| INTERPLANT STANDARD - STEEL INDUSTRY | | |
|---|---|---|
| IPSS | **CODE OF PRACTICE FOR OVERHAULING OF SLIPRING INDUCTION MOTORS WITH ANTI-FRICTION AND SLIDING BEARINGS** | **IPSS:1-03-036-04** |
| | Corresponding IS does not exist | |

## 0. FOREWORD

0.1 This Inter Plant Standard has been prepared by the Standards Committee on Rotating Electrical Machinery , IPSS 1:3 with the active participation of the representatives of the steel plants and major consultancy organizations and was adopted in June 2004.

## 1. SCOPE

1.1 This Interplant standard covers overhauling of slipring induction motors with anti-friction and sliding bearings. This standard provides some checks and limits of fitment for components of slipring induction motors viz. bearing, housing, coupling, etc during dismantling and assemblying of machines

1.2 Feedback of motor performance with correct alignment and coupling to be obtained & recorded.

## 2. GENERAL CONSIDERATIONS

2.1 Frequency of the overhauling should be decided on the basis of recommendations of manufacturer and the experience of the user, operating conditions & condition monitoring.

2.2 Replacement of defective components, to be planned/done during overhaul after proper pre-planning.

## 3. DOCUMENTATION

3.1 Proper & systematic documentation of identifiable components during dismantling of motors must be done.

3.2 Recording of various parameters, viz, bearing clearances, stator and rotor winding resistance & inductance, slipring dia before and after turning, insulation resistance of insulation of brush holder assembly insulation resistance before & after assembly is a must.

## 4. PRE-DISMANTLING ACTIVITIES

4.1 Carry-out visual external examination.

4.2 Record Machine Nameplate & Serial Number of the Motor.

4.3 Check for any missing parts & record.

4.4 Check insulation resistance of the stator and rotor.

4.5 Remove all dirt & dust from motor body. Motor to be cleaned externally, preferably in a de-dusting chamber with dry compressed air.

4.6 Before removing the motor from foundation, check alignment, foundation marking and coupling gap shaft axial clearance & record. Also check air gap and stator rotor coil alignment in case of sliding bearing motors. Shaft and coupling flange run out to be checked and recorded. Rotor shaft at both ends to be tied firmly by Manila rope with stator body before lifting the motor from the foundation.

4.7 Check the condition of slipring and the brush holder assembly, check the carbon brushes for free movement in the brush holder. Observe any abnormal heating mark of the pig tail. Check and record any threading, grooving on the sliprings.

## 5. DISMANTLING

5.1 All dismantable parts to be properly marked.

5.2 All fasteners removed to be properly marked and placed in ONE container.

5.2.1 *Motors with anti-friction bearings* – The bearing no. with designated clearance to be noted.

5.2.2. *Motors with sliding bearing* – Check bearing clearances axial play and condition of grease & record. This is required to be done both for anti-friction as well as sliding bearings prior to complete dismantling of the motor. Check slipring condition for any threading, grooving and ovality. Check security of slipring end connection (brazing condition), rotor to slipring connecting lead clamping, brush holder spring tension, etc. Also check air gap, stator and rotor, core alignment, in case of sliding bearing motor. The matching marks for TOP & BOTTOM halves of the bearing covers as well as sleeves are to be read & accordingly markings are to be given for its locating positions. Check, measure and record if any packing (sheams) is given between top half of bearing cover and top of bearing bush.

5.2.2.1 *Motors with SLIDING BEARING mounted on pedestals* – The bearing housings, the bearing bushes, oil rings, labyrinths, thermometers, etc, are to be taken out very carefully after properly identification w.r.t. individual pedestals. Shaft level is to be checked at both the journals and recorded in heavy duty/large motors.

5.2.2.2 Rotor shaft journals are to be protected by wrapping it with Wax paper.

5.2.2.3 Oil pipelines connected to bearings must be disconnected before dismantling the bearings.

5.2.2.4 All components viz, coupling end shields, grease caps, bearing housings, lockrings, lock-nuts, etc, to be removed carefully, identification of parts by paint numerals to be done for both DE & NDE side.

5.3 Remove cooling system/heat exchangers provided on the top of the motor.

5.4 **Removal of Rotor** :

a) A rubber gasket/prespon gasket of suitable thickness is inserted into the bottom half of the air-gap.

b) Remove both stator & rotor at a time to separate place & place it on a pre-arranged stand. Care is to be taken to ensure that the load is absolutely balanced. The rotor to be lifted with the crane hook while taking precaution that the sling does not damage the overhang winding. Wooden piece of suitable thickness to be given as packing. While threading out/in the rotor from/into the stator it must be leveled to avoid damage inside the motor.

c) Depending on the size of the motor, a balance beam with a ratchet hoist may be deployed. Otherwise the job can be completed with the help of any kind of Crane.

5.4.1 The job can be carried out by any one of the following methods :

a) With the help of a balance beam & a ratchet hoist.

b) Use of two hooks of the crane (where available) & two pipes at both ends.

c) Use of traverse with sliding rollers & with screw jacking up facility. The traverse will hold one of the rotor shaft and other end with pipe to be held by crane hook.

d) Use of single pipe in a cantilever manner and with the help of traverse held by both the hooks.

e) Use of single pipe in cantilever manner with manual labour to balance the weight of the rotor at one end of the pipe.

## 6. INSPECTION OF INTERNAL PARTS

6.1 Stator & rotor to be cleaned thoroughly by dry compressed air in a dedusting chamber. Where such chambers are not available, it should be done in an open space, so that the dust does not enter into other motors. Then apply suitable solvents to remove settled oil, dust & grime.

6.2 Check insulation resistance of the stator windings. Check overhang portion of the windings. Check looseness of the slot wedges. Check for hot points (loose connections) in end connections. Check condition of connecting leads & terminal insulators.

6.2.1 Check insulation resistance of the rotor assembly. Check overhung portion of the rotor assembly including condition of the binding. Also check the resiglass bondage condition in the overhang portion. Check sliprings including their connections. Check surface of the sliprings. Measure slipring diameter and record. Check for any loose or hot connections in the rotor winding & slipring termination. Check termination of slipring brush holder connecting leads to the terminal box of the motor. Check the condition of brush holder arm insulation, spring tension and thoroughly inspect the brush holder box for any crack in the side brazing.

6.3 Check core laminations, ventilation ducts, fan/fan hub, blade profile, cracks in rotor bars/shorting rings, looseness in lock nuts & wear out of bearing seating.

6.3.1 Test all the insulated components for IR, current balance, uniform heating of winding, proper formation of poles etc. The voltage applied should be so regulated that the current does not exceed the rated capacity of the component. Keep the current for atleast 15 minutes & then switch off. Touch by hand all over the winding and core. Localised hotspots in the core indicate shorted core and likely to cause failure of the winding. Further investigation to be done by core flux test method. If hotspots are too hot or too many in the stator, re-stacking of the core is the only solution and should be considered only if it is found economical. Similar tests to be carried out on wound rotor also.

6.4 In case of motors with sliding bearing, condition of the journal surface to be examined for smoothness including condition of bearing.

6.5 All other accessories related to bearings are to be critically inspected for defect.

6.6 A complete condition list is to be prepared before actual overhauling process is started.

6.7 Laminations in stator and rotor, rotor winding, end brazing condition, security of stator and rotor core, end plate locking, check and clean for any blockage of

stator or rotor, radial/axial, ventilation ducts. Check for security tightness of balancing weight of rotor, ventilation fan and record any abnormality.

## 7. OVERHAULING

### 7.1 Bearings

7.1.1 *Anti-friction bearings* – clean the bearing thoroughly with kerosene/a suitable solvent and marking cloth and check surface conditions for pits, burns, dents, scratches, etc.

7.1.1.1 Check rollers and balls for any visible defects. Check condition of the cage.

7.1.1.2 Measure bearing clearances by lead wire.

7.1.1.3 If the condition of the bearing is good and bearing clearances are within normal limits, then protect the bearing by wrapping it with Wax paper. Bearing can be smeared with machine oil.

7.1.1.4 If the bearing is found defective, replace with a new bearing after taking precautions to avoid application of spurious bearing.

7.1.1.5 Clean and check other parts of the bearings, viz, seals, grease caps, clearance of grease cap with the shaft.

7.1.1.6(a) Bearing housing should be removed and bearing seating surface on the rotor shaft to be checked and measured. Remedial measures to be taken if bearing inner race is found loose on the shaft. Similarly, inner surface of bearing housing should be checked with reference to the outer race of the bearing.

7.1.1.6(b) Replace defective bearing. Use bearing puller for taking out the bearings. Use recommended cleaning agent for removing conservative grease from the new bearing. After measurement of bearing gap of the new bearing, compare the observed data with respect to allowable limits (earlier table as above). For correct fitment of bearing, measure shaft dia at the bearing seating surface and measure internal dia of the bearing inner race. For mounting bearing, use oil bath for heating upto 100°C or make use of induction heating process. For mounting the bearing, use of hammer is strictly prohibited. However, if unavoidable, copper or teflon hammer is to be used. After attaining room temperature check fitness and grease the bearing with recommended grease grade. Check for free rotation of the bearing and ensure that there is no pre-loading of the bearing.

7.1.1.7 Coupling seating surface should be polished. Keyway on shaft should be checked for any deformation. Key fitting in the keyway should be checked properly. No sideway gap is permissible in shaft/coupling

keyway, however, ensure clearances of 0.2 mm or more in the top of the key after fitting of the coupling. No sideway gap is permissible in shaft/ coupling keyway, however, ensure clearances of 0.2 mm or more in the top of the key.

*7.1.2 Sliding Bearings*

7.1.1.1 Check surface polish condition of the shaft journal. Retain surface glaze by polishing wherever necessary with coconut cordage soaked in oil or with felt and smooth grinding paste (Molybiddnem di sulphide).

**NOTE : Use of Emery Cloth is to be strictly avoided.**

7.1.1.2 Check white/babbit metal condition of the lower and upper halves of the bushes. In case of any defects, viz, unusual wear, breakage bearing metal on liner, choking of oil passage, etc, replace the bearing.

7.1.1.3 Check for ovality deformation and cracks in the oil rings. Defective rings to be replaced. Also check the labyrinths and clean oil grooves and holes.

**NOTE** – For checking of ovality of rings permissible difference between mutually perpendicular dia is 0.5-1.0% of ring dia.

7.1.1.4 Rotor journal radial clearance to be checked with led wire. For a shaft diameter of 100 to 200 mm, the permissible radial runout of the shaft journal is not to exceed 0.02 mm and that of the shaft diameter above 200 mm it is not be to be over 0.03 mm. At the shaft where labyrinths are fitted, the run-out is not to exceed 0.05 to 0.06 mm. However, in case of a working rotor having vibration within norm, it can be overlooked.

7.1.1.5 While fitting the bushes of the non-split bearings, measure shaft journal diameter with outside micrometer and the bush internal dia with an internal micrometer, feeler gauges may be used to measure gaps of an assembled bearing. The clearances between the shaft journal and the bush must be within norms given in **Annexure-I**.

7.1.1.5.1 For split bush bearings, clearances (a1, a2, a3) should be measured. Collar and oil pocket clearances should also be measured and recorded (Refer Annexure-V). Bearing clearances for split bush bearings can be between 0.1 to 0.25% of the shaft journal diameter in case of oil ring lubricated bearings subject to a maximum of 0.45mm. Bearings having forced oil lubrication can have bearing clearances between 0.15 to 0.35% of the shaft journal diameter subject to a maximum of 0.45 mm.

7.1.1.6 Proper fitment of non-split bushes is to be ensured. In case end-shield housing gap w.r.t. sleeve bearing is found more, it would then be necessary to repair or replace the end-shield or sleeve. The sleeve has to

just fit in the end-shield and this has to be ensured. For split bushes refer clause 8.3 later.

7.1.1.7 In case of motors with separate pedestals for sleeve bearings, oil sumps are cleaned after draining out the used oil at a frequency as decided by the condition of the oil, but definitely NOT later than three years of service. The oil taken out may again be re-used after reconditioning. Pedestal insulation resistance is checked and if found low, these insulating plates and insulated dowel pins are taken out. Defective plates are replaced with similar good plates and other plates are dried, varnished before re-fixing. All defective threaded holes are reworked. Oil level indicating glasses and reflectors are cleaned.

The procedure for checking the pedestal insulation is given in **Annexure-II**.

## 7.2 Heat Exchanger and Cooling System

7.2.1 Heat exchanger tubes should be checked and cleaned with suitable industrial cleaner. In case of water cooled heat exchanger, pressure testing with water to be done to ensure there is no tube leakage. In case tube leakage is observed, then the same can be plugged subjected to maximum 5% plugging of tubes.

7.2.2 All accumulated muck, etc, found inside the tubes or in the air circuit to be thoroughly cleaned.

## 7.3 Stator

7.3.1 After ensuring electrical healthiness of the stator winding and with no apparent damage to the stator winding, thorough cleaning with suitable solvent viz CTC or equivalent to be carried out. However, if the winding condition does not require any solvent for cleaning, only dry compressed air may be used. Solvent should be chemically inactive with the organic insulating material and should have no hygroscopic properties. It is preferable to use cleaning agent (solvent) which are not prone to fire and injurious to health of person working with it.

7.3.2 All pores of the ventilation ducts are to be cleaned with wooden sticks and thin nylon brushes. Precaution is to be taken so that the winding insulation inside the slot is not affected.

7.3.3 Clean the winding with spray jet in which mixture of compressed air and with suitable solvent as given in 7.3.1 is to be used to remove oily dirt.

7.3.4 In the case of re-wedging, it should start from the middle of the stator core proceeding towards both ends. The grooves in the wedges should coincide with the ventilating ducts in the core when properly fitted. While driving the wedges, care should be taken to avoid damage to the winding insulation. The

wedges should be made tight by providing spacers of suitable thickness. Use EPOXY REDJEL or equivalent along with suitable hardener in the prescribed ratio (100:35) by weight and prepare the glue mix for application on the spacers and wedges. Consume the glue mix within 4 hours after its preparation as per **Annexure-III**.

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7.3.6 Varnish the stator by air-drying varnish after completely drying the stator winding and ensuring Absorption co-efficient >1.3 (R60/R15).

7.3.7 Winding healthiness to be checked as per clause 9 (Final Testing as per Annexure-IV) and Test results to be recorded.

**7.4 End Shield & other Parts**

7.4.1 Clean end shields. Check for any surface cracks, dents, etc inner diametric surface where outer race of bearing fits should be thoroughly checked for any depression, groove, ovality, dents, cracks, etc. Rectify defects or use new end shields. Also check end shield bearing installation, if provided. Check the end shield bearing housing insulation (in case of HT Motors only).

7.4.2 Bearing outer race diameter and inside of the end shield to be measured and compared. A slide fit should be achieved so that outer race of bearing just fit in by slight tapping. However, ensure that this should not be loose fitted.

7.4.3 Fan blades fixing on fan hub are to be examined and any broken rivet or welding joint loose or missing balancing weights to be reworked to ensure proper fan condition.

7.4.4 End-shield collar which is fitting into stator body should be carefully examined and any defect observed should be rectified.

7.5 Rotor

7.5.1 The rotor is to be checked on a lathe for trueness of the sliprings. If it is out of centre for more than 0.1 mm, it will need machining. If the sliprings are worn out and the balance depth of the ring is 5 mm or less, the slipring assembly is to be replaced as a whole. This will be true for both moulded and assembled slipring.

7.5.2 The end threads on rotor shaft for locking of coupling should be refreshed where ever necessary.

7.5.3 The brush holders should be checked for their soundness of springs as they loose tension over a period of prolonged use due to repeated heat cycles.

7.5.4 Carbon brushes should be checked for their freeness inside the brush-box, broken pig-tails, height of the brush reached to its minimum mark, broken & burnt edges, etc. Radial clearance between the brush box and the slipring should be as maintained in the original machine.

7.5.5 Brush holder arms should be re-insulated and tested as per the rating of the motor.

7.5.6 Test all the insulated components for IR, current balance, uniform heating of winding, proper formation of poles etc. The voltage applied should be so regulated that the current does not exceed the rated capacity of the component. Keep the current for atleast 15 minutes & then switch off. Touch by hand all over the winding and core. Localised hotspots in the core indicate shorted core and likely to cause failure of the winding. Further investigation to be done by core flux test method. If hotspots are too hot or too many in the stator, re-stacking of the core is the only solution and should be considered only if it is found economical. Similar tests to be carried out on both stator and rotor.

7.5.7 A HV test with appropriate voltage level is to be carried out after repairs depending upon the voltage rating of the motor, in addition to PI determination for both stator and rotor separately (This has to be decided based on the Rating Plate of the Motor). Refer Annexure-IV for testing method.

**7.6 Rotor Assembly**

7.6.1 Rotor is inserted in accordance with the method explained at clause 5.4 & 5.4.1. While insertion, care must be taken to ensure that rotor parts do not rub/damage stator winding.

7.6.2 Fixing end-shield should start from the ball bearing side end/non driving end. Hammering should not be resorted to while fixing the end shield. However, uniform gentle tapping or use of extended studs should be resorted to. Wherever locating pins are provided, these should be driven in first before final tightening of end shield bolts.

7.6.3 Ensure proper tightening of bearing housing, grease cup bolts on the end shields.

7.6.4 Fix other side of the end shield similarly.

7.6.5 External fan hub should he keyed fit. Tighten the lock bolt after proper fixing of the fan.

7.6.6 Check grease pipe and grease nipple and clean with kerosene oil.

7.6.7 Check thermometer fixing and ensure that thermometer lead does not touch any rotating parts.

7.6.8 Fit brush holder assembly on the slipring. Mount carbon brushes inside the brush holders. Check freeness of the carbon brush inside the brush box. Connect pig-tails to the connecting terminals.

7.6.9 Check free rotation of rotor and observe. If free rotation is normal, send the motor for power trial purpose to test bed.

## 8. MOTOR FITTED WITH SLIDING BEARINGS

8.1 The rotor is inserted into the stator safely with the help of traverse and crane main/auxiliary hook. Rotor is tied firmly with stator body by manila rope at both ends. It is then lifted & placed on foundation by crane.

### 8.2 Fitting of sliding bearing

8.2.1 In case of split bearing; oil rings, shell, pedestal foundation bolt tightness, oil level indicating glass, reflectors brightness and oil drain out plugs are ensured for proper fitment.

8.2.2 For insertion of lower bush of split bearing, the rotor is lifted and positioned just above pedestal so that the shaft journal and the lower bush are exactly accommodated in the pedestal.

8.2.3 In case a new split bearing is used : a1, a2, a3 gaps and collar clearances are measured and adjusted. Oil pockets are made as per **Annexure-IV**.

8.2.4 Bearing matching by rotating shaft twice or thrice on lower bush babbit surface and scrapping glittering high point (spots) is carried out. 2 to 5 spots per sq. cm area is to be achieved. Then knurling on babbit surface at 10 to 15 mm distance from one another is done. This process of knurling is also called making oil grooves.

8.2.5 In case of non-split bearing shells, shaft journal is coated with a thin layer of paint (ultramarine). The bearing shell is then rotated two or three rotations on the shaft. Paint's spots on the babbited surface is then scraped and by this process 2 to 5 mark per sq. cm area over an arc of 60°C -120°C is achieved.

8.2.6 Bearings are boxed up in the pedestal and labyrinths are provided with proper gaskets. Labyrinth gaps are adjusted as per norm given in **Table-2** of Annexure-I.

8.2.7 Oil, as per grade recommended by the motor manufacturer, is filled in the pedestal sump upto the mark in the indicating glass. Thermometers are then placed in position.

**8.3 Fitting of external fans and other accessories**

8.3.1 External fan hub should be keyed fit. Tighten the lock bolt after proper fixing of the fan.

8.3.2 Check grease pipe and grease nipple for free flow of grease in the bearings.

8.3.3 Check thermometer fixing and ensure that thermometer lead does not touch any rotating parts.

8.3.4 Check free rotation of rotor and observe. If free rotation is normal, send the motor for trial & test to the Test bed.

**8.4 Final alignment & Air gap adjustment**

8.4.1 External fan hub should be keyed fit. Tighten the lock bolt after proper fixing of the fan. The axial and radial tolerance limits for alignments of half couplings by Four Dial Gauge method is given in **Annexure-V**.

The axial tolerance is given per 100 mm of distance of dial gauge tip from centre to shaft.

8.4.2 Air gap is then adjusted and maximum permissible variation is kept within $\pm$ 10% of average gap. Magnetic core adjustment is also done with air gap.

8.4.3 Winding covers, air baffle rings, end covers, etc, are fitted and it is ensured that they must not foul with the rotor rotating parts. Here all clearances are precisely adjusted as per suppliers manual guide or pre-dismantling data.

8.4.4 In motors where extra shims are provided on end-shield to align the stator & rotor, these are re-fitted in accordance with pre-dismantling identification.

8.4.5 Insulation resistance of insulating plates, pins, bushes on motor free end pedestal is ensured.

**9. FINAL TESTING**

9.1 **Preliminary Tests** - Following tests are to be carried out before the motor is run on trial.

*9.1.1 Visual inspection*

*9.1.2 Measure insulation resistance*

9.1.2.1 The phase to phase and phase to earth insulation resistance (M-Ohms) at the working temperature of the machine shall not be lower than the value found from the equation :

$$R60 = \frac{V \text{ rated}}{(1000+0.01P)}$$

Where V rated = Rated voltage in Volts
P = Rated output (kVA)

However, as a rule, the insulation resistance should not be lower than 0.5 M-Ohms for LT Machines.

9.1.3 Measure resistance and inductance per phase. Measured value of motor resistance (stator & sound rotor) shall match with the corresponding values indicated in manufacturer's test report (Ref. Cl. No. 22.3.1 b of IS 325:1996 for Type Test).

*9.1.4 Measure dc winding resistance*

9.1.4.1 The difference in dc resistance must not exceed 2% between different phases. The results of measurement must not differ by 2% also from the manufacturers data.

9.1.5 Balance Test

9.1.6 Inter Turn Test

9.1.7 Measure Absorption Co-efficient (>1.3)

Degree of insulation dampness is estimated by :

$$\mathbf{K = \frac{R60}{R15.}}$$

The value of K above 1.3 indicates that insulation is dry. When K is less than 1.3, the machine requires drying.

9.1.8 All the above tests are to be carried out for Rotor also.

9.2 No load running Test (only for motors with anti-friction bearings).

9.2.1 Before starting the test it will be necessary to short the rotor winding at slipring with a heavy gauge conductor. If facility for running the motor with rotor resistance exists, it should not be utilised.

a) Connect motor terminals to a three phase variable voltage source.

b) Increase voltage gradually till the rated speed is achieved, preferably at rated voltage in case of a LT motor.

c) Measure RPM

d) Measure current in each phase of both Stator & Rotor.

e) Check bearing condition with bearing analyser.

f) Check temperature rise of the motor bearing after one hour of running at rated speed.

g) Check vibration of the motor with vibrometer & record.

9.3 No load running in the case of motors with sleeve bearings shall be done after fixing the motor on its base.

9.4 Declare motor ready for despatch.

**ANNEXURE-I**

## TABLE – 1

## PERMISSIBLE CLEARANCES BETWEEN THE SHAFT JOURNAL AND BUSH OF A NON-SPLIT BEARING

| Shaft Diameter mm | CLEARANCES BETWEEN SHAFT JOURNAL AND BUSH OF A NON-SPLIT RING LUBRICATED BEARING (mm) | | | |
|---|---|---|---|---|
| | Free Running Fit for Machines Running at upto 1000 R/min | | Loose Running Fit for Machines Running at 1000 R/min and Higher Speed | |
| | Minimum | Maximum | Minimum | Maximum |
| 80-120 | 0.08 | 0.12 | 0.12 | 0.17 |
| 120-180 | 0.10 | 0.15 | 0.15 | 0.21 |
| 180-260 | 0.12 | 0.18 | 0.18 | 0.25 |
| 260-360 | 0.14 | 0.21 | 0.21 | 0.29 |
| 360-500 | 0.17 | 0.24 | 0.25 | 0.34 |

## TABLE – 2

## LABYRINTH CLEARANCES

| Shaft Diameter mm | Clearance between shaft & Labyrinth |
|---|---|
| 50-80 | 0.08 |
| 80-120 | 0.1 |
| 120-150 | 0.12 |
| 180-240 | 0.13 |
| 260-360 | 0.14 |
| 360-500 | 0.15 |
| 750 | 0.15-0.2 |

**ANNEXURE-II**

# INDUCED SHAFT & BEARING CURRENTS

The leakage magnetic fields in long electric machines generate a voltage in the rotor shaft. This induced voltage causes induced currents through the bearings and bed-plates. The resultant electrolitic action causes gradual pitting and subsequent failure of bearings and possible sludging of the lubricating oil. To eliminate shaft currents, the outboard bearing shell is insulated from the housing of one outboard bearing pedestal needs to be insulated from ground. All oil piping connections, etc, which are connected to the shaft or bearing must also be insulated. The shell or pedestal insulation should be kept clean and should not be painted with metallic or other non-insulating paints.

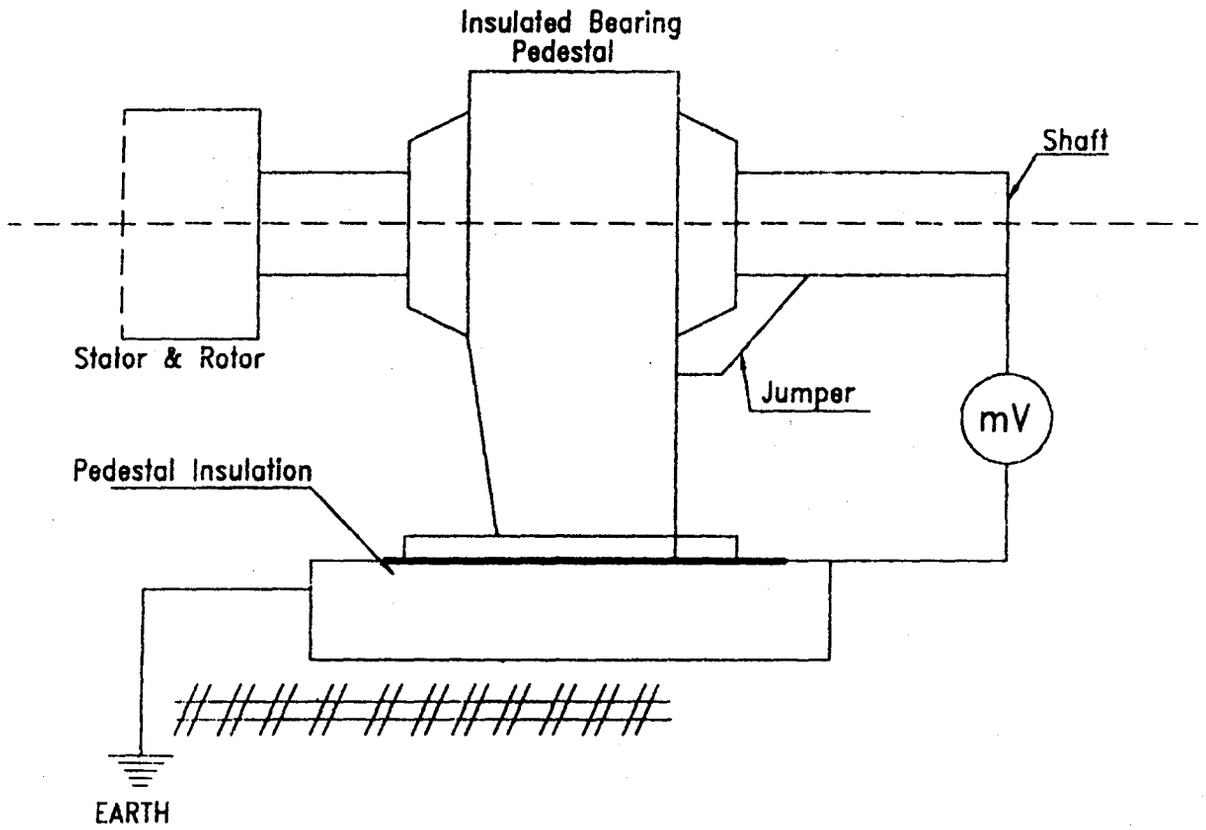



Fig.: Testing Bearing Pedestal Insulation

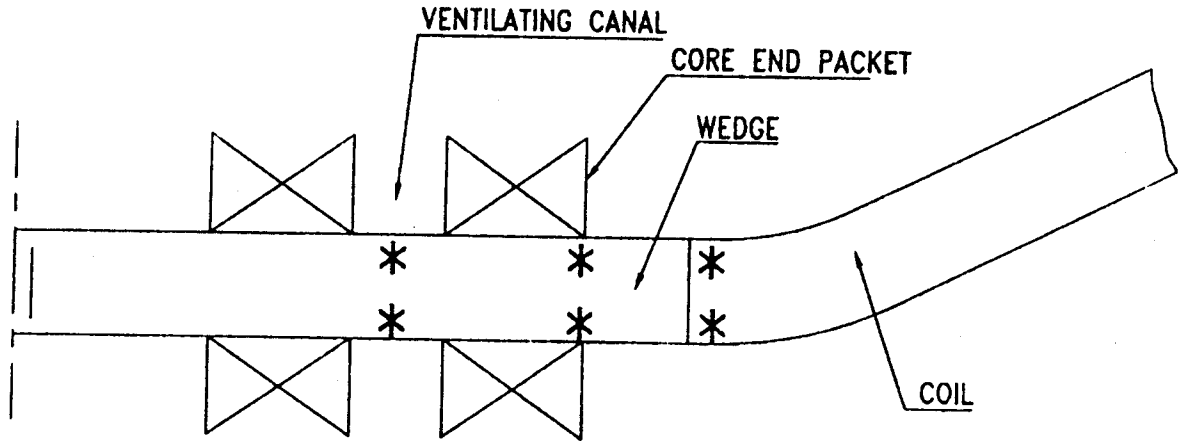
To measure the value of the pedestal insulation two readings are to be taken after disconnecting the external earthing connection.

a. mV rading to be taken, with a jumper connecting the shaft to the pedestal.
b. mV reading taken without jumper.

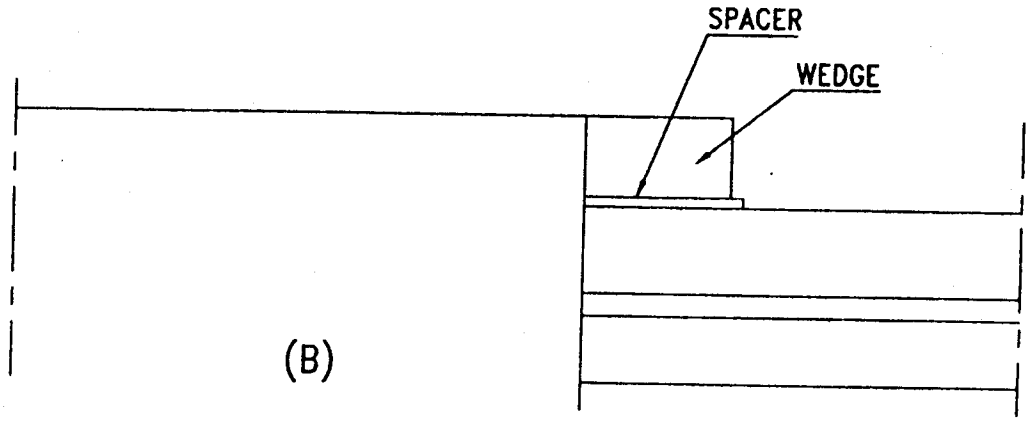
If bearing insulation is good the reading will be equal. In case of any defect the reading of (a.) will be higher than that of (b.)

ANNEXURE-II
ANNEXURE-III

## SKETCH FOR THE APPLICATION OF THE GLUE MIX.




(A)

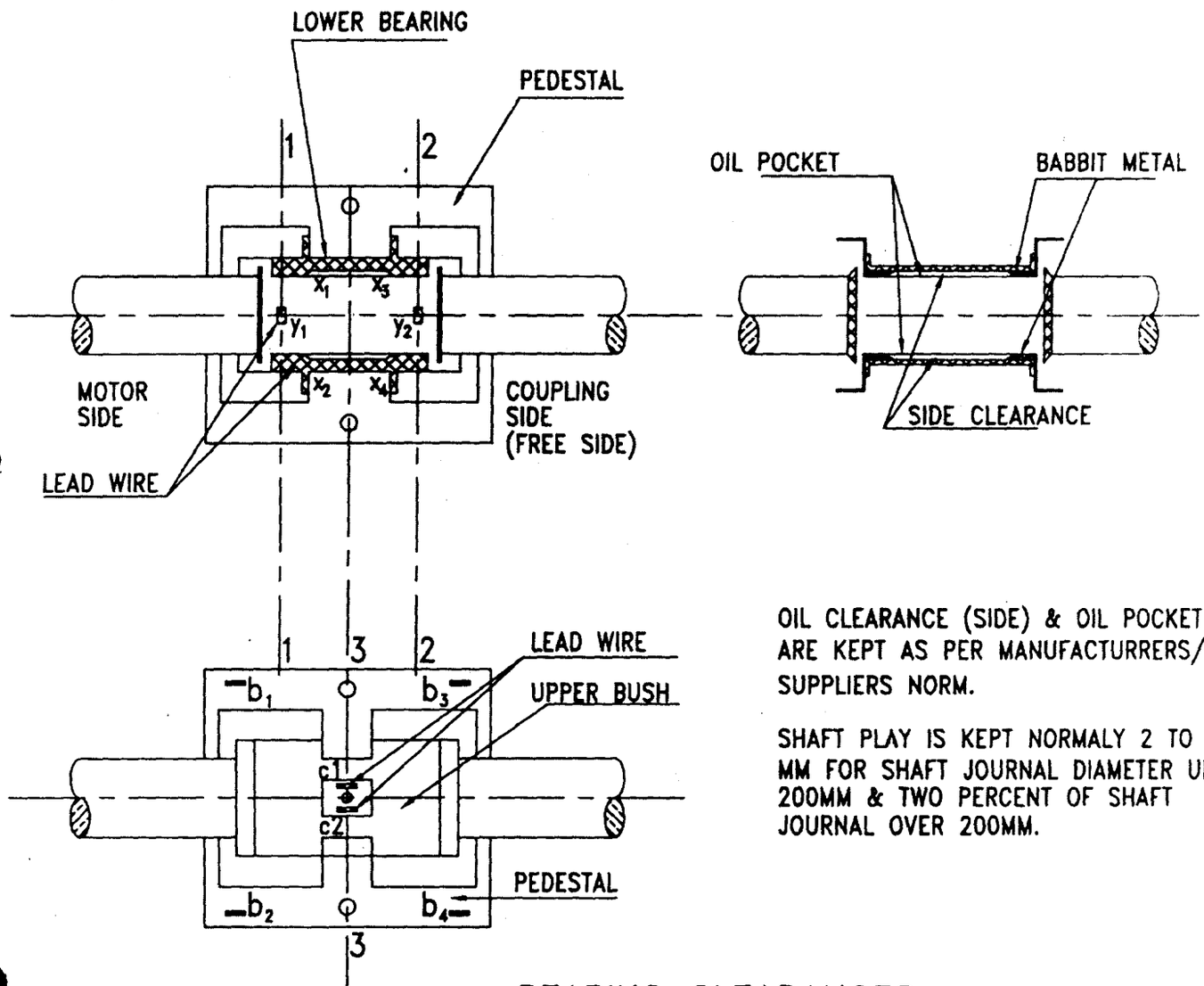



(B)

*- APPLY GLUE HERE

[MIX THOROUGHLY THE EPOXY REDGEL AND HARDNER EH 411 IN THE RATIO OF 100:35 PARTS IN CLEAN CONTAINER FOR 10 MINUTES CONSUME. THE GLUE (MIX) WITH IN 4( FOUR) HOURS].

**ANNEXURE-IV**




OIL CLEARANCE (SIDE) & OIL POCKET ARE KEPT AS PER MANUFACTURRERS/ SUPPLIERS NORM.

SHAFT PLAY IS KEPT NORMALY 2 TO 4 MM FOR SHAFT JOURNAL DIAMETER UPTO 200MM & TWO PERCENT OF SHAFT JOURNAL OVER 200MM.

# BEARING CLEARANCES

| NOMENCLATURE | CLEARANCE IN MM | BEARING NO. | | | | EQUATION TO DETERMINE AVERAGE VALUE OF CLEARANCES |
|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | |
| TOP CLEARANCE BETWEEN SHAFT JOURNAL AND UPPER BUSH. | a1 | | | | | $a1 = y1 - \frac{x1+x2}{2}$ |
| | a2 | | | | | $a2 = y2 - \frac{x3+x4}{2}$ |
| CLEARANCE BETWEEN UPPER BUSH AND BEARING HOUSING | a3 | | | | | $a3 = \frac{c1+c2}{2} - \frac{b1+b2+b3+b4}{4}$ |

PERMISSIBLE VALUE OF a1,a2 & a3 ARE NORMALLY GIVEN BY THE MANUFACTURER.
HOWEVER WHERE THESE ARE NOT GIVEN a1, a2 ARE KEPT WITHIN 0.15 TO 0.25 PERCENT OF SHAFT BIA (JOURNAL) AND TEIR DIFFERENCE IN VALUE MUST BE WITHIN 10 PERCENT a3 MUST BE ± 0.05MM.

## ANNEXURE-V

# AXIAL AND RADIAL TOLERANCE LIMITS FOR MISALIGNMENTS OF SHAFTS

| Type of coupling | Acceptable Limit | |
|---|---|---|
| | Axial misalignment/100 mm | Radial misalignment |
| Rigid | 0.05 mm | 0.04 mm |
| Pin bush | 0.06 mm | 0.06 mm |
| Bibby, Flex, Tyre | 0.06 mm | 0.06 mm |
| Gear | 0.08 mm | 0.08 mm |

**ANNEXURE-VI**

## MAGNETIC CENTRE CHECK AND ADJUSTMENT

For checking the magnetic centre test chalk paste is applied on the circumference of the shaft (maximum width of the chalk paste bent is 30-40 mm width) and sharp marker fixed in a suitable magnetic stand is positioned in such a way that a minimum gap of 0.5-1 mm is maintained from the shaft. The motor is switched on and is allowed to attain full speed. While motor is running at full speed, the marker is pressed lightly against shaft and a circular mark is obtained. This is the magnetic centre mark of the motor. Motor is switched off and is allowed to slow down upto 5-10% of normal speed. At this position, the motor shaft end is pushed axially (with the help of wooden rod) to the extreme positions of either side and two numbers of circular markings are obtained. If the circular marking obtained initially (motor running condition) is located in the middle of the end position markings (obtained during motor switched off condition and at 5-10% of normal speed) then the magnetic centre is perfectly O.K. If the three distinct marks are not obtained and then it indicates the possibility of collar rubbing with bearing is there. This needs corrective adjustment as described below :

i) For cylindrical sleeve bearing, bearing sleeve to be shifted in the required direction with the help of bearing puller and after adjustment and confirmatory test both the bearing to be locked in position with the set screws.

ii) For split type bush bearing, required adjustment is carried out by shifting of stator axially in the required direction and after adjustment and confirmatory test the stator is then fixed in position with the help of control pins.