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BUREAU OF INDIAN STANDARDS
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Draft Indian Standard

Three Phase Induction Motors for Use in Nuclear Power Plants — Specification

(First Revision of IS 14578)

Rotating Machinery Sectional Committee, ETD 15

Last date for comments- 04/12/2024

FOREWORD

Foreword clause of the draft will be added later.

This standard has been prepared with a view to separately covering three-phase induction motors for use in Nuclear Power Plants.

The general requirements of three-phase induction motors are covered in IS 325: 1996 ‘Specification for three phase induction motors (*fifth revision*)

To ensure satisfactory installation and maintenance of induction motors, it is urged that the recommendations contained in IS 900: 1992 ‘Code of practice for installation and maintenance of induction motors (*second revision*)’ should be carefully followed.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2: 2022 ‘Rules for rounding off numerical values (*second revision*)'.The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

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THREE PHASE INDUCTION MOTORS FOR USE IN NUCLEAR POWER PLANTS — SPECIFICATION

(First Revision)

1 SCOPE

1.1 This standard covers three-phase induction motors for voltage up to and including 11000 volts having windings with Class-B, Class-F, Class-H and Class-C (see IS 1271) for use in Nuclear Power Plants. The motors specified in this standard are assigned any one of the rating specified in **9.4**.

1.2 Motors within the scope of this standard for use on systems employing non-preferred voltages and frequencies shall be considered as complying with this standard provided that they comply in all other respects with this standard. The voltages and frequency for which they are designated shall be stated on the rating plate.

1.3 In addition to this standard, the motor shall comply with IS/IEC 60034 or IS 15999 series in cases where no specific requirement is given in this standard.

2 REFERENCES

The provisions in following documents become the provisions of this part through reference in this part. All standards at the time of publication the edition indicated were valid. All standards are subjected to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

IS No. / IEC	*Title*
IS 5	Colours for ready mixed paints and enamels
IS 325: 1996	Specification for three phase induction motors (*fifth revision*)
IS 900: 1992	Code of practice for installation and maintenance of induction motors (*second revision*)
IS 1271	Electrical insulation - Thermal evaluation and designation
IS 1231	Dimensions and output series of foot mounted induction motors — Frame numbers 56 to 315 L
IS 2223	Dimensions of flange mounted AC induction motors
IS 3043	Code of practice for earthing
IS 4029	Guide for testing three phase induction motors
IS 6362 / IEC 60034 Part 6.	Designation of methods of cooling of rotating electrical machines
IS 1885 (Part 35) /IEC 60050 (411)	Electrotechnical vocabulary Part 35 Rotating machinery
IS 12075	Mechanical vibration of rotating electrical machines with shaft heights 56 mm and higher — measurement, evaluation and limits of

	vibration severity (IEC 60034-14 : 2018, MOD)
IS 12065	Permissible limits of noise levels for rotating electrical machines
IS 12360	Voltage bands for electrical installations including preferred voltages and frequency
IS 12615	Line operated three phase a.c. motors (IE CODE) "Efficiency classes and performance specification"
IS 13529	Rotating electrical machines Part 26 Effects of unbalanced voltages on the performance of three-phase cage induction motors
IS 15999 Part 1 /IEC 60034 -1	Rotating electrical machines Part 7 Classification of types of construction mounting arrangements and terminal box position (IM Code)
IS 15999-15	Rotating Electrical Machines Part 15 Impulse voltage withstand levels of form-wound stator coils for rotating ac machines
IS / IEC 60034 -5	Rotating electrical machines Part 5 degrees of protection provided by the integral design of rotating electrical machines (IP Code) - Classification
IS / IEC 60034-8	Rotating electrical machines Part 8 Terminal markings and direction of rotation

3 TERMINOLOGY

For the purpose of this standard, the following definitions in addition to those given in IS 1885 (part 35) /IEC 60050- 411 shall apply.

3.1 Full Load

The state of a motor rotating at normal speed under rated conditions when rated output is required out of it.

3.2 Overload

Any load in excess of the rated load, usually expressed numerically as the amount percentage excess torque for motors.

3.2.1 *Sustained Overload*

An overload sustained for a sufficiently long period to affect appreciably the temperature of the motor.

3.2.2 *Momentary Overload*

An overload the duration of which is on short as not to affect appreciably the temperature of the motors.

4 SITE CONDITIONS

The following shall constitute the normal site conditions.

4.1 Altitude and Temperature

Motors shall be designed for the following site condition unless otherwise agreed between the supplier and the purchaser.

4.1.1 *Altitude*

Altitude not exceeding 1000 m. Motors intended for service on sites where the altitude is in excess of 1000 m are covered in Table 11 of IS 15999 (Part-1).

4.1.2 *Temperature*

The reference ambient temperature for both LT and HT motors shall be 50 °C. For motors having CACW cooling the reference water temperature shall be furnished while enquiring for and ordering an electrical motor (based on requirement given in the purchaser specification in Annex A).

4.2 *Humidity*

Unless otherwise specified, all motors shall be designed for operation in an ambient with a relative humidity of 90 percent at 40 °C.

4.3 *Radiation*

Where specified, motors shall be designed to continuously operate under a minimum cumulative gamma radiation dose of 50 Mega Rads (or higher radiation levels as specified). Such motors shall also be capable of continuous service after withstanding building pressure test, during which the pressure of air seen by motor will be approximately 1.5 kg/cm2 (gauge). The building pressure may very base on the technology of the nuclear plant. The capability of the motor to withstand air pressure may be proved either by calculation or by test or by any other method agreed by the purchaser and supplier.

4.4 Special Environment

Motors which are to be installed in the reactor building must be capable of withstanding pressure and temperature transients, stream environment, which may occur on the account of LOCA (Loss of Coolant Accident) condition when the areas in the reactor building where motors are installed may become steam bound for a short duration as indicated in the technical specification / datasheet. The temperature of steam and pressure seen by motor inside reactor building in case of the accident shall be provided in the technical requirement / datasheet by purchaser in the tender or procurement request. The methods to qualify the motor for such environment shall be mutually agreed between the manufacturers and the customers.

4.5 Form and Symmetry of Currents and Voltages

4.5.1 The form and symmetry of voltage and current definition shall be in accordance with clause **7.2** of IS 15999-1 /IEC 60034 Part-1.

4.5.2 These motors shall also be capable of operation with an unbalance of 3 percent in supply voltage when calculated as per IS 13529.

Should the limits at 4.5.1 and 4.5.2 occur simultaneously in service at the rated load, this shall not lead to any deleterious temperature in the motor and it is recommended that the excess resulting

temperature shall not be more than 10 °C above temperature rise limit specified by purchaser.

4.6 Supply Voltage and Frequency Variation

Unless otherwise specified, all motors shall be capable of delivering the rated output under following variation in supply voltage and frequency:

a) Variation in voltage from its rated value ±10 percent;
b) Variation in frequency ±5 percent, and
c) Combined variation in voltage and frequency ±10 percent.

In case of continuous operation at extreme voltage limits, the temperature-rise limits specified by Purchaser shall not exceed by more than 5 °C. Motors when operated under the extreme conditions of voltage and frequency variation may not necessarily have their performance in accordance with this standard.

4.7 Whenever specified the motors shall be designed either for SSE (Safe Shut down Earth quack) or for OBE (Operation Basis Earth quack) to meet the floor response spectra applicable. The normal motors shall be designed such that it meet the industrial codal requirements. The method of the qualification shall be subjected to agreement between the purchaser and the supplier.

5 TYPES OF ENCLOSURES

5.1 Motors covered by this standard shall have one of the degrees of protection in accordance with IS / IEC 60034 Part 5.

6 METHOD OF COOLING

The methods of cooling of motors and their designations shall be in accordance with IS 6362 / IEC 60034 Part 6.

7 MATERIALS

7.1 All materials and components used in the manufacture of motors shall conform to relevant Indian Standards wherever these exist. Whenever it is not practicable to comply with this requirement, it shall be subject to agreement between the supplier and the purchaser.

7.2 For motors of 3300 V and above, the windings, coils and insulation system shall be capable of withstanding an impulse of 1.2/50 micro second as specified in IS 15999-15. The insulation system for the motors shall also be suitable to withstand satisfactorily the voltage surges produced due to chopping of currents by vacuum circuit breakers controlling the motors without any deterioration when surge suppressors are not provided. The supplier may carry out necessary tests on sample coils in accordance with IS 15999-15 to prove this capability.

7.3 When radiation withstand requirement is specified, the motor windings and all the components of the insulation system shall be selected suitably to withstand the specified cumulative dose of gamma radiations.

Also for motors located in radiation area, the materials used for the parts designed for periodic replacement (such as seals, gaskets, O rings, etc) the period of unimpaired operation with respect to radiation damage shall be at least 5 years. In case such materials are not capable of withstanding

such radiations, the replacement programme shall be clearly stated.

7.4 The slot wedges in large machines shall preferably be of non-magnetic material.

7.5 The retaining rings if used for the rotor shall be of non-magnetic forged material.

7.6 Painting

7.6.1 The motor external parts shall be finished and painted to produce a neat and durable surface which would prevent rusting and corrosion. The equipment shall be thoroughly degreased, all rust, sharp edges and scale removed and treated with one coat of primer and finished with two coats of enamel paint to shade 631 of IS 5.

7.6.2 For the motors in the reactor building, the painting shall be done with epoxy based paint system.

8 SPACE HEATERS

The motors rated 30 kW and above shall be provided with space heaters of adequate capacity to maintain motor internal temperature above the dew point, to prevent moisture condensation, when the motor is not in service. The space heaters shall be located at the accessible places preferably in the lower part of the motor.

9 PREFERRED VOLTAGES, FREQUENCY AND OUTPUT

9.1 Preferred Voltages

For the purpose of this standard, the preferred voltages shall be in accordance with IS 12360. The voltages preferred for three-phase, 50 Hz machines are: 415 V, 3.3 kV, 6.6 kV and 11 kV.

9.2 Frequency

The frequency shall be the standard frequency of 50 Hz.

9.3 Preferred Outputs

The preferred output ratings for ac induction motors up to and including 200kw shall be in accordance with IS 12615. The output rating above 200 kw shall follow purchaser technical specification / requirement.

10 DIMENSIONS

10.1 The dimensions of foot-mounted induction motors and flange mounted induction motors shall preferably be in accordance with IS 1231 and IS 2223 respectively.

11 DUTY

11.1 The class of duty rating assigned to motors has been specified in required shall be specified in 4 of IS 15999-1 / IEC 60034 Part 1. The purchaser datasheet or technical document shall specify the duty rating requirement accordingly.

11.2 Starting Duty

11.2.1 The general purpose motors for driving fans or pumps whose GD2 values referred to motor speed are the same or lower than motor GD2 shall be capable of two successive restarts when coupled to its driven equipment, with coasting down to rest between starts under both cold and hot conditions and a third restart shall be feasible after 20 min. The motor shall further be capable of three equally time spaced starts in an hour, the motor initially being at a temperature, not exceeding the rated load operating temperature.

11.2.2 For other applications, the starting duty shall be as agreed between the purchaser and the supplier.

11.3 Fast Bus Transfer

The motors shall be capable of withstanding the voltage torque stresses developed due to the vector difference between the residual voltage and the incoming supply voltage equal to 150 percent motor rated voltage during fast changeover of the supply.

12 EARTHING

Earthing of the motor shall be done in accordance with the relevant provisions of IS 3043.

13 TEMPERATURE-RISE

13.1 The limits of permissible temperature rise of winding with Class-B and Class-F insulation shall be in accordance with purchaser specification / requirement. For Class C insulation, the permissible temperature rise shall be as agreed between the purchaser and the supplier.

13.2 Under normal conditions of use, the motors rated up to 650 V and located in the reactor building and also all motor rated above 1100 V shall have windings of insulation Class F. However, the temperature rise of the windings shall be limited to those specified for Class B insulation (IS 1271).

14 OVERLOAD

The provisions of 9.4 IS 15999-1 / (IEC 60034 Part 1) shall apply.

15 LIMITS OF VIBRATION

Unless otherwise specified by the user, the severity of vibration for the motors for Nuclear Power Plants shall be within the limits specified in IS 12075

16 LIMITS OF NOISE

Unless otherwise specified the maximum permissible noise level shall be as specified in IS 12065.

17 PERFORMANCE VALUES

The performance values of the motor for use in Nuclear Power Plant shall be governed in accordance with IS 15999-1 / IEC 60034 Part 1.

18 EFFICIENCY AND POWER FACTOR

The provisions of IS 12615 / IEC 60034 Part 30 Section 1 shall apply.

19 TOLERANCE

Unless otherwise specified, tolerance applicable to the determined values shall be in accordance with Table 21 of IS 15999-1 / IEC 60034 Part 1.

20 TERMINAL MARKING

Terminal markings when used shall be in accordance with IS / IEC 60034-8.

21 MARKING

21.1 A rating plate stating the following shall be supplied with each motor:

a) Reference to this standard, that is, Ref IS;
b) Induction motor;
c) Name of the supplier;
d) Manufacturer's number and frame reference;
e) Type of duty;
f) Class of insulation;
g) Frequency in Hz;
h) Number of phases;
j) Rated output in kW;
k) Rated voltage and winding connections;
m) Current, approximate in amperes at rated output;
n) Speeds in revolutions per minute, at rated output;
p) Ambient temperature when above 50 °C;
q) Nominal efficiency of motor at rated output;
r) Type of bearings used for motor and the details of recommended lubricant;
s) Temperature rise in degrees over 50 °C;
t) Limit and conditions of successive starts;
u) Degree of protection and
v) Type of cooling.

21.2 When the motor is provided with space heaters, an additional name plate indicating the voltage and wattage rating of space heaters shall be provided.

22 INFOMATION TO BE GIVEN WITH INQUIRY AND ORDER

The general information to be furnished when inquiring for and ordering an electrical motor is given in Annex A

23 TESTS

23.1 The provision of IS 15999 / IES 60034 relevant parts shall be applicable.

23.2 The following tests may be performed when specified and agreed between the supplier and the purchaser.

a) Vibration test as per IS 12075;
b) Over speed test;
c) Tan Delta test on winding (only for motor rated above 3kV);
d) Polarization index test (for HT motors only) and
e) Shaft voltage measurement.

Note — The tests at (c), (d) and (e) above shall be for reference only

23.3 The method of test shall be in accordance with IS 4029.

24 SEISMIC TESTS

Whenever specified by the purchaser at the time of enquiry and specifically agreed by the supplier while commenting on the specification, the supplier shall prove either by actual testing or by design calculations that seismic accelerations of specified magnitude will not affect the life of bearings, change in air gap length or cause any structural failure, and motor will continue to run even after the earth quack, without any deterioration in performance.

ANNEX A

(Clause 4.1.2, *and* 22)

INFORMATION TO BE GIVEN WITH ENQUIRY AND ORDER

When inquiring for and ordering an electrical motor to comply with this standard the following particulars should be supplied:

Sl No.	Data to be provided
1)	Site and operating conditions;
2)	Reference to this standard, that is, Ref IS ;
3)	Type of enclosure;
4)	Class of duty;
5)	Method of cooling;
6)	Type of construction and mounting;
7)	Frequency in Hz and permitted variation;
8)	Number of phases;
9)	Mechanical output in kW;
10)	Rated voltage and permitted variation;
11)	Class of insulation;
12)	Speed in revolutions per minute, approximate, at the rated output;
13)	Direction of rotation, viewing from the driving end;
14)	Unidirection or bidirection of rotation required;
15)	The maximum temperature of the cooling air and water in the place in which the motor is intended to work in ordinary service;
16)	Maximum permissible temperature-rise of motor required, if different from this standard;
17)	The altitude of the place in which the motor is intended to work in ordinary service, if it exceeds 1000 m;
18)	If a motor is required to operate between various limits of voltage, current, frequency or speed, the corresponding values of the voltage, current, frequency and speed, respectively;
19)	System of earthing, if any, to be adopted;
20)	Particulars of tests required and where they are to be carried out;
21)	Particulars as to whether voltage-limiting devices will be employed;
22)	Rotor, whether squirrel cage or slip-ring;
23)	Details of shaft extension required;
24)	Type of slip-ring gear, whether continuously rated or for starting purposes only, and whether to be fitted with brush lifting or short-circuiting arrangements or both, and if interlocks are required;
25)	Method of starting to be employed;
26)	Breakaway torque in terms of the rated-load torque and the corresponding breakaway starting current which may be taken from the supply with the starting apparatus in circuit;
27)	Nature of load and any information regarding the driven machine which has a bearing upon the torque required during the accelerating period, the kinetic energy of the moving parts to be accelerated, and the number of starts during a specified period;
28)	For high voltage motors, system fault level and duration of the fault along with the details of protective devices and cable of the system to which the motor is connected to enable the manufacturer to design a suitable terminal box;
29)	Method of drive;
30)	Temperature of steam and pressure in Reactor building under LOCA condition and maximum duration of steam exposure;
31)	Seismic requirements;

32)	Any specific requirement.