top	Horizontal Tube sheet heaters Vertical Tube sheet heaters with water box at bottom
	<u>Tube Side</u> Increase ammonia dosing to achieve pH between 9.5-10 prior to shutting down (Action –Chemical Services) <u>Dry storage:</u> a) Remove water from each tube by either a vacuum system or dry compressed air. (Action – Maintenance) b) Verify that each tube is completely dry by blowing compressed air through each tube while observing that no water is discharged from downstream end. (Action – Maintenance) c) Store dry with waterbox or headers open (Action -Operating)	<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 open (Action - Operating) d) Store the system dry (Action - Operating)
	<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 Flash boxes are dry as well (Action - Operating)	
Potential storage risks which need to be mitigated	a) General corrosion. b) Pitting of feedwater heater shell and tubes.	

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

Table 10 : Fan Preservation Actions

For information refer to 240-131963944 Draught Group Preservation Standard

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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 11 : 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 always ensuring the availability of adequate fire protection 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 (like a new installation). Re-commissioning should include flushing, pressure, and leak tests, and fully flow tested to confirm functionality of the system.	
	Where transformers remain energised, the fire systems should remain active	

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3.13 FUEL OIL SYSTEM AND BURNERS

Table 12 : 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 diesel 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 13 : 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.	

3.15 GENERATOR AND EXCITER

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

Table 14 : 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 are monitored as for running plant and partial gas flow	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 are monitored as for running plant and partial gas flow drying is carried out using a gas dryer with an additional gas recirculation

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	Short-term Shutdown (<7 days)	Long-term Shutdown (>7days)
	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)	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 if 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 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.
	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)	

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	Short-term Shutdown (<7 days)	Long-term Shutdown (>7days)
	b) Coolers shall never be subjected to stagnant conditions for long periods. The normal analytical surveillance shall be maintained during shutdowns.	(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.	

3.16 GENERATOR STATOR COOLANT

Table 15 : 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, <u>without</u> 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, <u>without</u> 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, 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)

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	Short-term Shutdown (<7 days)	Long-term Shutdown (>7days)
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.	

3.17 LAGGING

Refer 32-303 & 240-56247004 for more information.

Table 16 : 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 17 : 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)	

3.19 TRANSFORMERS AND SWITCHGEAR

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

Table 18 : 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 –	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.

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	Short-term Shutdown (<7 days) Operating, Engineering)	Long-term Shutdown (>7days) (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	

3.20 EMERGENCY SUPPLIES

Table 19 : 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 20 : 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 H₂

Table 21 : 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 CO ₂ cylinders after air purge before. (Action Operating) e) Hydrogen is introduced into the generator, to ensure that 2x generator CO ₂ purge can be performed. (Action – Maintenance, Engineering)
Potential storage risks which need to be mitigated	a) Corrosion b) H ₂ fire / explosion	

3.23 SECONDARY PLANT

Table 22 : 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 always remain active and ready. (Action – Maintenance) e) Ensure all Transmission interfaces are reviewed. (Action – Maintenance and Engineering) f) HVAC systems to be functioning. (Action – Maintenance) g) Access to equipment to be controlled. (Action – Operating)	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 always remain active and ready. (Action – Maintenance) e) Ensure all Transmission interfaces are reviewed. (Action – Maintenance and Engineering) f) HVAC systems to be functioning. (Action – Maintenance) g) Access to equipment to be controlled. (Action – Operating)

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Potential storage risks which need to be mitigated	a) Inactive protection b) Inability to record disturbances. c) Premature failure of numerical type technology equipment d) People performing activities on devices that may be incorrect	

3.24 LIGHTING

Table 23 : 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	

3.25 HVAC

Table 24 : 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 always remain in service. (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 4 for Condenser cooling water side actions.

Table 25 : 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 be 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.	

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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 1. Another variation is shown in Figure 2.

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 1 can be described as follows:

Dry air is discharged from the dehumidifier (DH) into the hot well, 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 hot well 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.

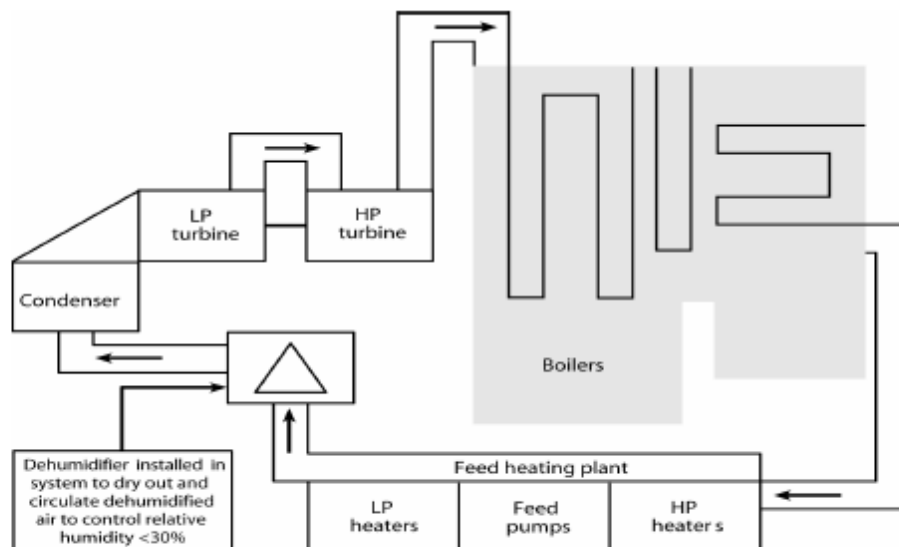


Figure 1: Option 1 - Block Diagram of Dehumidifier Steam/Feed Cycle

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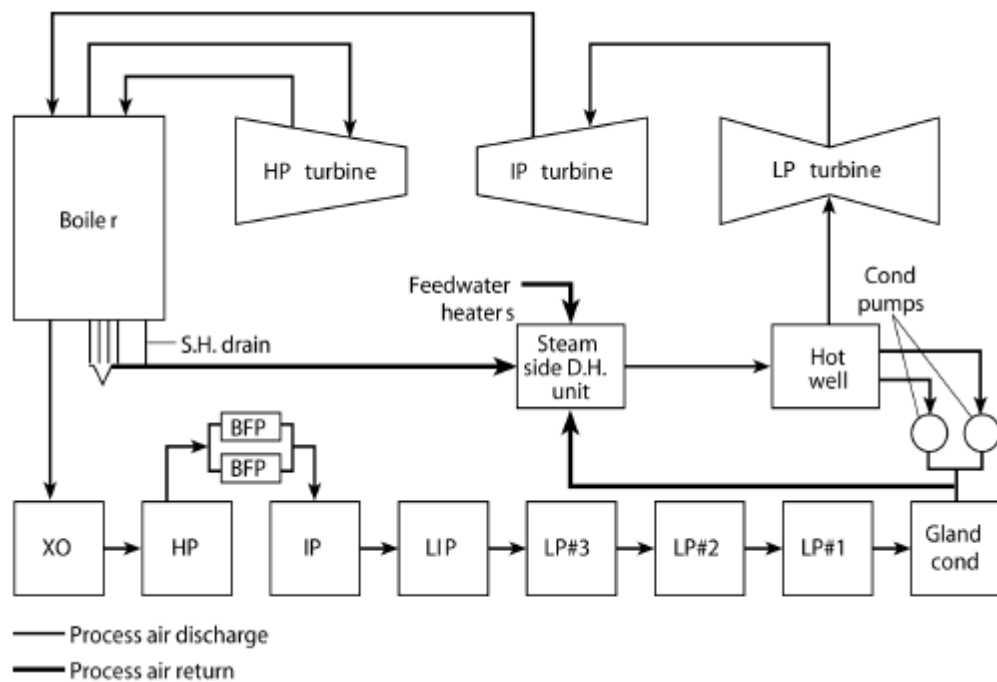


Figure 2: Option 2 - Steamside Dehumidification Flow

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) using 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 26 : 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.	

3.28 DUCTINGS – PRIMARY AIR, SECONDARY AIR AND FLUE GAS

Table 27 : 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 supply joint expansion bellows c) Failures of ducts due to limited allowance for thermal expansion during start-up and operation, because of fouled expansion bellows	

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3.29 AIR COOLED CONDENSER (ACC) FANS**Table 28 : Fan Preservation Actions**

	Short-term Shutdown (<30 days)	Long-term Shutdown (>30days)
Before shutdown	a) Check fan vibrations. (Action - Condition Monitoring)	a) Check fan vibrations. (Action - Condition Monitoring)
During shutdown	No actions	a) Analyse oil samples from a representative number of gearboxes 3 monthly for contamination and action as required. (Action - Condition Monitoring) b) Test run all fans every two months for 30 minutes to maintain an oil film on all bearing & gear surfaces. (Action – Operating)
Potential storage risks which need to be mitigated	a) General corrosion and moisture ingress. b) Fretting due to vibration from adjoining units. c) Grease gearbox output bearing and motor bearings before return to service.	

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6. 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)
March 2024	3.1	J Zwiigelaar	First Draft Document for Comments Review Process
June 2024	3.2	J Zwiigelaar	Final Draft Document after Comments Review Process
June 2024	4	J Zwiigelaar	Final Rev 4 Document for Authorisation and Publication

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