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मानक

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Mazdoor Kisan Shakti Sangathan

“The Right to Information, The Right to Live”

“पुराने को छोड़ नये के तरफ”

Jawaharlal Nehru

“Step Out From the Old to the New”

IS 325 (1996): Three-phase induction motors [ETD 15:
Rotating Machinery]



“ज्ञान से एक नये भारत का निर्माण”

Satyanarayan Gangaram Pitroda

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“ज्ञान एक ऐसा खजाना है जो कभी चुराया नहीं जा सकता है”

Bhartrhari—Nitiśatakam

“Knowledge is such a treasure which cannot be stolen”

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भारतीय मानक

तीन-फेजीय प्रेरण मोटरें — विशिष्ट

(पाचवा पुनरीक्षण)

Indian Standard

THREE-PHASE INDUCTION MOTORS — SPECIFICATION

(*Fifth Revision*)

First Reprint AUGUST 1997

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

July 1996

Price Group 6

**AMENDMENT NO. 1 FEBRUARY 1998
TO
IS 325 : 1996 THREE-PHASE INDUCTION MOTORS
— SPECIFICATION
(Fifth Revision)**

(Page 1, clause 4.1.1, line 3) — Insert 'in 6.3 of 12802 : 1989' at the end.

(Page 1, clause 4.1.2, line 3) — Insert 'in 5.3 of 12802 : 1989' at the end.

(Page 3, clause 12.2, line 5) — Delete the words 'other than efficiency and power factor'.

(Page 4, clause 12.2) — Delete the last sentence.

(Foreword, third cover, para 2, line 2) — Delete the following sentence:

'and alsomanufacturer'.

(ET 15)

Reprography Unit, BIS, New Delhi, India

**AMENDMENT NO. 2 MAY 2002
TO
IS 325 : 1996 THREE-PHASE INDUCTION MOTORS —
SPECIFICATION
(Fifth Revision)**

[Page 4, Table 1, Sl No. (iv), col 2] — Substitute the following for the existing text:

'iv) Slip at full load and at working temperature:

- a) For machines having output 1 kW (or kVA) or more: $\pm 20\%$ of the guaranteed slip
- b) For machines having output less than 1 kW (or kVA): $\pm 30\%$ of the guaranteed slip'

(Page 5, clause 17.1, line 5) — Substitute 'IS 4889 : 1968' for 'IS 4029 : 1967'.

(Page 5, clause 20.2, line 1) — Insert the following at the beginning:

'If the rated temperature rise or the rated temperature is declared as that of a lower thermal class than that used in the construction, the same shall be marked on name plate.'

[Page 5, clause 20.2(d)] — Insert the following after 20.2(d) :

- e) Power factor,
- f) Weight.

(Page 7, clause 23.4, last sentence) – Delete.

(Page 7, clause 23.5, para 2, second sentence) – Delete.

(ET 15)

AMENDMENT NO. 3 FEBRUARY 2011
TO
IS 325 : 1996 THREE-PHASE INDUCTION MOTORS —
SPECIFICATION

(Fifth Revision)

[Page 6, clause 22.3.2(d)] — Substitute the following for the existing test:

‘Locked rotor readings of voltage, current and power input at a suitable reduced voltage except breakaway torque measurement (*see 23.4*).’

(ET 15)

FOREWORD

This Indian Standard (Fifth Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Rotating Machinery Sectional Committee had been approved by the Electrotechnical Division Council.

This standard had been first issued in 1951 and covered motors with Class A insulation for use on medium pressure systems. An amended version of this standard was published in 1956 to include motors with class B insulation also. The standard was completely revised in 1959 to incorporate a number of significant changes so as to bring the standard in conformity with the manufacturing practice at that time and also to take into account the work done at IEC level with respect to short time and intermittent ratings. The second revision of this standard was issued in 1961 to introduce the following modifications:

- i) Inclusion of motors with Class E insulation;
- ii) A test for balancing of motors;
- iii) Inclusion of preferred kW ratings up to 250 kW, the range of kW ratings covered by the standard was also left unlimited; and
- iv) Inclusion of two new classes of ratings, that is, rating for periodic duty and for continuous duty with intermittent load.

This standard was amended in 1965 to cater for voltages up to and including 11 000 volts.

The third revision was issued in 1970 with a view to aligning this standard with IS 4722 : 1968. Most of the rotating electrical machines that are used in practice are only three-phase induction motors. Keeping this fact in view the Committee responsible for the preparation of this standard decided to retain it as a separate standard although the requirements of these motors were also covered in IS 4722 : 1968. It was felt that this standard would not only help the large amount of users and manufacturers of these motors but also facilitate in understanding the requirements of three-phase motors to the small manufacturers. The important features of this revision were as follows:

- i) Distinction between the terms duty and rating was clearly brought out. The motors were classified into eight duty types to facilitate the purchaser of a motor to declare a particular duty type needed for his application. These duty types were illustrated by time-sequence graphs also.
- ii) With the availability of IS 4691 : 1968 which represented international practice, the types of enclosures for motors covered in this standard were also aligned with the above Indian Standard.
- iii) With the publication of IS 4728 : 1975, and IS 4889 : 1968 the corresponding clauses were deleted and reference made to these standards.

With a view to achieving conservation of materials, the trend in manufacture of induction motors in the country is towards greater use of Class E or higher temperature index insulation. Motors having windings with Class A insulation were retained in the standard for the interim period till motor manufacturers particularly in the small scale sector are also able to completely changeover from the manufacture of Class A to Class E motors.

The fourth revision was issued with a view to include motors with Class F and H insulation as these type of motors are also being manufactured in the country now.

NOTE — Motors with Class H insulation should be used when Class B or F insulated motors are found to be not suitable. Special precautions may be necessary in the design and use of these motors such as in the choice of greases of bearing, brush grades in view of the high temperature-rises that might be encountered.

The fifth revision has been undertaken:

To include optional tests such as tests for vibration severity, noise levels, degree of protection by enclosure, temperature rise at limiting values of voltage and frequency variation, overspeed, and insulation system.

Marking clause has also been amended to include bearing sizes, lubricant and lubrication material as optional requirements.

(Continued on third cover)

Indian Standard

THREE-PHASE INDUCTION MOTORS — SPECIFICATION

(Fifth Revision)

1 SCOPE

1.1 This standard covers three-phase induction motors for voltage up to and including 11 000 V and having windings with Class A to Class H insulation (see IS 1271 : 1985). The motors covered by this standard are assigned any one of the ratings given in 9.3.

1.2 Motors for use on systems employing non-preferred voltage and frequency (see 8) shall be considered as complying with this standard provided that these comply in all respects. The voltage and frequency for which they are designed shall be indicated on the rating plate of the motor.

2 REFERENCE STANDARDS

2.1 The standards given in Annex A are necessary adjuncts to this standard.

3 TERMINOLOGY

3.0 For the purpose of this standard, the following definitions in addition to those given in IS 1885 (Part 35) : 1993/IEC 50(411) : 1993 shall apply.

3.1 Full Load

The state of a motor rotating at normal speed under rated conditions when rated output is required 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 sufficient long period to effect appreciably the temperature of the motor.

3.2.2 Momentary Overload

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

3.3 Rating

The whole of numerical values of the electrical and mechanical quantities with their duration and

sequences assigned to the motor by the manufacturer and stated on the rating plate, the motor complying with the specified conditions.

NOTE: — The duration may be indicated by a qualifying term.

3.4 General Purpose Motors

A motor designed in standard ratings with standard operating characteristics and mechanical construction for use under usual service conditions without restrictions to a specific application or type of application.

4 SITE CONDITIONS

4.0 The following shall constitute the normal site conditions.

4.1 Altitude and Temperature

Motors shall be designed for the following site conditions unless otherwise agreed between the manufacturer and the purchaser.

4.1.1 Altitude

Altitude not exceeding 1 000 metres. Motors intended for service on sites where the altitude is in excess of 1 000 metres are covered.

4.1.2 Temperature

The cooling medium temperature not exceeding 40°C. Motors intended for service with a cooling medium temperature other than 40°C are covered.

4.2 Form and Symmetry of Voltages and Currents

The motor shall be so designed to be able to operate under the conditions given in 4.2.1.

4.2.1 In the case of an ac motor, the supply voltage is assumed to be virtually sinusoidal as defined in (a) below. In the case of a polyphase motor, the supply voltages are also assumed to form a virtually balanced system as defined in (b) below:

- a) The voltage is considered to be virtually sinusoidal, if, when supplying an ac motor at rated load, the waveform is such that the difference between the instantaneous value

and the instantaneous value of the fundamental component does not exceed five per cent of the amplitude of the latter. Such amplitude difference shall not exceed 2.5 percent when conducting test for temperature rise.

- b) A polyphase voltage system is deemed to form a virtually balanced system of voltages if the negative sequence component does not exceed 1 percent of the positive-sequence component of the system of voltages over a long period, or 1, 5 percent for short period not exceeding a few minutes, and if the voltage of the zero-sequence component does not exceed 1 percent of the positive sequence component.

Should the limits (a) and (b) 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-rise or temperature related to the limits specified in Table 1 of IS 12802 : 1989 should be not more than approximately 10°C.

In test for temperature-rise, the negative sequence component shall be less than 0.5 percent of the positive sequence component of the system of voltages, the influence of the zero-sequence system being eliminated. By agreement between the manufacturer and the purchaser, the negative-sequence component of the system of currents may be measured instead of the negative-sequence component of the voltages, and this shall not exceed 2.5 percent of the positive-sequence component of the system of currents.

NOTES

1 In the vicinity of large single-phase loads (for example, induction furnaces), and in rural areas particularly on mixed industrial and domestic systems supplies may be distorted beyond the limits set out above. Special arrangements will then be necessary between the manufacturer and the purchaser.

2 For guidance on effects of unbalanced voltage on the performance of three-phase induction motors see IS 13529 : 1992

4.3 Voltage and Frequency Variation

Motors shall be capable of delivering rated output with:

- a) the terminal voltage differing from its rated value by not more than ±6 percent, or
- b) the frequency differing from its rated value by not more than ±3 percent, or
- c) any combination of (a) and (b).

In the case of continuous operation at extreme voltage limits, the temperature-rise limits specified in Table 1 of IS 12802 : 1989 shall not exceed by

more than 10°C for motors of output up to and including 1 000 kW and 5°C for motors of output exceeding 1 000 kW. Motors, when operated under the extreme conditions of voltage and frequency variation, may not necessarily have their performance in accordance with this standard.

4.4 It shall be assumed that the location and moisture or fumes shall not seriously interfere with the operation of the motor.

5 ENCLOSURES

5.1 Motors covered by this standard shall have one of the degrees of protection against ingress of solid bodies and liquids in accordance with IS 4691 : 1985.

6 COOLING

6.1 The methods of cooling of motors and their designations shall be in accordance with IS : 6362 : 1995/IEC Pub 34-6 : 1991.

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 manufacturer and the purchaser.

8 RATED CONDITIONS OF VOLTAGE, FREQUENCY AND OUTPUT OF MOTORS

8.1 Rated Voltages

For the purpose of this standard, the preferred rated voltages shall be in accordance with IS 12360 : 1988. The voltages for three phase, 50 Hz motors are:

415 V, 3.3 kV, 6.6 kV and 11 kV

8.1.1 Coordination of Voltages and Output

In the case of three-phase induction motors it is recommended that the minimum rated output should be greater than the limits given below in terms of the rated voltage:

Rated Voltage (kV)	Minimum Rated Output (kW)
$2 < U_N \leq 3.3$	100
$3.3 < U_N \leq 6.6$	200
$6.6 < U_N \leq 11$	1 000

where U_N is the rated voltage.

8.2 Rated Frequency

The rated frequency shall be 50 Hz.

8.3 Rated Output

The preferred output ratings for ac induction motors up to and including 110 kW are:

kW	kW	kW	kW
0.06	0.55	5.5	30
0.09	0.75	7.5	37
		9.3	
0.12	1.1	11	45
0.18	1.5	15	55
0.25	2.2	18.5	75
0.37	3.7	22	90, 110

8.3.1 The output ratings above 110 kW shall follow the R20 series [see IS 1076 (Part 1) : 1985].

NOTE — Preferred output ratings of 3 kW and 4 kW are under consideration.

9 TYPE OF DUTY AND CLASS OF RATING

9.1 General

The declaration of duty and the assignment of rating for three phase induction motors shall be in accordance with IS 12824 : 1989.

9.2 Type of Duty

The following shall be the duty types:

- S₁ — Continuous duty
- S₂ — Short time duty
- S₃ — Intermittent periodic duty
- S₄ — Intermittent periodic duty with starting
- S₅ — Intermittent periodic duty with starting and electric braking
- S₆ — Continuous duty with intermittent periodic loading
- S₇ — Continuous duty with starting and electric braking
- S₈ — Continuous duty with periodic speed changes

9.2.1 The details of duty types and their designations are given in IS 12824 : 1989.

9.3 Assignment of Rating

9.3.1 In arriving at the rating, the manufacturer may select a suitable motor to meet the required duty from his standard list of ratings (see 8.3).

For the majority of applications, continuous rating, short time rating, intermittent ratings, or continuous rating with intermittent loading corresponding to duty types, S₁, S₂, S₃, and S₆ respectively, shall be found appropriate, but for special duties, equivalent continuous, short time or intermittent rating may be required.

9.3.2 Equivalent Continuous, Short Time or Intermittent Rating

Where a motor is designed for cyclic duty, it shall be possible to assign to it for testing purposes an equivalent continuous, short time or intermittent rating such that the motor shall satisfactorily meet

the actual duty required whilst complying with the specified conditions.

NOTE — In order that this clause may be properly applied, the manufacturer should be in possession of all the data of the required duty which the purchaser may supply him; if this is insufficient, agreement may have to be reached by discussion between purchaser and manufacturer.

9.4 Rating for Multi-Speed Motor

A multi-speed motor shall have a definite rating for each speed.

10 DIMENSIONS, FRAME NUMBER AND OUTPUT RELATIONSHIP

10.1 The fixing dimensions and shaft extensions of induction motors shall conform to the values specified in IS 1231 : 1974 and IS 2223 : 1983 as relevant.

In the case of general purpose application motors the relationship between the output in kW and the frame number shall conform to IS 1231 : 1974, IS 2223 : 1983 and IS 2254 : 1985 as relevant. In the case of specific application motors or where motors are integral component of any equipment, the relationship between output and frame number of IS 1231 : 1974 may not be applicable. However, the motor shall be constructed in one of the standard frame numbers specified in IS 1231 : 1974 wherever the construction permits.

10.1.1 The dimension of large size motors of frame No. 355 to 1080 may be selected from IS 8223 : 1976.

11 PROVISION FOR EARTHING

11.1 Earthing of the motor shall be done in accordance with the relevant provisions of IS 3043 : 1987.

12 PERFORMANCE VALUES

12.1 The values of the minimum full load speed, maximum full load current, minimum breakway torque and nominal value of efficiency of the 2-, 4-, 6- and 8 pole three-phase squirrel cage induction motors having output in accordance with 8.3 up to and including 37 kW and having enclosures for type of protection IP 44 or superior and method of cooling IC 41; or enclosures for type of protection IP 21, IP 22 or IP 23 (see IS 4691 : 1985) and method of cooling IC 01 (see IS 6362 : 1995) at rated voltage and frequency of 415 V and 50 Hz respectively for duty type S₁ shall be in accordance with IS 8789 : 1996).

12.2 In case the manufacturer declares superior values of performance characteristics than these specified in IS 8789 : 1996, declared values shall be subject to verification. For performance characteristics other than efficiency and power factor, the values obtained from test results shall conform to the declared values of the manufacturer within the tolerances specified in Table 1. However the lowest

values obtained after applying tolerances in accordance with Table 1 for any performance characteristics shall not be lower than these specified in IS 8789 : 1996. In case of superior values of efficiency and power factor, no tolerance shall be applicable.

13 OVERLOAD

13.1 Momentary Excess Torque

13.1.1 General Purpose Application Three-Phase Induction Motors

The motors shall, whatever their type of duty and construction, be capable of withstanding for 15 seconds without stalling or abrupt change in speed (under gradual increase of torque) 1.6 times their rated torque, the voltage and frequency being maintained at their rated values.

13.1.2 Induction Motors for Specific Applications

13.1.2.1 Motors intended for specific applications that require a high torque (for example, for hoisting) shall be the subject of special agreement.

13.1.2.2 For squirrel cage motors specially designed to ensure a breakaway starting current less than 4.5 times the rated current corresponding to the rating, the excess torque may be below 60 percent specified in 13.1.1 above, but not less than 50 percent of the rated torque.

13.1.2.3 The special types of induction motors with special inherent starting characteristics, the value

of the excess torque shall be the subject of agreement between the manufacturer and the purchaser.

13.2 Pull-Up Torque

Unless otherwise specified by the user, the minimum, pull-up torque of squirrel cage induction motors at rated voltage shall be in accordance with Table 2.

**Table 2 Pull up Torque of Squirrel Cage Induction Motors
(Clause 13.2)**

Rating	Pull Up Torque
<i>Single Speed Motors</i>	
i) Output < 100 kW	0.5 times the rated torque and not less than 0.5 times the breakaway torque
ii) Output ≥ 100 kW	0.3 times the rated torque and not less than 0.5 times the breakaway torque
<i>Multi Speed Motors</i>	
Any rating	0.3 times the rated torque

13.3 Sustained Overloads

Motors rated in accordance with this standard are not suitable for carrying sustained overloads.

14 TEMPERATURE RISE

14.1 The determination of the temperature rise of three-phase induction motors delivering rated output under the rated conditions of voltage, frequency and power factor shall be in accordance with IS 12802 : 1989.

**Table 1 Schedule of Tolerances
(Clauses 12.2, 17.1, 17.2 and 18.1)**

Sl No.	Item	Tolerance
(1)	(2)	(3)
i) Efficiency (η):		
a) By summation of losses:		
Motors up to 50 kW		- 15 percent of $(1 - \eta)$
Motors above 50 kW		- 10 percent of $(1 - \eta)$
b) By input — output test		- 15 percent of $(1 - \eta)$
ii) Total losses applicable to motors above 50 kW*		+ 10 percent of the total losses
iii) Power factor ($\cos \phi$)		- 1/6 of $(1 - \cos \phi)$ Min 0.02 and Max 0.07
iv) Slip at full load and at working temperature		± 20 percent of the guaranteed slip
v) Breakaway starting current of squirrel cage induction motors with short-circuited rotor and with any specified starting apparatus		+ 20 percent of the guaranteed starting current (no negative tolerance)
vi) Breakaway torque		- 15 percent to + 25 percent of the guaranteed torque (+ 25 percent may be exceeded by agreement)
vii) Pullout torque		- 10 percent of the guaranteed torque except that after allowing for this tolerance, the torque shall be not less than 1.6 or 1.5 times the rated torque (see 13.1)
viii) Moment of inertia or stored energy constant applicable to motors of frame sizes above 315		± 10 percent of the guaranteed value
ix) Rotor voltage		± 10 percent

*Upon agreement between the manufacturer and the purchaser.

14.2 The limits of temperature rise applicable to three-phase induction motors shall be in accordance with Table 1 of IS 12802 : 1989.

15 LIMITS OF VIBRATION SEVERITY

15.1 Unless otherwise specified by the user the severity of vibration for the motors shall be within the limits specified in IS 12075 : 1987.

16 LIMITS OF NOISE LEVELS

16.1 Unless otherwise specified by the user, the limits of noise level shall be in accordance with IS 12065 : 1987.

17 EFFICIENCY AND POWER FACTOR

17.1 Efficiency

If a statement of efficiency at partial output is required, the purchaser shall specify at the time of enquiry the loads to which the statement shall apply. The method of arriving at the efficiency shall be as given in IS 4029 : 1967.

17.2 Power Factor

If a statement of power factor at rated or partial output is required, the purchaser shall specify at the time of enquiry the loads on which the statement is to be based.

18 TOLERANCE

18.1 Unless otherwise specified by the user, tolerances shall be in accordance with Table 1. Where a tolerance stated is in only one side, the tolerance in the other side is considered unimportant.

19 TERMINAL BOX AND TERMINAL MARKINGS

19.1 The position of terminal box of the motor shall be in accordance with 5 of IS 1231 : 1974. The size of the terminal box and terminals shall be adequate to accommodate aluminum conductor insulated cables.

19.1.1 Terminal markings and direction of rotation of shaft shall be in accordance with IS 4728 : 1975.

20 MARKING

20.1 The following indelible markings shall be provided on the rating plate fixed on each motor:

- a) Reference to this standard, that is Ref IS 325 : 1996
- b) Induction motor;
- c) Name of manufacturer;
- d) Manufacturer's number and frame reference;
- e) Rated voltage and winding connections;
- f) Rated output in kW;

- g) Current, in amperes at rated output;
- h) Frequency in Hz;
- j) Type of duty;
- k) Class of insulation;
- m) Number of phases;
- n) Speeds in revolutions per minute, at rated output;
- p) Efficiency at rated output;
- q) Rotor (secondary) voltage and winding connections (for wound rotor motors);
- r) Rotor (secondary) current in amperes at rated output (for wound rotor motors);
- s) Ambient temperature when above 40°C; and
- t) Degree of protection.

20.2 Subject to agreement between the manufacturer and purchaser the following information may also be marked on the rating plate:

- a) Bearing sizes,
- b) Lubricant,
- c) Lubrication material, and
- d) Year of manufacture.

20.3 BIS Certification Marking

The motors may also be marked with the Standard Mark

20.3.1 The use of the Standard Mark is governed by the provisions of the *Bureau of Indian Standards Act*, 1986 and the Rules and Regulations made thereunder. The details of conditions under which a licence for the use of the Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

21 INFORMATION TO BE GIVEN AT THE STAGE OF ENQUIRY AND PLACING ORDER FOR SUPPLY

21.1 The general information to be furnished when enquiring for and ordering an electrical motor is given in Annex B.

22 TESTS

22.1 General

The tests specified in this clause shall normally be carried out at the manufacturer's works. If normal test arrangements are inapplicable, as for example, in the case of certain large or special motors, the test to be made and the manner of application shall be a matter of agreement between the manufacturers and the purchasers. For details of test method, reference may be made to IS 4029 : 1967.

The temperature-rise test on motors is generally done at rated conditions. When loading to rated conditions is not possible due to limitations in facility, the super-imposition method of loading

shall be considered in accordance with the method given in Annex A of IS 4029 : 1967.

22.2 Test Certificates

22.2.1 Unless otherwise specified when inviting tenders, the purchaser, if so desired by the manufacturer, shall accept manufacturer's certificate as evidence of the compliance of the motor with the requirements (see 10, 11, 12, 13 and 17) of this standard together with a type test (see 22.3.1) certificate on a motor identical in essential details with the one purchased, together with routine test certificate on each individual motor for a batch of 20 or more similar motors is supplied on one order, type tests, as specified, shall be made on one of these motors, in addition to the other certificates if the purchaser so requires.

22.2.2 Certificates of routine tests (see 22.3.2) shall show that the motor purchased has been run and has been found to be electrically and mechanically sound and in working order in all particulars.

22.3 Classification of Test

22.3.1 Type Tests

The following shall constitute type tests:

- a) Dimensions (for motors covered by IS 1231 : 1974 and IS 2223 : 1983 only) (see 10);
- b) Measurement of resistance of windings of stator and wound rotor;
- c) No load test at rated voltage to determine input current power and speed (see 23.1);
- d) Open circuit voltage ratio of wound rotor motors (Slip ring motors) (see 23.3);
- e) Reduced voltage running up test at no load (for squirrel cage motors upto 37 kW only) (see 23.2);
- f) Locked rotor readings of voltage, current and power input at a suitable reduced voltage (see 23.4);
- g) Full load test to determine efficiency power factor and slip (see 23.5);
- h) Temperature rise test (see 14);
- j) Momentary overload test (see 13.1);
- k) Insulation resistance test (see 25);
- m) High voltage test (see 24);
- *n) Test for vibration severity of motor (see 15);
- *p) Test for noise levels of motor (see 16);
- *q) Test for degree of protection by enclosure (see 5);
- *r) Temperature rise test at limiting values of voltage and frequency variation;
- *s) Overspeed test (see 26); and
- *t) Test on insulation system (see 27).

* These are optional tests subject to mutual agreement between purchaser and the manufacturer.

22.3.1.1 It is recommended that the reports of type tests be made in the form recommended in Annex C.

22.3.2 Routine Tests

The following shall constitute the routine tests:

- a) Insulation resistance test (see 25);
- b) Measurement of resistance of windings of stator and wound rotor;
- c) No load test (see 23.1);
- d) Locked rotor readings of voltage, current and power input at a suitable reduced voltage; (see 23.4)
- e) Reduced voltage running up test (see 23.2) (for squirrel cage motors);
- f) Open circuit voltage ratio of stator and rotor windings (for slip ring motors); (23.3) rotor; and
- g) High voltage test (see 23.4).

23 PERFORMANCE TESTS

23.1 No Load Test

The motor shall be run at rated voltage and frequency given on the rating plate. The motor shall run to its normal speed and shall not show abnormal electrical or mechanical noise. The input power, current and speed shall be measured and used in the determination of no load losses and efficiency at full load.

NOTE — In case proper facilities for conducting this test at rated voltage are not available, the method of testing shall be mutually agreed between the manufacturer and the purchaser.

23.2 Reduced Voltage Running Up Test

The test is applied to squirrel cage motors. The test is made to check the ability of motor to run upto its rated speed at no load. The motor upto 37 kW shall be supplied with reduced voltage $1/\sqrt{3}$ of rated value for each direction of rotation. For motors above 37 kW, the voltage shall be $1/\sqrt{3}$ of rated value or less but motor shall be run only in the specified direction of rotation.

23.3 Open Circuit Voltage Ratio Test for Wound Rotor (Slip Ring) Motors

The stator of the motor is supplied with rated voltage and open circuit voltage at the slip ring shall be determined (by lifting the slip ring brushes). The voltage shall comply with the declared values of the manufacturer.

23.4 Locked Rotor Test

The test shall be carried out in accordance with provision of IS 4029 : 1967. The test may be carried out at reduced voltage. The readings of the input

current, power and breakaway torque shall be determined. The values of breakaway torque shall be not less than the value given in IS 8789 : 1996.

23.5 Full Load Test

The motor shall be supplied with rated voltage and load on the shaft shall be adjusted such that it delivers the rated output.

The value of voltage, power input, current and speed shall be measured. The efficiency determined for full load shall not be less than the values specified in IS 8789 : 1996. The detailed procedure of testing three phase induction motors shall be in accordance with IS 4029 : 1967.

NOTE — In case proper facilities for conducting this test at rated voltage are not available, the method of testing shall be mutually agreed between the manufacturer and the purchaser.

24 HIGH VOLTAGE TEST

24.1 The requirements specified in IS 4029 : 1967 shall apply.

25 INSULATION-RESISTANCE TEST

25.1 The requirements specified in 30.2 of IS 4722 : 1992 shall apply.

26 OVERSPEED TEST

26.1 All motors shall be designed to withstand 1.2 times the maximum rated speed.

26.2 An overspeed test is not normally considered necessary, but may be performed when this is specified and has been agreed between the manufacturer and the purchaser at the time of the order. An overspeed test shall be considered as satisfactory, if no permanent abnormal deformation is apparent subsequently and no other weakness is detected which may prevent the motor from operating normally, and provided the rotor windings after the test comply with the required high-voltage test. The duration of any overspeed test shall be two minutes.

27 TEST ON INSULATION SYSTEM

NOTE — Unless otherwise specified when inviting tenders, the purchaser, if so desired by the manufacturer, shall accept manufacturer's test certificate as evidence of the compliance of the motor/insulation system with the requirements of the following tests together with the test certificates as stated in 22.2.

27.1 Tangent Delta and Delta Tangent Delta Test

The requirements and method of test shall be as per IS 13508 : 1992.

27.2 Impulse Voltage withstand Test

The requirements and method of test should be as per IS 14222 : 1995.

ANNEX A

(Clause 2.1)

LIST OF REFERRED INDIAN STANDARDS

IS No.	Title	IS No.	Title
900 : 1992	Code of practice for installation and maintenance of induction motors (revised)	2254 : 1985	Dimensions of vertical shaft motors for pumps (second revision)
996 : 1979	Single-phase small ac and universal electric motors (second revision)	3043 : 1987	Code of practice for earthing (first revision)
1076 (in parts)	Preferred numbers	3855 (in parts)	Rectangular and square enamelled copper conductors
1231 : 1974	Dimensions of three-phase foot-mounted induction motors (third revision)	4029 : 1967	Guide for testing three-phase induction motors
1271 : 1985	Thermal evaluation and classification of electrical insulation (first revision)	4691 : 1985	Degrees of protection provided by enclosures for rotating electrical machinery (first revision)
1885 (Part 35) : 1973/ IEC 50 (411) : 1993	Electrotechnical vocabulary: Part 35 Rotating machinery	4722 : 1992	Rotating electrical machines (first revision)
2223 : 1983	Dimensions of flange mounted ac induction motors (second revision)	4728 : 1975	Terminal marking and direction of rotation for rotating electrical machinery (first revision)

IS 325 : 1996

<i>IS No.</i>	<i>Title</i>	<i>IS No.</i>	<i>Title</i>
4800 (Part 5) : 1968	Enamelled round winding wires : Part 5 Wires for elevated temperatures	12065 : 1987	Permissible limits of noise level for rotating electrical machines
4889 : 1968	Method of determination of efficiency of rotating electrical machines.	12075 : 1986	Mechanical vibration of rotating electrical machines with shaft heights 56mm and higher - measurement, evaluation and limits of vibration severity
6362 : 1995/ IEC Pub : 34-8 : 1991	Designation of methods of cooling for rotating electrical machines	12360 : 1988	Voltage bands for electrical installations including preferred voltages and frequency
6455 : 1972	Single row radial ball bearings	12661 (Part 1) : 1988	High voltage motor starter: Part 1 Direct on line (full voltage) ac starters
6457 : 1972	Single row cylindrical roller bearings	12802 : 1989	Temperature-rise measurement of rotating electrical machines
8223 : 1976	Dimensions and output ratings for foot-mounted rotating electrical machines with frame numbers 355 to 1 000	12824 : 1989	Type of duty and classes of rating assigned (<i>second revision</i>)
8544 (in parts)	Motor starters for voltages not exceeding 1000 V	13947 (Part 4/Sec 1) : 1993/IEC 947-4-1 (1990)	LV switchgear and controgear : Part 4 contactors and motor starters, Sec 1 Electromechanical
8789 : 1996	Values of performance characteristics for three-phase induction motors		

ANNEX B**(Clause 21.1)****INFORMATION TO BE GIVEN AT THE STAGE OF ENQUIRY AND PLACING ORDER**

When enquiring for and ordering an electric motor to comply with this standard the following particulars should be supplied by the purchaser:

- 1) Site and operating conditions;
- 2) Reference to this standard, that is, 'Ref ISS';
- 3) The degree of protection provided by enclosure; namely IP 54, IP 23 ...
- 4) Type of duty;
- 5) Method of cooling;
- 6) Type of construction and mountings;
- 7) Frequency in Hz;
- 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;
- 16) Maximum permissible temperature-rise of motor required, if different from this standard;
- 17) The attitude of the place in which the motor is intended to work if it exceeds 1 000 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 and the place where these are to be carried out;
- 21) Particulars as to whether voltage-limiting devices will be employed;
- 22) Whenever a motor is associated with a reciprocating machine any information regarding the associated machine which will enable the natural frequency of torsional resonance of the combined unit to be determined;
- 23) Rotor, whether squirrel cage or slip-ring;
- 24) Details of shaft extension required;
- 25) 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;
- 26) Method of starting to be employed;
- 27) Breakaway torque in terms of the rated load torque and the corresponding breakaway starting current which may be drawn from the supply with the starting apparatus in circuit;
- 28) 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;
- 29) For high voltage motors, fault capacity and duration of the fault alongwith 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;
- 30) Method of drive and type of coupling; and
- 31) Any specific requirement.

Attention is drawn to the type of duty rating of switching starter which should be selected from IS 13947 (Part 4/sec 1) : 1993/IEC 947-4-1 (1990) and IS 12661 (Part 1) : 1988 for voltage upto 1 000 V and above 1 000 V respectively.

ANNEX C

FORM FOR TYPE TEST REPORT OF THREE PHASE INDUCTION MOTOR
(Clause 22.3.1.1)

MANUFACTURER

CERTIFICATE NO.

PURCHASER

PURCHASE ORDER NO.

ORDER ACCEPTANCE NO.

NAME PLATE DATA

OUTPUT kW	PHASE	VOLTS V	CONNECTION	FULL LOAD CURRENT A	FREQUENCY	FULL LOAD SPEED RPM	FRAME	DUTY	INSULATION	EFFICIENCY NOMINAL PERCENT	MANUFACTURER'S NUMBER/REF

TESTS

LOAD CONDITION	VOLT V	CURRENT A	POWER W	SLIP PERCENT	LOAD	POWER FACTOR		EFFICIENCY	
						GUARANTEED	TEST	GUARANTEED	TEST
NO LOAD					1/4				
					1/2				
					3/4				
					FULL				

TEMPERATURE RISE TEST RUN

HOURS RUN	VOLT V	CURRENT A	POWER INPUT W	CALCULATED POWER OUTPUT W	COOLING AIR °C	TEMPERATURE RISE °C			
						STATOR		ROTOR	
						Core	Winding	Core	Winding

BREAKAWAY TORQUE AND STARTING CURRENT

LOCKED ROTOR

VOLTAGE V	BREAKWAY STARTING CURRENT A	TORQUE kg. M	POWER kW

- ==
- INSULATION RESISTANCE STATOR. ROTOR:
- HIGH VOLTAGE TEST:
- OPEN CIRCUIT ROTOR VOLTS:
- RESISTANCE OF WINDINGS PER PHASE: STATOR ... ohms at °C
- RESISTANCE OF WINDINGS PER PHASE: ROTOR ... ohms at °C
- REDUCED VOLTAGE RUNNING UP TEST:
- OVERLOAD
- a) MOMENTARY EXCESS TORQUE TEST:
- b) PULL-UP TORQUE:
- VIBRATION SEVERITY:
- NOISE LEVEL:
- DEGREE OF PROTECTION BY ENCLOSURE:

TESTED BY
DATE

APPROVED BY
DATE

(Continued from second cover)

Reference standards has been updated and the amendments issued earlier pertaining to temperature rise test and reduced voltage running up test have been incorporated.

The aspect of energy conservation has been introduced by specifying the efficiency in place of product of efficiency and power factor and also tolerance has not been permitted on declared superior values of efficiency and power factor declared by the manufacturer.

The dimensions for a range of frame sizes and the associated normal output ratings of electric motors are covered by IS 1231 : 1974 'Dimensions of three-phase foot-mounted induction motors (*third revision*)'. IS 2223 : 1983 'Dimensions of flange mounted ac induction motors (*first revision*)', IS 2254 : 1985 Dimensions of vertical shaft motors for pumps (*second revision*)'.

The requirements of induction motors for various applications are covered by the following standards:

IS 996 : 1979 Single-phase small ac and universal electric motors (*second revision*)

IS 2972 (Part 1) : 1979 Textile motors: Part 1 Loom motors (*first revision*)

IS 2972 (Part 2) : 1979 Textile motors: Part 2 Card motors (*first revision*)

IS 2972 (Part 3) : 1979 Textile motors: Part 3 Spinning frame motors (*first revision*)

IS 3682 : 1966 Flameproof ac motors for use in mines

IS 7538 : 1996 Three-phase squirrel cage induction motors for centrifugal pumps for agricultural applications

IS 8151 : 1976 Single-speed three-phase induction motors for driving lifts

IS 9283 : 1995 Motors for submersible pump sets

IS 9582 (Part 1) : 1980 Single-phase electric motors for definite purposes: Part 1 Domestic laundry machine motors

IS 9628 : 1980 Three-phase induction motors with type of protection 'n'

IS 12066 : 1987 Three-Phase induction motors for machine tools

IS 12615 : 1989 Energy efficient three-phase squirrel cage induction motors

For guidance on selection of three-phase induction motors reference may be made to IS 13555 : 1993 'Guide for selection and application of three-phase ac induction motors for different types of driven equipment'.

To ensure satisfactory installation and maintenance of induction motors, it is urged that the recommendations contained in IS 900 : 1992 should be followed.

In the preparation of this standard, assistance has been derived from IEC Publication 34-1 (1983) Rotating electrical machines: Part 1 Rating and performance, issued by the International Electrotechnical Commission.

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, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. 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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Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the latest issue of 'BIS Handbook' and 'Standards Monthly Additions'.

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