INTER PLANT STANDARD – STEEL INDUSTRY		
IPSS	**SPECIFICATION FOR GENERAL PURPOSE MEDIUM VOLTAGE (MV) SQUIRREL CAGE INDUCTION MOTORS** (*Second Revision*)	**IPSS:1-03-018-14**
	BASED ON IS 325:1996	Formerly : IPSS:1-03-018-07

0. FOREWORD

0.1 This Interplant Standard has been prepared by the Standards Committee on Rotating Electrical Machinery, IPSS 1:3 with the active participation of representatives of steel plants, other concerned organizations and established manufacturers of Electric Motors; and was adopted in July, 2014.

0.2 Inter Plant Standards for steel industry primarily aim at achieving rationalization and unification of parts and assemblies used in steel plant equipment and accessories, and provide guidance in Indenting stores or equipment (or while placing orders for additional requirements) by individual steel plants. For exercising effective control on inventories, it is advisable to select a fewer number of sizes (or types) from among those mentioned in this standard, for the purpose of company standards of individual steel plants. It is not desirable to make deviations in technical requirements.

0.3 This Inter Plant standard should be read in conjunction with IPSS:1-03-024-14 `Standard Information for Enquiry and Order for MV Squirrel Cage Induction Motors' (first revision).

0.4 This revision has been carried out to update the standard from the latest technology point of view.

1. SCOPE

1.1 This Inter Plant standard covers the requirement of 2, 4, 6, 8 & 10 pole squirrel cage three phase Induction motors for voltages 3.3 kV, 6.6 kV & 11 kV or as per customer’s requirement for general purpose application in Steel Industry (namely Drives for Pumps, Blowers, Centrifugal fans, compressors etc).

1.2 This Inter Plant standard does not cover the requirements of flame proof, V/F drive and increased safety motors.

2. SITE CONDITIONS

2.1 The following shall constitute normal site conditions for the purpose of this standard:

2.1.1 *Ambient Temperature and Humidity* - The motor shall be designed for operation in tropical humid climate with an ambient temperature of 50°C or higher as per customer's requirement and a maximum relative humidity upto 100%. However, both the extreme conditions may not occur simultaneously.

NOTE: The user shall indicate wherever higher ambient temperatures are specified and the manufacturer shall accordingly affect changes in the rating of the motor.

2.1.2 **Ambient Air** - The ambient air may contain fair amount of conductive dust.

2.1.3 **Altitude** - Altitude not exceeding 1000 m above mean sea level.

2.1.4 The motor shall be suitable for outdoor application.

2.2 **Form and Symmetry of Currents and Voltages** - Motors shall be designed assuming the supply voltage to be virtually sinusoidal. The supply voltages shall also form a virtually balanced system (refer to clause 4.2 of IS 325:1996).

NOTE: The voltage is considered to be virtually sinusoidal if none of the instantaneous values of the wave differ from the instantaneous values of the same phase of the fundamental wave by more than 5 percent of the amplitude of the latter.

A system of three-phase voltages is considered to be virtually balanced if none of the negative-sequence and zero-sequence components exceed 2 percent of the positive-sequence component.

2.3 **Voltage and Frequency Variation** - The motors shall be capable of delivering the rated output with:

i) The terminal voltage differing from its rated value by not more than $\pm$6% in general cases but in special cases if desired by the purchaser, voltage fluctuation of $\pm$10% shall have to be provided; or

ii) The frequency differing from its rated value by not more than +3% in general cases but in special cases if desired by the purchaser, frequency fluctuation of +3/-6% shall have to be provided; or +10% or -10% of combined variation is sufficient.

In the case of continuous operation at extreme voltage limits, the temperature-rise limits specified in Table 1 of IS 325:1996 shall not exceed by more than 10°C. Motors, when operated under the extreme conditions of voltage and frequency variation, may not necessarily have their performance in accordance with this standard.

3. TYPE OF ENCLOSURE

3.1 The degree of protection to be provided by the enclosure shall be IP 55 in general as per IS/IEC 60034-8(2002) [IS 4691:1985 is withdrawn]..

4. METHOD OF COOLING

4.1 The method of cooling shall be IC4AIAI (IC 411-TEFC), IC5A1A1 (IEC 511-TETV), IC6A1A1, IC611 (CACA) or IC8A1W7 (IC 81W-CACW) in accordance with IS 6362:1995 `Designations of methods of cooling of rotating electrical machines'.

5. RATED VOLTAGE, FREQUENCY AND OUTPUT

5.1 .**Rated Voltage** - Preferred voltages for the purpose of the standard shall be 3.3 kV, 6.6 kV, 11 kV with the earthed neutral or unearthed neutral.

NOTE: Method of system earthing shall be specified at the time of enquiry.

5.2 **Rated Frequency** - Rated frequency shall be 50 Hz.

5.3 **Duty & Rating**

5.3.1 All motors shall be rated for continuous duty (type S1) and shall be suitable for direct on-line starting. While manufacturing the motor as per duty, the manufacturers shall ensure that the motor develops the rated torque at 90% of the rated voltage.

Motor shall be capable to withstand voltage torque stresses and forces developed due to vector difference between the motor residual voltage and the incoming supply voltage equal to 150% motor rated voltage for 1 second during auto change over of supply."

a) The pull out torque of the motor at rated voltage shall be at least 200% of full load torque taking care of load requirement.

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b) Motor shall be capable of satisfactory operation at full load without injurious heating when the terminal voltage drops to 80% of the rated voltage for ten minutes.

5.3.2 Unless otherwise specified, the locked rotor current shall not exceed 720% of the current of the motor.

All motors shall be suitable for three cold starts or two hot starts per hour.

5.3.3 Machines covered by this standard shall have minimum :

locked rotor withstand time (cold) = 15 sec*
locked rotor withstand time (hot) = 10 sec*

* = Specified time is the minimum time. Higher time is required for higher GD^2 load as specified.

NOTE: Actual requirement shall be specified at the time of enquiry.

Locked rotor withstand time under hot condition shall be greater than the starting time of the motor with load. Locked rotor withstand time need not be specified.

6. TECHNICAL REQUIREMENTS

6.1 **Mounting** - The construction and mounting shall conform to IS 2253:1974 `Designations for type of construction and mounting arrangements of rotating electrical machines'.

6.2 **Frame sizes and Dimensions** - Frame sizes and dimensions shall be selected in accordance with IS 8223:1999 `Dimensions and output series for rotating electrical machines for foot mounted with frame numbers 355 to 1000' and IS 2223:1983 `Dimensions of flange mounted ac induction motors' for flange mounted motors.

NOTE: Along with the enquiry, frame sizes and critical mounting dimensions shall be specified.

6.3 **Constructional Details**

6.3.1 Foundation fixing bolts shall be approachable from outside. Foundation shall have the provision of fixing dowel pins. Threaded jacking holes to be provided for jacking up for insertion or removal of shims for facilitating alignment with driven equipment.

6.3.2 The stator core shall be built from high permeability silicon steel laminations. These laminations shall be insulated on both sides to minimize the losses due to eddy currents. The built up laminations shall be hydraulically pressed and held by steel ribs welded by CO_2 gas welding or equivalent method. Stiffener fingers are to be welded to the stiffener end plates to prevent vibration fatigue of the teeth section. The stator shall be housed in heavy, well brazed fabricated steel/cast iron frame to ensure sufficient rigidity against electro-magnetic and mechanical vibrations during start-up and also while running.

The core punching and internal shall be tropicalized and given a treatment of fungus inhibiting coating.

Joints of motor frame and winding shall be brazed in accordance with ASME Boiler and Pressure Vessel Code Section IX or equivalent.

Motor winding should be given tropical weather condition, fungus growth moisture, oil, abrasive and conducting dust, sulphur & weak acid in combination with alkali fumes. Insulation of oil lubricated motor shall not deteriorate when exposed to oil vapour and/or oil leaks on to the stator winding".

Motor shall have drain plugs to permit removal of water accumulated inside the motor.

6.3.3 The stator winding insulation system shall be mica moulded non-cracking type or VPI insulation as per requirement of the purchaser. The winding shall be

fully braced on the overhang and blocking of coils shall be done to withstand the mechanical stresses produced during starting of the motor. Stator slots shall be of open type construction. The insulating material used shall not shrink or bulge with time. Insulation system of the windings shall be designed suitably to withstand voltage surges as may develop when the motor is operated through VCB or SF6 breakers. The coils shall be fixed in the slot by wedges. Epoxy glass cloth laminated wedges or magnetic putty shall be used for tightening the coils inside the slot.

During starting of the motor. “The support for the overhang portion, if used, shall be of non-magnetic material.

6.3.4 The Rotor shaft shall be made from high grade steel (EN 24) or equivalent / better to ensure sufficient strength against torque and vibration stresses. To improve the cooling effect, a shaft with ribs is desirable.

6.3.5 The rotor core shall be built up using high permeability silicon steel varnish insulated laminations directly on shaft or on spider arm of structural plates welded to the shaft. Care shall be taken to prevent flaring out of laminations.

6.3.6 The cage shall be made from high conductivity copper or copper alloy bars extending beyond core embedded in short circuiting ring and brazed. The bars shall be fixed in such a way that they do not break during operation from the end joints due to repetitive starts and stops. The end ring assembly shall be such that it is free to move with the expansion of the bars without distortion”. “Stiffening ring, if used, shall be of forged material. Forging shall be subjected to ultrasonic and dye penetration testing as per relevant standards. In 2 pole motors, to avoid breakage of rotor bars from ends joints, stiffening rings over the end rings may be provided on either side.

6.3.7 The rotor shall be dynamically balanced with a high degree of accuracy to ensure operation of motor at rated speed, to a low level of vibrations. To enable future replacement, each rotating component such as flywheel, fan, coupling etc. that are to be mounted on shaft shall be individually balanced. Weights added for the purpose of balancing shall be free of defects and shall be firmly fixed such that there is no displacement while in service & proper fixing arrangement should be there (less than 10 microns). Rotor shall be dynamically balanced to achieve a vibration level as specified in IS 12075:2008.

6.3.8 Free shaft ends shall be provided with a suitable guard to prevent accidental touch while rotating. Shaft pulse transducer shall be provided as per the requirement of purchaser. Provision for mounting the shock pulse transducer shall be made based on the data provided by the purchaser.

6.3.9 The end shields shall have suitable jacking holes for facilitating easy removal.

6.3.10 Fans - Radial cooling of stator and rotor is preferable. Fans (internal and external) shall be of radial type and preferably of fabricated design. Fixed location

of fans (internal and external) shall be ensured to prevent dislocation of fans which may upset balance. It is preferable to have radial type cooling fans with straight blades for both internal and external cooling for running in both the directions. The direction of rotation shall be indicated if the drive is unidirectional. Internal and external fans wherever provided, shall be with suitable jacking holes for facilitating easy dismantling. Cooling fan shall be made of mild steel.

6.3.11 For specific use only :

20% margin shall be provided in the design of heat exchanger to allow for fouling of cooling tubes or ducts under service condition.

Heat exchangers cooling tubes or ducts shall be adequately braced and supported to prevent vibration and premature fatigue or facture. If water is used as cooling medium the design shall be such that there shall be no possibility or water being ingress into the motor winding. Heat exchangers shall be provided with valves for draining from the lowest points. Water cooler shall be hydro tested with water as a test medium at 1.5 times the maximum working pressure.

6.3.12 Replaceable anti-condensation heaters of adequate capacity shall be provided on all motors and heater terminals shall be brought out to a separate terminal box. The heaters shall be rated to operate on single phase 240 V supply.

6.3.13 The serial number of the motor shall be punched on the rotor key-way or shaft end face and on the spider.

6.4 **Shaft Extension** - All motors shall have a single cylindrical shaft extension unless otherwise specified.

6.5 **Bearings**

6.5.1 Depending upon rating, motor shall be provided with either roller type or babbit type bearings. It is preferable to have capsule mounted bearings instead of end cover mounted bearings. In case of babbit type bearings, dipstick with high/low level marks shall be provided for checking of bearing oil level.

6.5.2 For horizontal foot mounted motors, a combination of roller bearing on DE and roller plus ball bearing on NDE side may be used. For vertical mounted motors, roller bearing on DE and two or more angular contact bearings on NDE side may be used. Wherever required, adequately insulated bearings shall be provided to limit the shaft currents to a safe value so that the bearings are not damaged.

Suitable Thrust Bearing shall be used for vertical motors.

When motor shaft is not located axially by its own bearing, it shall be permanently marked to indicate its running position and the extent of float in either direction.

6.5.3 Regreasing of bearings during motor operation shall be possible from outside without removal or dismantling of any part. An out-let for old grease shall be provided at the bottom preferably with withdrawable receptacle arrangement. Suitable means to be provided for preventing the entry of grease into the winding.

Lubricant shall be selected for prolonged storage and use of the motor in a tropical climate and shall contain corrosion and oxidation inhibitors and anti foaming agents. Grease shall have suitable bleeding characteristics to minimize setting.

When pressure lubrication is required or recommended as for large motors, oiling shall be adequate for starting and continuous operation of the motor without the pressure oiling system in operation. The sight flow gauges shall be supplied to indicate oil flow from each motor bearing.

6.5.4 It is desirable to have an oil injection system for removal of antifriction bearings to prevent damage to bearing seatings.

6.5.5 The maximum limit of shaft voltage shall not exceed 250 mV to limit shaft currents and thus prevent damage to the bearings. Earthing brushes to be provided on the shaft.

NDE end shield should be insulated.

Motor shall be provided with vibration pads on DE & NDE with vibration pads / any other latest arrangement.

6.5.6 It is necessary to have provision for fixing vibration monitoring sensors on the bearings.

Provision for fixing vibration monitoring sensors on the bearings can be made if the probe details are furnished at the time of order.

6.5.7 In case of machines with sleeve/babbit bearing mounted on separate pedestals, I.R. value of pedestal insulation shall not be less than 1 M-ohm when measured with 500 V Megger.

6.6 **Terminals & Terminal Boxes**

6.6.1 Motor shall have 2 terminal boxes one for phase terminals and another for neutral, centrally located on either side of the motor for bringing out leads on either side. The terminal boxes shall be sealed from the motor enclosure so as to prevent entry of dust and moisture from the motor. The main and neutral terminal boards and boxes shall be of robust design made of either cast steel or of fabricated construction. The neutral terminal box and main terminal box shall be interchangeable and detachable. The neutral terminal box shall have provision for fixing CT within the terminal box if required for motor differential protection. The terminal box shall be suitable for cable entry from bottom. It shall be possible to

rotate the terminal box by 180 degrees at site to make it suitable for top cable entry, if required.

For TFC 411 construction, TB will be towards the DE. Main and Neutral Point TB are interchangeable and hence cabling will not be an issue.

The cables from the cable gland to terminals or connectors and terminal leads from these terminals or connectors to windings, if more than 150 mm, shall be adequately braced to withstand the forces produced by maximum fault current (40 KA or as applicable).

6.6.2 The terminal box shall be well structure supported. Also it shall be able to withstand the vibrations which are usually present when the machine is in operation.

6.6.3 For containment of a high energy fault in motor terminal box itself, phase segregated terminal box shall be used. The entire terminal box shall be designed to withstand the mechanical stress of a high fault current commensurate with the voltage. The terminal box shall have provision for release of gases generated during faults. The terminal box shall be CRPI / accredited test house.

The terminal box should be able to withstand fault current for 0.25 seconds.

The power terminal box shall be capable of withstanding fault current level of 40 KA till clearing time without damage.

6.6.4 For motors with star connected windings, all six leads shall be brought outside to allow neutral to be formed outside. For motors with delta connected windings, the delta connection shall be done within the motor and leads are to be taken out on both sides.

6.6.5 The connections from the windings shall be brought out to terminal box using varnished fibre glass covered flexible copper cable or silicon rubber cables as specified by the purchaser. The cable used shall be of appropriate voltage grade depending upon the voltage rating of the motor.

6.6.6 Separate terminal boxes shall be provided for space heater, winding/bearing RTDs and air temperature detectors etc as required.

6.6.7 A connection diagram and phase sequence for the designed direction of rotation shall be provided on the terminal box cover.

6.7 **Interchangeability of Parts** - In the motors with identical type and frame size supplied by one particular manufacturer, the following parts shall be interchangeable:

i) Rotor
ii) End shields
iii) Bearing capsule

iv) Cooling fans
v) Coolers
vi) Terminal box.
vii) Fan cover

7. EARTHING

7.1 Two separate earthing terminals of proper size suitable to receive galvanized iron conductor shall be provided on the bottom half of the motor body. In addition to the two outside earthing terminals, provision for one more earthing terminal inside the terminal box is to be kept. Size of earthing terminal shall conform to clause 12.2.2.2 of IS 3043:1987 `Code of practice for earthing (first revision)'.

8. INSULATION & TEMPERATURE RISE

8.1 The class of insulation shall be minimum of class `F'.

8.2 Maximum temperature rise of windings shall be limited to allowable temperature rise limit of class `B' insulation.

8.3 Six numbers embedded and symmetrically placed RTDs in the stator winding and one number of RTD for each DE side and NDE side bearing shall be provided for monitoring temperature. Air temperature detector (RTD) in the motor ventilation circuit shall be provided for CACA motor. The RTDs shall be Pt 100 type. The RTDs requirement as specified shall continue. Also comply with latest edition of IS 2848:1986.

9. LIMITS OF VIBRATION

9.1 Limits of vibration intensity shall be in accordance with normal class of Table 1 of IS 12075:2008 `Mechanical vibration of rotating electrical machines with shaft heights 56 mm and higher - measurement, evaluation and limits of vibration severity (superseding IS 4729:1968) '.

NOTE: The manufacturer shall indicate in the test certificate whether the rotor is balanced, with or without the coupling fixing key in the shaft.

10. LIMITS OF NOISE LEVEL

10.1 The noise level shall not exceed the limits specified in IS 12065:1987 `Permissible limits of noise level for rotating electrical machines'.

11. PERFORMANCE CHARACTERISTICS

11.1 Motors shall be designed for a maximum working speed of 1.2 times rated speed for a duration of 2 minutes.

11.2 Motors shall be capable of withstanding full wave impulses of the waveform 175/2000 micro-sec (to be checked with IS 14222:1995), having the peak value of

voltage equal to (4u + 5) where u is rated line to line voltage. The capacity of withstanding full wave impulses shall be as per IS 14222:1995.

Motors shall be capable of withstanding full wave impulses of the waveform 1.2/50 micro-sec having the peak valve of voltage equal to (4U+5), where U is the rated line to line voltage.

12. TOLERANCES

12.1 Tolerances as specified in IS 325:1996 shall apply wherever relevant.

12.2 Designed service life shall be 25 years.

13. RATING PLATE

13.1 A legible and indelibly marked rating plate of non rusting metal shall be provided giving the following information.

Material of rating plate shall be stainless steel. The name plate of the motor shall be corrected in line with clause No. 20.1 of IS 325:1996. the letter size is also to be mentioned.

i) Type and frame size
ii) Rating only at ambient temperature will be indicated.
iii) Serial number
iv) Voltage
v) Current
vi) Frequency
vii) RPM
ix) Winding connection 3 phase.
x) Weight of motor in kg
xii) p.f. at full load
xiii) Manufacturer's name
xiv) Year of manufacture
xv) Bearing details
xvi) Frequency of lubrication, quantity and type of grease to be used
xvii) Degree of protection
xviii) Class of insulation
xix) Duty
xx) Reference to this IPSS standard i.e. IPSS:1-03-018-14(F)
xxi) Method of cooling
xxii) No. of stator slots & rotor bars
xxiii) Direction of rotation
xxiv) GD2
xxv) No. of hot starts & cold starts
xxvi) Efficiency

14. TESTS

14.1 The tests specified in clause 22 of IS 325:1996 `Specification for three-phase induction motors (fourth revision)' shall be applicable.

14.2 Other special tests, as desired by the purchaser, shall be carried out at factory.

14.3 Along with routine test certificates and other documents, the motor manufacturer shall also furnish stall withstand time, negative sequence impedance of the motor to facilitate relay setting and thermal withstand curve.

Full load and temperature rise shall be conducted as type tests. All other tests shall be as routine tests.

All type tests as specified by IS 325 Clause 22.3.1 (b,c,e,f,j,k,m,n,p,s) shall be carried out as routine tests for all MV motors. Besides, test for resistance and insulation resistance for RTD or BTD or CBs or open circuit voltage test.

ROUTINE TESTS

1	Measurement of resistance of windings of stator and wound rotor
2	No load test at rated voltage to determine input current power and speed
3	Reduced voltage running up test at no load
4	Locked rotor readings of voltage, current and power input at a suitable reduced voltage
5	Momentary overload test
6	Insulation resistance test
7	High voltage test
8	Test for vibration severity of motor
9	Test for noise levels of motor
10	Overspeed test
11	Resistance and IR of RTD/BTD and space heaters
12	Open circuit voltage test