INTER PLANT STANDARD – STEEL INDUSTRY		
IPSS	**SPECIFICATION FOR AC MOTORS for VFD APPLICATION**	**IPSS:1-03-039-14**
	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 representatives of steel plants, reputed consulting organizations and established manufacturers of ac 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 sub-assemblies used in steel plant equipment and accessories and provide guidance in indenting stores or equipment for existing or new installations by individual steel plants. For exercising effective control on inventories, it is advisable to select 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:1-03-016-14 `Standard information for enquiry and order for LT electric motors.

1. SCOPE

1.1 This Inter Plant Standard covers the requirements of three phase squirrel cage induction motors including geared motors operating on variable voltage, variable frequency source up to 690V in the steel plants.

1.2 **Class of Insulation** – The ac motors for VFD application shall have windings of class `F' insulation with temperature rise limited to class B unless otherwise specified [see 'IS 1271:2012 'Electrical Insulation – Thermal evaluation and Designation']

2. SITE CONDITIONS

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

2.1 ***Ambient Temperature*** – The reference ambient temperature shall be 50°C.

Note : For using motors at higher ambient temperature the guidance given in 7.3 shall be followed.

2.2 ***Relative Humidity*** – The maximum relative humidity shall be 100%. However, maximum ambient temperature and 100% relative humidity may not occur simultaneously.

2.3 ***Ambient Air*** – Ambient air may contain fair amount of conductive dust.

2.4 ***Altitude*** – The altitude shall not exceed 1000 m.

3. TYPE OF ENCLOSURE

3.1 The degree of protection to be provided by the enclosure shall be IP 55 of IS 4691:1985 `Degrees of protection provided by enclosures for rotating electrical machinery (first revision)' or better as required by the purchaser.

5. METHOD OF COOLING

5.1 The method of cooling used shall be IC 0041(fan cooled) / IC 43(separately powered force cooled by fan) / IC411(TEFC)/IC 416(A), IC416R in accordance with IS 6362:1995 `Designation of methods of cooling of rotating electrical machines'. In case of separately cooling motor, the motor speed is to be limited to 1500 rpm (synch).

6. MOUNTING

6.1 The mounting shall conform to any one of the designations IMB 3 ,IMB 5, IM 1001, IM3001 specified in IS 2253:1974 `Designations for types of construction and mounting arrangement of rotating electrical machines (first revision)'. If specified, hollow shaft extension may be provided according to the drawing provided by the purchaser.

7. RATED VOLTAGE, FREQUENCY AND PERFORMANCE VALUES

7.1 **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 +6%, -10% in general cases but in special cases if desired by the purchaser.

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

iii) Any combination of (i) and (ii).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^{o}C. Motors, when operated under the extreme conditions of voltage and frequency variation, may not necessarily have their performance in accordance with this standard.

7.1.1 The motor shall be suitable for operating in the frequency range as per requirement with corresponding voltage variation for obtaining rated torque when used for variable speed application.

7.1.2 The motor shall be suitable for direct-on-line starting for non-inverter application. The starting current shall be limited to max. six times the full load current.

7.2 **Performance Values** - The performance values shall be as given in Table-1.

7.3 **Correction Factors for temperature**

Ambient temperature deg C	Output correction factor%
55	80
60	75

7.4 The motors shall also be suitable for operation on direct online starting.

7.5 The motors shall be suitable for type of duty S4, S5, S6 and S7 as specified in IS 12824:1989 `Type of duty and classes of rating assigned to rotating electrical machines [withdrawn]'.

7.6 Motor shall be suitable for Total harmonic distortion of 5%.

8. DIMENSIONS

8.1 The basic dimensions of foot-mounted and flange mounted ac roller table motors and their shaft extensions shall correspond to IS 1231:1974 `Dimensions of three-phase foot-mounted induction motors (third revision)' and IS 2223:1983 `Dimension of flange-mounted ac induction motors (first revision)' respectively.

9. SPECIAL CONSTRUCTIONAL FEATURES

9.1 **Material of Body** - Material of the motor body shall be cast iron grade FG-260 conforming to IS 210:2009 `Specification for grey iron castings (fourth revision)', or SG iron conforming to IS 1865:1991 `Specification for iron castings with spheroidal or nodular graphite (second revision)' or fabricated steel conforming to IS 2062:2011 `Hot rolled medium & high tensile structural steel'. Non ferrous material for motor body is not acceptable.

9.2 For foot-mounted motors with cast iron / Spheroidal Graphite iron body, the feet shall be integrally cast with the body.

9.3 Separately screwed eyebolts or lifting lugs of suitable sizes shall be provided on the motor for the purpose of lifting. Eyebolts conforming to IS 4190:1984 `Specification for eyebolts with collars' shall be used.

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

9.5 **Bearings** - All bearings shall have an L10 life of at least 40000 h according to IS 3824:2002 `Rolling bearings – Dynamic load ratings & rating life.' The bearings shall be selected so as to take care of the thrust to which the motors are likely to be subjected. The actual thrust value shall be indicated by the user.

9.6 **Lubrication of Bearings** – Re-greasing facility through a grease nipple conforming to IS 4009(Parts 1 & 2):1981 `Specification for grease nipples (*first revision*)', along with facility for excess grease removal shall be provided for motors of frame sizes 200 and larger.

9.7 The provisions of the terminal box shall be in accordance with clause 5 of IS 1231:1974. It shall be possible to turn the terminal box to any of the four positions at 90^{o} intervals to permit cable entry from any of these four positions.

9.8 **Interchangeability of Parts** - The motors of identical rating supplied in a lot by the same supplier shall have the interchangeability in the following parts:

a) Rotors,

b) End shield,

c) Bearing capsules

d) Bearing cups

e) Self cooling fans.

10. EARTHING

10.1 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)'.

11. TEMPERATURE-RISE TEST

11.1 The temperature-rise test shall be carried out at full load in accordance with 22 of IS 325:1996 by subjecting the motor to the rated acceleration value (B). The permissible limits of temperature-rise shall not exceed the relevant values given in Table-1 of IS 325:1996.

11.2 **Temperature Rise Test Under Stalled Rotor Condition** – The temperature shall be measured by applying rated voltage to the motor with rotor locked. The temperature-rise shall not exceed the permissible value for the relevant insulation class.

12. LIMITS OF VIBRATION

12.1 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.'

NOTE: The manufacturer shall indicate in the test certificate that rotor has been dynamically balanced with half key.

13. LIMITS OF NOISE LEVEL

13.1 The noise level shall not exceed the limits specified in IS 12065:1987 `Permissible limits of noise level for rotating electrical machines', if required by the user.

14. TERMINAL MARKING

14.1 Terminals shall be marked in accordance with IS/IEC 60034-8 (2002) [in supersession to IS 4728:1975]. Identical markings shall be provided both on the leads and the terminal blocks.

15. RATING PLATE

15.1 Rating plate made of stainless steel stating the following particulars shall be fixed on the body of the motor:

a) Reference to this interplant standard, i.e. IPSS:1-03-039-14

b) Rated output in kW,

c) Name of the manufacturer and trade mark,

d) Manufacturer's serial number and frame reference,

e) Rated voltage and winding connection of the motor,

f) Rated current in Amps. at rated voltage,

g) Speed in rev/min at rated output,

h) Rated frequency,

i) Class of insulation,

j) Type of duty,

k) Bearing designation,

l) Type of enclosure,

m) Mass of motor in kg,

n) Year of manufacture.

o) Motor suitable for VFD,

NOTE: An additional name plate may be used to indicate the designation of bearings, lubrication details (type, quantity and frequency).

16. TESTS

16.1 The tests applicable to the motors covered by this standard shall be in accordance with Table-2. A certificate indicating the routine tests conducted on each motor including thermal withstand capability shall be supplied with the motors. A Performa given in Appendix-A may be used to indicate the results of type tests specified in Table-2. The manufacturer shall supply type test certificate with each order whenever required by the user. The manufacturer will supply the air gap figure.

Table-1

Parameters	Remarks
Frame Size	To be furnished by manufacturer / As per Purchaser's requirement.
Voltage level	Voltage level from 220 V to 690 V with variation +10 % - 15%
Output KW	As per customer requirement
Dimensional Standard	As per relevant IS
Protection	Minimum IP55 / To be furnished by manufacturer
Mounting	As per application & relevant IS
Cooling	As per relevant IS however in case of fan cooled at lower RPM than rated the cooling should be sufficient to take care of temperature rise limited to Class B. In case of separately forced cooling motor, the motor speed is to be limited to 1500 rpm(synch).
Peak Voltage	Peak Voltage 1.6 KV/ Min. For 460 volt motor- Both Drive and Motor shall comply with NEMA MG1 section 30.40.4.2 which specifies these limits at a maximum peak voltage of 1600 Volts and a minimum rise time of .1 microseconds. For 690 V to be covered. IEC to be checked for 460 V & upto 690 V.
Carrier switching frequency	As guided by the inverter drive specification
Voltage rise time	0.1 micro seconds
Distortion	To be specified by the purchaser
Suitable for up to supply voltage and frequency	To be furnished by manufacturer
Duty	As per purchaser requirement

Insulation	Minimum F Class with temp rise limited to class B
Cooling arrangement	To be furnished by manufacturer
Grade of wire	For wire wound motors, the grade of winding wire must be dual coat high grade enamelled wire or Inverter grade wire to be furnished by the manufacturer,
Vacuum Impregnation	Winding must be vacuum impregnated
Special arrangement to safe guard against Bearing current	Pl. refer to following IEC spec. - TS60034-17 refer to page 37 / TS60034-25 refer to Cl.8.1.2 (IEC recommends NDE side bearing insulated for frame size 315 and above)(>=55 kW for 8 pole, >=75 kW for 6 pole, >=110 kW for 2&4 pole)
Maximum permissible RPM for each frame size	To be furnished by manufacturer
Any special series indicated for VFD application motor on name plate	Name plate must indicate that it is suitable for VFD application

Stalled Rotor Withstand Time - Motor stalled rotor withstand time is to be furnished by the manufacturer.

TABLE – 2

TESTS ON ac MOTORS FOR VFD APPLICATION

SL No.	Test	Clause Ref. In ISs	Classification of Test
1	Measurement of winding resistance at ambient temperature	21.3.1 of IS 325:1996	Routine and type test
2	Insulation resistance test (both before and after the high voltage test)	24 of IS 325:1996	Routine and type test
3	High voltage test	23 of IS 325:1996	Routine and type test
4	No Load Test	. 21.3.1 of IS 325:1996	Routine and type test
5	Locked rotor test (for breakaway torque and breakaway starting current)	21.3.1 of IS 325:1996	Routine and type test
6	Performance at the lowest and at the highest frequency		Routine and type test
7	Temperature-rise test (see 11.1) 22 of IS 325:1996		Type test
8	Load test at rated voltage (for verification of efficiency, power factor and slip as declared by manufacturer)	21.3.1 of IS 325:1996	Type test
9	Speed torque test (pull-up, pull-out and breakaway torque) over the entire		Type test

	range of 10 to 75 Hz with an interval of 5 Hz		
10	Over speed test (120 % of the speed corresponding to maximum frequency for two minutes)	25 of IS 325:1996	Type test
11	. Mechanical inspection a) Dimensional checking (including checking of air gap) b) Dismantle/Inspection/Reassembly c) Balancing of the rotor d) Mass of the motor		Type test
12	Stalled rotor withstand time test (for 3 minutes or 10 minutes as specified under rated voltage condition)		Type test
13	Test for verification of acceleration value (dynamic constant) of the motor. The acceleration value (in kgm2/h) may be verified by subjecting the motor to continuous plug reversals with a pure inertia load coupled to the motor. The rate of plug reversals to be adjusted depending on the acceleration value specified and the inertia of load. The steady state temperature-rise should be within the limits specified for the		Type test

	insulation class.		

PROFORMA FOR TYPE TEST REPORT OF AC MOTORS FOR VFD APPLICATION CONFORMING TO IPSS:1-03-039-14

APPENDIX - A (Clause 16)		
Name and Address of the Manufacturer		
Purchaser Certificate No. Purchaser's Order No. Order Acceptance No.		
NAME PLATE DATA		
1	Rated voltage	
2	Winding connection	
3	Rated frequency & range of frequency in Hz	
4	Speed in RPM at rated output	
5	Frame size/Flange designation	
6	Enclosure	
7	Method of cooling	
8	Rated Current in amps at rated voltage	
9	GD^2 of rotor	
10	Motor for VFD application	Yes
11	Stalled rotor withstand time	
12	Locked rotor current	
13	Type of duty	
14	Rated output at design ambient temp.	

15	Mass of motor in kg	
16	Insulation class	
17	Bearing designation	
18	Year of manufacture	
19	Lubrication details	
20	Standards/certifications	

APPENDIX - A (Contd/-)

TESTS

Sl No	Tests to be conducted	Remarks
1	Stator Winding resistance per phase	Ohms
2	Insulation Resistance before HV test and after HV test	Mho
3	High voltage test	With stood ---kV for --minutes
4	Over speed test	Tested at –RPM for --minutes
5	Stalled rotor withstand time	Rotor stalled for ….....kV for …… minutes, Temperature-rise minutes at the end of the Test …^{o}C

8. LOAD TESTS

Loading Volts Amperes Watts % Slip Load Power Factors Efficiency

Condition Guaranteed Test Guaranteed Test

No Load

1/2 Load

3/4 Load

Full Load

9. TEMPERATURE-RISE TEST

Condition of Test Temperature-Rise oC Stator

Hours Line Line Cooling Core by Thermometer Windings by Resistance or Thermometer

Run Volts Amperes Air oC

Breakaway Torque in kgm with…….Volts Breakaway Starting Current (Locked Rotor)

Applied with……..volts applied

10. PERFORMANCE AT THE LOWEST AND AT THE HIGHEST FREQUENCY

11. SPEED TORQUE TEST

Lowest Frequency Highest Frequency

Speed in rev/min

Current in amperes

Torque in kgm

12. VERIFICATION OF ACCELERATION VALUE

Acceleration Value computed as per clause 3 and as per test carried out as specified in Sl.No.13 of Table-2 of

IPSS:1-03-007-14……kgm2/h

Steady state temperature-rise……oC