INTER PLANT STANDARD – STEEL INDUSTRY		
IPSS	**CODE OF PRACTICE FOR REPAIR OF 3 PHASE LT SQUIRRELCAGE INDUCTION MOTORS** (*First Revision*)	**IPSS:1-03-019-06**
	Corresponding IS does not exist	Formerly : IPSS:1-03-019-95

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 reputed consultancy organizations; and was adopted in August 2006.

0.2 This standard has been made to lay-down the repair practices of 3 phase LT Induction Motors in steel plants. The objective is to provide a procedure for repairs for shop floor people so that they are assisted with the combined effort of steel plants and consultants in making this standard.

1. SCOPE

1.1 These guidelines cover the requirement of all 3 phase squirrel cage LT motors, capacity ranging upto 250 kW rated for 415 V, 50 Hz. These are applicable for stators wound with coil of rectangular conductors or round conductors.

1.2 This standard is not intended to substitute in all the specific requirements of the customer.

2. GENERAL CONSIDERATIONS

2.1 The damage to motors the users normally come across are as under :

i) Stator winding gets earthed or burnt.

ii) Stator core burnt.

iii) Rotor bars found broken or melted at a few places (the rotor squirrel cage built of copper/brass bars). If the rotor is of aluminium die-cast design, the metal can melt and flow out, damaging the stator winding and core or open circuit can develop in some of the bars.

iv) Looseness of bearing on shaft.

v) Loose bearing in capsules (cartridges).

vi) Looseness of end covers on bearings or bearings capsules.

vii) Loose end cover collars in stator housing.

viii) Worn out bolt holes in end covers.

ix) Broken foundation legs.

x) Worn out coupling seating or damaged keyway.

xi) Stator leads burnt at point of connection to winding or at the terminals.

xii) Bending and breakage of rotor shaft.

xiii) Displacement or breakage of fans and fans covers.

3. STATOR REPAIRS

3.1 The stator winding usually gets burnt due to following reasons.

a) Overloading.

b) Inter-turn/inter-phase short

c) Single phasing.

d) Rubbing of stator with rotor and consequence damage to stator winding and stator/rotor core.

e) Entry of foreign objects.

f) Heavy vibration in the motor.

3.2 Rewinding of Stator

3.2.1 The following data shall be noted before starting the rewinding work:

a) Name plate details of the motor.

b) Winding type, showing :

i) Wire wound or formed coil of rectangular section.

ii) Double layer/single layer, concentric winding/Diamond winding, double layer fractional pitch winding.

iii) Other types.

c) Length of overhang of winding on both ends.

d) Number of poles.

e) Number of slots.

f) Pitch of coils.

g) Size of wire/conductor.

h) Number of turns/coil.

j) Number of parallel circuits in each phase.

k) Details of slot insulation and inter coil and inter phase insulation.

m) Y, YY or connection.

n) Number of terminals brought out (3 or 6)

p) Size of terminal leads and length required.

q) Wedge material and size.

r) Position of supporting ring, if any.

s) Any other relevant information.

After noting the above details, strip the winding. In the case of wire wound stators, too much force should not be employed for stripping as it is likely to damage/distort the core. After stripping the winding, sticking of some insulation material is often noticed inside the slots. These can be removed with a wedge shaped rod or knife. Badly stuck insulation can be removed by one of the following methods :

i) Keeping the stator immersed in a suitable cleaning agent for 8 hours.

ii) Keeping the stator immersed in a hot water bath (steam injected) for 12-16 hours.

iii) Keeping in burn-off oven at 300^{o}C for 2 hours.

After cleaning the stator, check for shorts in the stator core stampings. Repair wherever possible. To check the soundness of core, pass 1-2 turns of welding cable through the stator bore. Give supply from a welding transformer. Pass current (150-300 A depending on the size of the motor) for about 15 minutes.

If the core gets heated uniformally, then the stator can be passed for rewinding. In case core stampings are shorted, localized hot spots will be felt when hand is moved over the core. In such cases, attempts should be made to isolate the shorted area and to insulate the stampings. In case this is not possible, then the stator can be declared as unsuitable for rewinding. If such a stator is rewound, it will not give lasting service due to hot-spot-caused shorts and consequent burn out.

Before starting the rewinding operation, give a thin coat of Core plate varnish and dry it.

Rewind the stator as per the original data, using the materials as per the class of insulation of the machine.

NOTE: In this connection, it is relevant to point out that if any material of a lower class is used, then the whole stator gets lowered to that class, even though the other material belong to a higher class.

Impregnate twice and dry at the prescribed temperature and period as applicable to the varnish employed. A coat of air drying covering varnish will make it resistant to dust deposition and corrosive atmosphere.

3.3 Test Procedure for Rewound Stator

3.3.1 The following Intermediate Tests shall be conducted after rewinding and prior to varnishing :

a) *Megger Test* - The I.R. value shall not be less than 5 M. ohms in cold condition when meggered by a 500 V megger.

b) *High Voltage Test* - Apply a High voltage of 50 HZ frequency for 1 minute as under:

For stators upto 3 kW - 2.1 kV

For stators above 3 kW - 2.4 kV

c) *Magnetic Field Test* - An uniform rotating magnetic field should be obtained when connected to a low voltage, 3 phase supply.

d) *Polarity Test* - This shall be as per the speed of the machine. This can be checked by connecting a low voltage 2 (two) phase source and checking by a magnetic compass for the number of poles formed.

e) *Current Balance Test* - The rated 3 phase current shall be passed 15 to 30 minutes and it should be same in all the three phases. Any inbalance in current, abnormal heating of any coil, joint, lead etc. when compared with the rest of coils, joints and leads etc. calls for thorough inspection and rectification.

f) *Inter-turn Test* - This test can be conducted with 400 Hz ac supply given to stator/rotor. Any short circuit between the turns would become evident due to localized heating. Inter-turn test can also be carried out with the help of an inter-turn short tester (waveform comparison tester or surge testing equipment).

4. REPAIR OF ROTORS

4.1 *Squirrel Cage of Brass/Copper Bars* - Breakage of bars from the end rings is common, though occassionally the bar breaks inside the slots or melts inside slots. If the break is at the end ring, drill a hole through the end ring and bar. Make threads in the bar and fix screw and braze all round with silver solder.

If the break is inside the slot, replace the bar with bar of equivalent size and material. Melted material, if any, should be completely removed before replacement.

In all cases as above, it should be ensured that the bars are fully tight inside the slots. Loose bars lead to breakage and consequent breakdown of the machine. Growler test may be carried out to find out the breakage of rotor bars in the slots, if any. In case shaft has been replaced or many bars have been repaired, dynamic balancing of rotor must be done.

4.2 **Aluminium Die-cast rotors** - Open circuits in the aluminium die-cast rotors can develop due to overloading or jamming of rotors. If the metal (aluminium)melted out is excessive, then it is not possible to revive the rotor. If it is small, the metal sticking on the rotor core can be machined out on lathe and the rotor can be used. However, it is observed that such rotors do not give reliable service and the motor's torque capacity comes down.

4.3 **Repair of Broken Rotor Fan** - While cast aluminium alloy fans are not repairable, fabricated fans can be repaired. When extensive repairs are carried out on the fan, the rotor may need dynamic balancing on a balancing machine. This is absolutely necessary in machines.

4.4 **Repair of Bent Rotor Shaft:**

a) In small capacity machines upto 5.0 kW, repair can be carried out by cutting the shaft a little away from the bent area. An extension piece can be jointed at the parting by a male/female joint and is machined to size. Shaft should be replaced wherever possible.

b) In case of bigger machines, if the bend is within 15-20 from the axis, the shaft can be built up by depositing metal with low heat electrodes. The shaft is machined to size as per original dimensions.

c) In cases where the shaft bend is more than 20^{o}, the shaft is repaired by thermit welding process or replacement of shaft altogether.

NOTE: Repair of bent or broken shaft by depositing metal is not safe in case of hoist motors. In such cases replacement of shaft is desirable.

5. REPAIR OF LOOSENESS OF BEARING ON SHAFT

5.1 This can be rectified by depositing metal on shaft using a low-heat electrode and machining to size after heat treatment.

6. REPAIR OF LOOSENESS OF BEARINGS/BEARING CAPSULES IN END COVERS

6.1 This can be repaired by enlarging the bore of the end cover by 1-5 mm. (depending on the size of the machine) and fixing a sleeve. The sleeve is then machined as per bearing O.D. dimensions. In big capacity machines, the sleeve is to be locked by screws to prevent rotation during operation.

Loose bearing capsules are repaired by metallizing the bearing capsules on the outer surface and machining to size as per end cover dimensions.

7. REPAIR OF LOOSE END COVER COLLARS IN STATOR HOUSING

7.1 Due to frequent/repeated dismantling of machines over a long period of time, the end cover collars become loose in the stator housing. This can be rectified by depositing metal on the end cover collar and machining to required dimensions.

8. REPAIR OF WORN OUT BOLT HOLES IN STATOR BODY

8.1 During the life of a machine, it is to undergo many dismantling and assembly operations. Over the period, the bolt holes in stator body may wear out resulting in loose end cover fixtures. Such holes should be drilled to a higher size and retapped. It may also become necessary to enlarge the end cover bolt holes to accommodate bigger sized bolts.

9. BROKEN FOUNDATION LEGS

9.1 Broken foundation legs can be repaired by welding the broken piece back to the stator body after proper alignment of the piece. In case the broken leg is not available, a new foundation piece (cast iron or steel) can be made to proper size and welded. Foundation legs can also be attached by a costly technique known as `metal stitching'.

It is understood that foundation repaired motors are not reliable and legs may break again. Such machines should not be employed in critical locations.

10. TEST PROCEDURE FOR ASSEMBLED MACHINE

10.1 The following tests are to be carried out :

i) *Megger test* by 500 V megger.

ii) *H.V. test* - 1.5 kV, 50 cps for 1 minute.

iii) *No load test* - For noting electrical characteristic and studying the condition of bearings.

iv) *Inter turn insulation test* (The motor is subjected to 30% over voltage for 5 minutes.)

v) *Load test* - Though it is ordinarily difficult to simulate working regimes like class of duty, duty cycle etc, the test could be conducted wherever facilities exist.

vi) Motors to run for half an hour without attachments (fan, coupling pulley etc.) to check for mechanical condition besides noting its electrical characteristics.

vii) After fixing all attachments, it should be run at least for 10 mts to check whether attachments are loose or are adding to vibration or noise.

viii) Locked rotor test (short circuit test) may be carried out to confirm the starting characteristics of the motor.

ix) Single phase test may be carried out to find if any bar is cracked. This test is conducted by giving supply to one phase of the winding and on rotation of rotor by hand if current fluctuations are noticed in the ammeter connected in series with the supply source, it indicates possibility of broken bars.

x) Any other specific test the customer may specify.

NOTE: While testing, DOL starting is to be invariably carried out to simulate starting conditions (The motor must be on firm foundation).

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