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1. INTRODUCTION

Power stations are required to maintain a minimum level of strategic spares, which include impellers for Forced Draught, Induced Draught and Primary Air Fans. It is essential that the impellers are stored in a manner that will prevent damage, irrespective of the time that the impellers remain in storage. This standard documents the requirements for preservation of these impellers.

2. SUPPORTING CLAUSES

2.1 SCOPE

2.1.1 Purpose

The purpose of this document is to prescribe minimum requirements for the storage and preservation of FD, ID and PA fan impellers and shafts, so that impellers remain fit for service.

2.1.2 Applicability

This document shall apply throughout Eskom Holdings Limited Divisions.

2.2 NORMATIVE/INFORMATIVE REFERENCES

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

2.2.1 Normative

- [1] ISO 9001 Quality Management Systems.
- [2] 240-61379840 Management and Reporting of Strategic Spares.

2.2.2 Informative

None

2.3 DEFINITIONS

Definition	Description
Authorised Rigger	A person who is licensed to operate a crane.
Denso Tape	Petroleum based anti-corrosion synthetic fabric tape
Hydraulic Power Pack	Mobile Electrically driven hydraulic pressure/flow providing system
Impeller	Rotating component of a fan.
MoS2 Dry spray	Molybdenum Disulphide Lubricant Spray
Rotating assembly	Assembled Axial Flow Impeller (s) with shaft and bearings
Shaft	Mechanical device for transmitting torque and rotation
Shaft Journal	Section where the bearing is fitted on a shaft.
Tectile	Petroleum based anti-corrosion spray (Normally a Stock item)
Trestles	Supports used to support the impeller shaft

2.3.1 Disclosure Classification

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

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2.4 ABBREVIATIONS

Abbreviation	Description
DE	Drive End
FD	Forced Draught
ID	Induced Draught
MMD	Mechanical Maintenance Department
NDE	Non-Drive End
NDT	Non-Destructive Testing
PA	Primary Air
PM	Planned time or schedule based maintenance carried out with an explicit objective
QCP	Quality Control Plan
SAP	Computer software program for Maintenance and Stores Management
SOW	Scope of Work

2.5 ROLES AND RESPONSIBILITIES

2.5.1 STORES

- Ensure that MMD and the Draught Plant System Engineer complete the required quality inspections and signed quality documentation before new or refurbished spares are booked into the stores.
- Ensure the impellers and shafts are stored as per storage requirements stipulated below.
- Ensure free movement of crane or forklift in area where the impeller must turn

2.5.2 MMD

(LINE FUNCTION IS RESPONSIBLE FOR UNPLANNED OUTAGE RELATED WORK AND OUTAGE MANAGEMENT FOR PLANNED OUTAGE RELATED WORK)

- Responsible for quality control on new / refurbished spares before they are booked into the stores. This includes capturing history on SAP (per serial number) and handing in a hard copy of the newly built/refurbished spares quality documentation at the documentation centre.
- Ensure that fan shafts are rotated at the prescribed intervals as per the PM (See also Section 3.3).
- Do a six-monthly visual inspection on the impellers and shafts. (See also Section 3.3.4).
- Should the impeller or shaft be moved for any reason, MMD and the Draught Plant system engineer must ensure that it is done by an authorized rigger to prevent any damage during handling. (See also Section 3.1.3).
- Arrange all repairs to be done on impellers and shafts according to SOW from System Engineer.
- Arrange shafting or de-shafting as required, including possible machining (reaming), purchase and installation of special size high-tensile bolts.

2.5.3 DRAUGHT GROUP SYSTEM ENGINEER

- Inspect damage and defects identified by MMD during the six-monthly inspection PM, and compile a scope of work for repairs.
- Review reports, including NDT done on the spare items, and initiate corrective actions if required.

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- c. Approves QCP's for impeller and shaft refurbishment, and indicate witness/hold points for the system engineer on the QCPs.
- d. Approves QCP's for manufacturing of replacement impellers and shafts, and indicate witness/hold points for the system engineer on the QCPs.

2.6 PROCESS FOR MONITORING

The monitoring of this process shall take place through the continual assessments and "spot checks" by the station quality engineer.

Application of this procedure shall be audited at least once every 3 years at each site.

2.7 RELATED/SUPPORTING DOCUMENTS

[1] SAP PM (Preventative Maintenance Schedule)

3. PROCEDURE

3.1 WHEN NEW/REFURBISHED STOCK ARRIVES:

3.1.1 Quality control on the spare

- a. MMD is responsible to visually inspect and confirm that the spare is according to specifications/drawings.
- b. MMD to visually inspect the spare for signs of damage during loading or transportation.
- c. MMD to ensure that the **quality documentation is supplied with the spare**, and that this documentation is complete – signed by MMD, the system engineer and the third-party inspector.
- d. MMD to visually check that the machined surfaces are covered with a protective coat (see 3.2), and that the shaft journals are wrapped with denso tape and covered with longitudinal wooden strips, which are strapped to the shaft.

3.1.2 Receipt of spares by stores

- a. Fan/impeller shaft spares can only be booked into stores upon receipt of quality documentation supplied by MMD.

3.1.3 Moving the spare into position

- a. An authorized rigger must co-ordinate the offloading and positioning of the spare, assisted by MMD.
- b. Care must be taken not to damage the shaft journals or any other machined surfaces with steel slings or chains. Impellers and shafts may not be lifted or supported at journal surfaces unless it is impossible any other way.
- c. Wherever possible, Nylon slings are to be used for lifting shafts. If steel slings and chains are used a rubber canvas must be placed between the shaft and sling
- d. For Shafted single stage Axial flow fans (with overhang impeller), it is of utmost importance to adhere to an approved rigging procedure (The rotating assembly 'centre of mass' is heavily off-set and require specific guidance for rigging).
- e. The rigging instruction must form part of the risk assessment and at least the Crane driver; Rigger as well as the System Engineer must have reviewed it.
- f. For double stage Axial flow fans (ID Fans), it is important to note that rigging/lifting is to be performed by lifting the entire rotating assembly with supporting transport stand – the lifting lugs on

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the assembly bearing housings is dedicated for lifting bearings ONLY – refer to the attached photo below.



Figure 1: Double stage axial flow fan assembly with bearings on a dedicated stand

- g. For Axial flow fans, rotating assemblies are ONLY transferred on/with dedicated supporting stands (it is an integral part of the rotating assembly)

3.2 STORAGE REQUIREMENTS

3.2.1 Centrifugal Fan Shafts and Shafted Impellers

- a. Impeller shafts must be stored on a solid, flat surface in a water and dust free environment, preferably indoors or in such a way that corrosion is prevented.
- b. The entire surface of the shafts - with the exception of the shaft journal areas, must be coated with a layer of red oxide paint. Before painting commences the surfaces must be cleaned using a wire brush (to remove scale and rust) and degreaser (to remove oil and grease).
- c. The journals must be protected against moisture and dust ingress by means of greased cloth/denso tape covering the entire journal surfaces. The cloth tape must be tied properly so that it does not become detached from the shaft journals. Protect the covered areas from damage by covering it with longitudinal wooden strips that are strapped round the shaft
- d. The flange surface must be covered with a layer of grease to prevent corrosion
- e. Shafts must be stored in a horizontal position, supported by at least two trestles
- f. The trestles must be designated/certified to carry the load of that particular weight safely
- g. When shafts are fitted with an impeller, the shaft must be supported as close to the impeller as practically possible. The impeller periphery may not rest on the ground or any other object.
- h. When shafts are NOT fitted with an impeller, the trestles must be placed approximately one third the shaft length from the ends. (See Figures 2 and 3 below)

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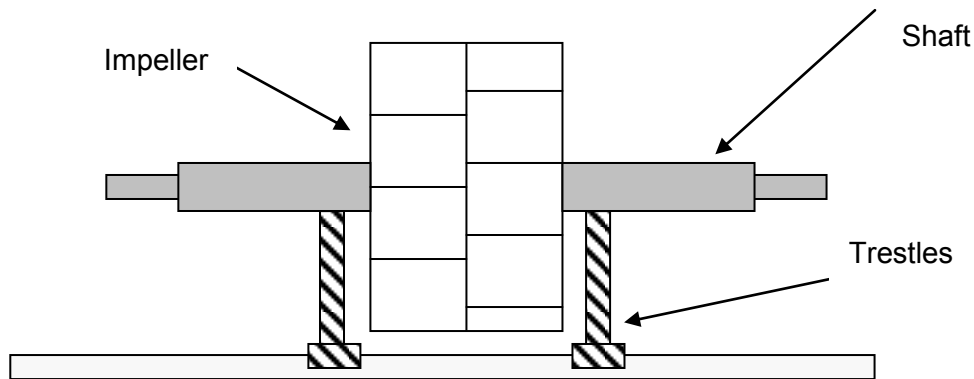


Figure 2: Storage of Shafted Impellers

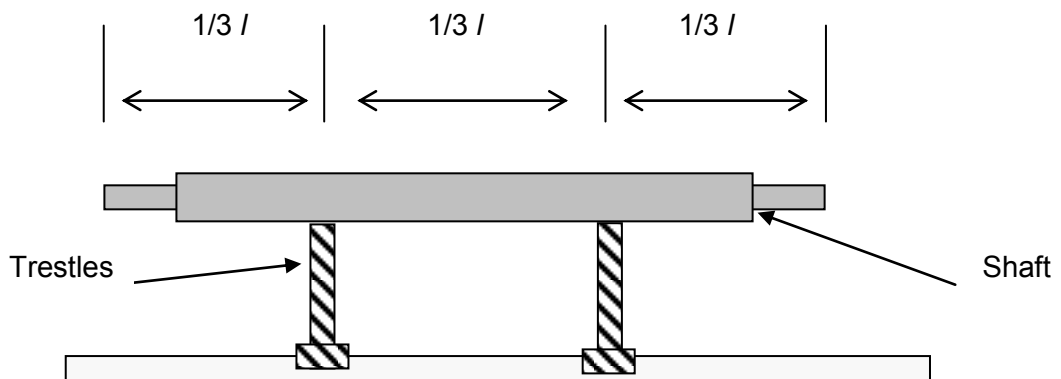


Figure 3: Storage of Shafts

3.2.2 Centrifugal Fan Impellers (not fitted to a shaft)

- Impellers must be stored on its side (horizontal) on a solid, flat surface in water and dust free environment, preferably indoors.
- The entire surface of the impellers must be coated with a layer of red oxide paint. Before painting commences the surfaces must be cleaned using a wire brush (to remove scale and rust) and degreaser (to remove oil and grease).
- The flange surface must be covered with a layer of grease to prevent corrosion
- Wood blocks must be placed underneath the impeller but enough blocks must be used to support the impeller weight evenly across its circumference
- Wood blocks must be of the same thickness

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3.2.3 Axial flow fan – Single stage (FD fans) Rotating Assembly (fitted to shaft)

- a. Rotating Assemblies are stored with Impeller mounted (shafted) to the shaft, and supported on dedicated stands. The NDE side must be supported as close as possible to the impeller, while avoiding machined bearing and seal surfaces.
- b. Rotating assembly shafts (excluding journal/seal areas) must be coated with a layer of red oxide paint (done by refurbishing contractor). Journal/seal areas are coated with a layer of multi-purpose grease and wrapped with DENSO tape. The coupling with brake disc must be wrapped with DENSO tape.
- c. The external machined Impeller area is to be corrosion protected with a tectile coating. The exposed blade shaft flanges must be also tectile coated with the caution NOT TO apply coating onto the PTFE bushes in the blade base port area. The Impeller area must be covered with a dedicated canvas to conceal the exposed blade pitching shafts/flanges.

3.2.4 Axial flow fan – Double stage (ID Fans) Rotating Assembly (fitted to shaft and bearings)

- a. Rotating assemblies are stored with Impeller mounted (shafted) to the shaft and bearings, and the entire assembly is supported in a dedicated stand. The supporting stand facilitates easy rotation of the impeller with the caution that white metal bearings need to be supplied with forced lubrication BEFORE attempting to rotate.
- b. The external machined Impeller area is to be corrosion protected with red oxide paint. The exposed blade shaft flanges must be coated with MSO2 Dry spray (according to OEM recommendation), with the caution NOT TO apply coating onto the PTFE bushes in the blade base port area. The Rotating Assembly is to be covered with a dedicated canvas to conceal the exposed blade pitching shafts/flanges.

3.3 ROTATION AND INSPECTION DURING STORAGE**3.3.1 Shaft Rotation for a Centrifugal fan rotor**

- a. The shafted impeller assemblies must be rotated every 3 months through 90 degrees to prevent sagging of the shaft. Divide the impeller in to four quarters and mark 1, 2, 3 and 4 on the drive plate. Set No. 1 in the center top for the first quarter then No. 2 for the second quarter and continue until No 4 is reached. Include an arrow drawn on the drive plate to indicate direction of rotation. Affix a form (see Appendix A – or similar) showing the date and direction of rotation and the signature of the person that turned the impeller. Rotation must always continue in the same direction. Sling around the shaft as close as possible to the impeller, and lift the assembly just enough to allow rotating of the impeller.
- b. Bare shafts must be rotated every 6 months through 90 degrees to prevent sagging of the shaft, using the same procedure outlined in a. above.
- c. When rotating the shafts, ensure that the shaft surfaces are not damaged (see 3.1.3), and that suitable trestles are used for support.
- d. The trestles must be placed in the positions given in section 3.2.

3.3.2 Shaft Rotation for Single stage Axial flow fan Rotating assembly

- a. The shafted impeller assemblies must be rotated every 3 months through 90 degrees to prevent sagging of the shaft. Divide the runner in to four quarters and mark 1, 2, 3 and 4 on the drive plate. Set No. 1 in the center top for the first quarter then No. 2 for the second quarter and continue until No 4 is reached. Include an arrow drawn on the drive plate to indicate direction of rotation. Affix a form (see Appendix A – or similar) showing the date and direction of rotation and the signature of the person that turned the impeller. Rotation must always continue in the same direction.

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- b. The impeller is to be positioned on the stand wedges with a rubber insert on contact surface.
- c. It is recommended to inspect the rubbing/contact surface between the rotated shaft and support stands, ensuring there is no debris in the contact wedge, and apply oil as lubricant to facilitate turning.
- d. Sling around the shaft as close as possible to the impeller, and lift the assembly just enough to allow rotating of the impeller.
- e. Connect the hydraulic power pack to the blade pitching system, in order to facilitate the exercising of the blade pitch mechanism. (A dedicated procedure for connection and hydraulic system set-up is required)
- f. Rotate the blade pitch position from max to min for approx. 10 cycles, where after the hydraulic system can be switched off and disconnected

3.3.3 Shaft Rotation for a Double stage Axial flow fan Rotating assembly

- a. The shafted impeller assemblies must be rotated every 3 months through 90 degrees to prevent sagging of the shaft. Divide the runner in to four quarters and mark 1, 2, 3 and 4 on the drive plate. Set No. 1 in the center top for the first quarter then No. 2 for the second quarter and continue until No 4 is reached. Include an arrow drawn on the drive plate to indicate direction of rotation. Affix a form (see Appendix A – or similar) showing the date and direction of rotation and the signature of the person that turned the impeller. Rotation must always continue in the same direction.
- b. Connect a dedicated Hydraulic power pack with connecting hoses to the bearing supply and return connections, in order to circulate oil through the bearings. (A dedicated procedure for connection and hydraulic system set-up is required)
- c. With stable oil circulation, rotate the double impeller by hand as stipulated above, where after the hydraulic power pack can be switched off and disconnected.
- d. Connect the hydraulic power pack to the blade pitching system, in order to facilitate the exercising of the blade pitch mechanism. (A dedicated procedure for connection and hydraulic system set-up is required)
- e. Rotate the blade pitch position from max to min for approx. 10 cycles, where after the hydraulic system can be switched off and disconnected.

3.3.4 Visual Inspection

- a. Inspect the impeller and shaft surfaces for signs of corrosion or mechanical damage. Check the condition of the red oxide paint layer.
- b. Inspect the journals on a yearly basis if stored outdoors and three yearly if stored indoors
- c. Remove the protection paint with thinners and inspect for rust and pitting. Refer to the Engineering Department if rust or pitting is visible. Dry thoroughly and repaint with bright part red paint. Allow to dry and cover with new denso tape and longitudinal wooden strips. **NB!! Do not remove by scraping with any hard material; only use a cloth and cleaning fluid!**
- d. Inspect the condition of the flange surface (applicable to shafts and impellers that are not assembled) for corrosion. This surface should be covered with a layer of grease.

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4. AUTHORISATION

This document has been seen and accepted by:

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5. REVISIONS

Date	Rev.	Compiler	Remarks
January 2017	0	M. Lander	To specify minimum requirements to preserve Impellers and shafts in storage
January 2017	0.1	M. Lander	Connie Bunce updated format, styles, etc
March 2017	0.2	M. Lander	Updated by M. lander
April 2017	0.3	M. Lander	Final Draft Document for Comments Review
May 2017	0.4	M. Lander	Final including comments from Comments review
May 2017	1	M. Lander	Final Document for Authorisation and Publication

6. DEVELOPMENT TEAM

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

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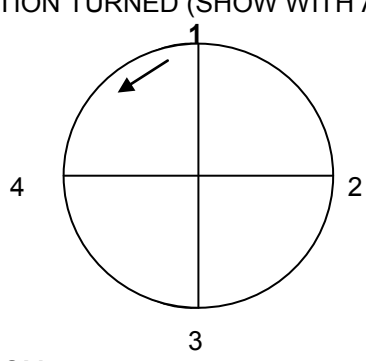
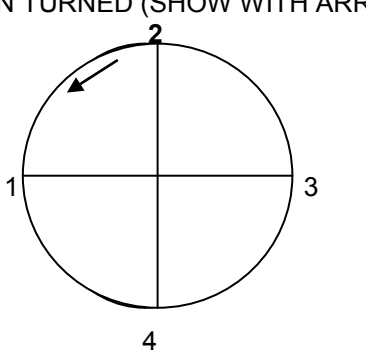
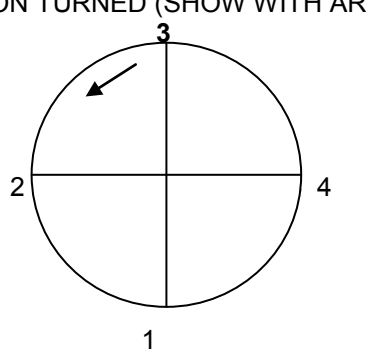
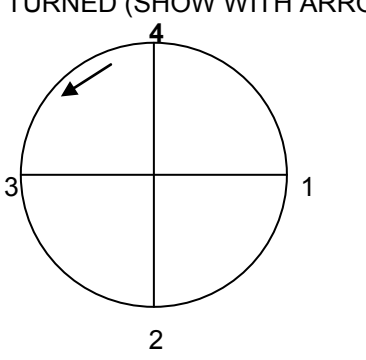
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7. APPENDIX A: FAN SHAFT ROTATION RECORD

IMPELLER/SHAFT SERIAL NUMBER.....

SHAFT SERIAL NUMBER.....

Date impeller/shaft was delivered to site:.....

FIRST QUARTER DIRECTION TURNED (SHOW WITH ARROW)  BY WHOM: DATE:	SECOND QUARTER DIRECTION TURNED (SHOW WITH ARROW)  BY WHOM: DATE:
THIRD QUARTER DIRECTION TURNED (SHOW WITH ARROW)  BY WHOM: DATE:	FOURTH QUARTER DIRECTION TURNED (SHOW WITH ARROW)  BY WHOM: DATE:

COMMENTS: When last were the journals inspected Date:.....

Any mechanical or visible damage:

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