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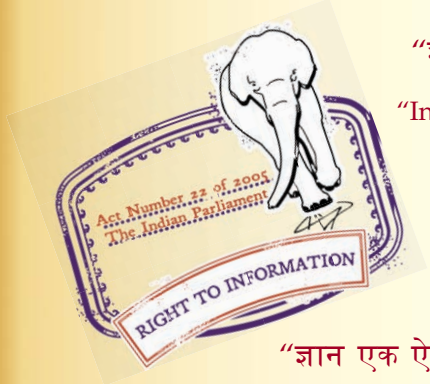
IS 1180-1 (1989): Outdoor type three-phase distribution transformers up to and including 100 kVA 11 kV, Part 1: Non-sealed type [ETD 16: Transformers]



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Bhartṛhari—Nītiśatakam
"Knowledge is such a treasure which cannot be stolen"

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IS 1180 (Part 1) : 1989
(Reaffirmed 1993)

Indian Standard

OUTDOOR TYPE THREE-PHASE DISTRIBUTION TRANSFORMERS UP TO AND INCLUDING 100 kVA 11 kV — SPECIFICATION

PART 1 NON-SEALED TYPE

(Third Revision)

भारतीय मानक

बाहरी टाइप तीन फेज़ी वितरण ट्रांसफार्मर 100 कि वो ए 11 कि वो तक के लिए — विशिष्टि

भाग 1 बिना सील वाले

(तीसरा पुनरीक्षण)

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

April 1990

Price Group 4

FOREWORD

This Indian Standard (Part 1) (Third Revision) was adopted by the Bureau of Indian Standards on 30 May 1989, after the draft finalized by the Transformers Sectional Committee had been approved by the Electrotechnical Division Council.

This standard was originally published in 1958 and was first revised in 1964 and subsequently in 1981. This third revision has been published to take into account the experience gained since the last revision of this standard.

The major changes in this revision include the rationalization of ratings, reduction of limits of no load and losses and the modification of the temperature rise for top oil, in line generally with REC Specification on the subject.

Although IS 2086 'Specification for power transformers' includes the range of transformers covered by this standard, it has been decided to retain the latter considering the advantages of having a standard which has simplified the requirements in the small range covered by it. However, for various common requirements references have been made to IS 2086 which is, therefore, a necessary adjunct to this standard.

The requirements of sealed type outdoor distribution transformers of similar voltage and kVA ratings are covered in Part 2 of this standard.

This standard is intended to cover the technical provisions relating to transformers and it does not include all the necessary provisions of a contract.

This standard calls for agreement between the purchaser and the manufacturer under **8.1, 10.1, 11.2, 12.1.1** and **19.1.**

In the preparation of this standard assistance has been derived from REC Specification 2/1971 'Distribution transformers', issued by the Rural Electrification Corporation.

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.

AMENDMENT NO. 1 APRIL 1994
TO
IS 1180 (Part 1) : 1989 OUTDOOR TYPE THREE-PHASE DISTRIBUTION TRANSFORMERS UP TO AND INCLUDING 100 kVA 11 kV — SPECIFICATION

PART 1 NON-SEALED TYPE

(Third Revision.)

(*Page* 1, *clause* 9.1, *line* 2) — Add the following after the first sentence:

'The tank cover can be of bolted/welded type as agreed to between the purchaser and the supplier.'

(ETD 16)

Printed at Dee Kay Printers, New Delhi, India

Indian Standard

OUTDOOR TYPE THREE-PHASE DISTRIBUTION TRANSFORMERS UP TO AND INCLUDING 100 kVA 11 kV — SPECIFICATION

PART 1 NON-SEALED TYPE

(Third Revision)

1 SCOPE

1.1 This standard (Part 1) specifies the requirements and tests for oil-immersed, naturally air-cooled, three-phase, double-wound non-sealed type outdoor distribution transformers of ratings up to and including 100 kVA, for use on systems with nominal system voltages up to and including 11 kV.

2 REFERENCES

2.1 The Indian Standards listed in Annex A are necessary adjuncts to this standard.

3 TERMINOLOGY

3.1 For the purpose of this standard, the definitions given in IS 1885 (Part 38) : 1977 shall apply.

4 SERVICE CONDITIONS

4.1 The provisions of 3 of IS 2026 (Part 1) : 1977 shall apply.

5 RATINGS

5.1 kVA Ratings

The standard ratings shall be 16, 25, 63 and 100 kVA.

5.2 Rated Frequency

The rated frequency shall 50 Hz.

5.3 Nominal System Voltage

Nominal system voltage shall be chosen from the following:

3·3, 6·6 and 11 kV.

6 NO-LOAD VOLTAGE RATIOS

6.1 The no-load voltage ratios shall be as follows:

3 300/433-250, 6 600/433-250 or 11 000/433-250

NOTE — An alternative no-load voltage ratios of 10 450/433-250 shall also be permissible for 11 kV systems.

7 WINDING CONNECTIONS AND VECTORS

7.1 The primary winding shall be connected delta and the secondary winding star [vector symbol Dyn 11 (*see* IS 2026 (Part 4) : 1977], so as to produce a positive phase displacement of 30° from the primary to the secondary vectors of the same phase. The neutral of the secondary winding shall be brought out to a separate insulated terminal.

8 TAPPING RANGES AND TAPPING METHODS

8.1 No taps are normally required to be provided on these transformers. Taps, however, may be provided, if specifically desired by the purchaser.

8.2 The standard tapping ranges, when taps are provided, shall be as follows:

	Up to and Including 25 kVA Rating	*Above 25 kVA Rating*
Winding tapped	Secondary	Primary
Number of tappings	2	5
Tappings at	+5 percent	±2½ and ±5 percent

8.2.1 Tap-changing shall be carried out with the transformer off-circuit as follows:

For ratings up to and including 25 kVA	By means of links
For ratings above 25 kVA	By means of an externally-operated switch with mechanical looking device and a position indicator. Arrangement for pad-locking shall be provided

9 TRANSFORMER TANK

9.1 Transformer tanks shall be of adequate strength to withstand the pressure built up in the tank. Compliance is checked by carrying out the test given in **22.5**.

9.2 The exterior of the transformer tank and other ferrous fittings shall be thoroughly cleaned, scraped and given a primary coat and two finishing coats of durable oil and weather-resisting paint or enamel. All steel screws, nuts and fasteners exposed to atmosphere shall be either galvanised or cadmium-plated.

10 TRANSFORMER OIL

10.1 The transformer oil shall comply with the requirements of IS 335 : 1983.

NOTE — Inhibited oil may be used subject to agreement between the user and the transformer manufacturer.

11 FITTINGS

11.1 Standard Fittings

The following standard fittings shall be provided:

a) Two earthing terminals, with the symbol ⏚ ;

b) Oil level gauge indicating oil level minimum, 30°C and maximum operating temperature;

NOTE — Minimum and maximum positions correspond to the operating temperature of —5°C and 95°C respectively.

c) Lifting lugs;

d) Rating and terminal marking plates;

e) Plain breathing device which would not permit ingress of rain water and insects;

f) Drain-cum-sampling valve (¾ nominal size thread) preferably steel with plug;

g) Thermometer pocket (for transformers of rating above 25 kVA); and

h) Oil-filling hole (1¼ nominal size threads) with cover (for transformers without conservator).

NOTE — The bottom drain valve and filling hole may be used for filtration purposes also.

11.2 Extra Fittings

The following shall be available as extra fittings at the option of the purchaser if specified when inviting tenders:

a) Dehydrating breather in lieu of plain breathing device,

b) Filter value (1¼ nominal size thread), and

c) Thermometer pocket (for transformers of rating 25 kVA and below).

11.3 Conservators

11.3.1 On transformers of ratings 63 and 100 kVA, the provision of conservators is obligatory.

11.3.2 When a conservator is fitted, the oil gauge and the plain or dehydrating breathing device shall be fixed to the conservator which shall also be provided with a drain plug and a filling hole [1¼ nominal size thread (*see also* IS 8999 : 1979)] with cover. In addition, the cover of the main tank shall be provided with an air release plug to enable air trapped within to be released, unless the conservator is so located as to eliminate the possibility of air being trapped within the main tank.

11.3.3 It is recommended that the pipe connecting the conservator to the main tank should be within 20 to 50 mm inside diameter and it should project into the conservator so that its end is approximately 20 mm above the bottom of the conservator so as to create a sump for collection of impurities. Minimum oil level (corresponding to —5°C) should be above the sump level.

12 TERMINAL ARRANGEMENT

12.1 The transformers shall be fitted with three high voltage and four low voltage outdoor type bushings of appropriate voltage and current ratings. The electrical characteristics of high voltage bushings shall conform to IS 2099 : 1986. The low voltage bushings shall conform to IS 7421 : 1974.

12.1.1 If required by the purchaser a suitable cable-end box may be provided on the secondary side.

12.2 The dimensions of bushings of the following voltage classes shall conform to Indian Standards mentioned against them:

Voltage Class	*Indian Standard*	
	For Porcelain Parts	*For Metal Parts*
Up to 1·1 kV bushings	IS 3347 (Part 1/Sec 1) : 1979	IS 3347 (Part 1/Sec 2) : 1979
3·6 kV bushings	IS 3347 (Part 2/Sec 1) : 1979	IS 3347 (Part 2/Sec 2) : 1979
12 kV bushings	IS 3347 (Part 3/Sec 1) : 1972	IS 3347 (Part 3/Sec 2) : 1982

12.2.1 The minimum phase-to-phase and phase-to-earth external clearances for LV (up to 1·1 kV) bushings shall be 75 mm and 40 mm respectively. For HV bushings the clearance shall be 255 mm for phase-to-phase and 140 mm for phase-to-earth. This 140 mm clearance does not apply to arring horn gap.

12.2.2 For transformers with cable-end box/connection chamber arrangement on LV side, the phase-to-phase and phase-to-earth clearance shall be not less than 45 mm and 20 mm respectively.

12.2.3 *Connectors*

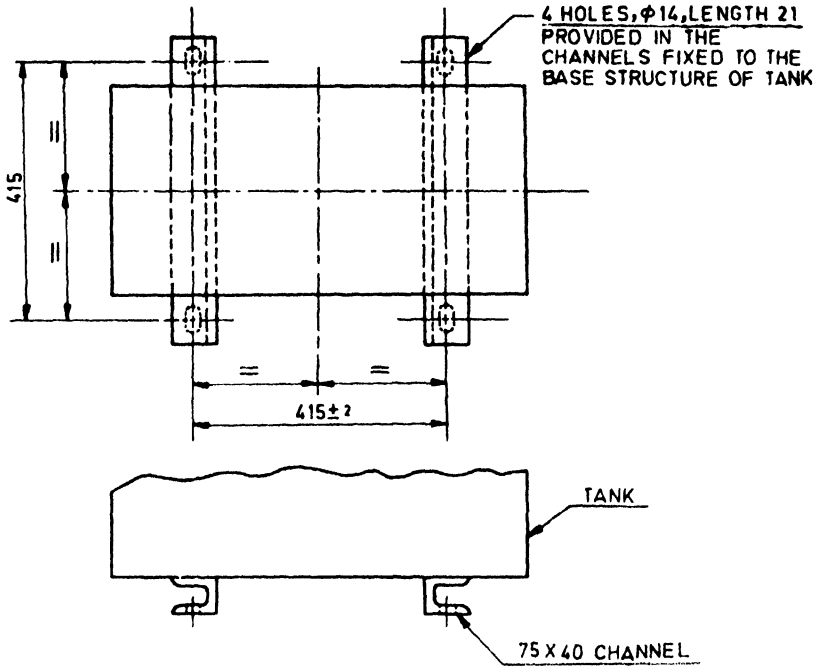
Suitable bimetal connectors (clamp type) shall be provided on both HV and LV side for making sound terminations.

12.3 Marking and Relative Positions of Terminals

Appropriate characters in accordance with IS 2026 (Part 4) : 1977 shall be indelibly marked upon or adjacent to terminals.

13 MOUNTING ARRANGEMENT

13.1 The under-base of all transformers shall be provided with two 75 × 40 mm channels 460 mm long as shown in Fig. 1 to make them suitable for fixing to a platform or plinth.



All dimensions in millimetres.

FIG. 1 MOUNTING DIMENSIONS OF TRANSFORMER

14 INSULATION LEVELS

14.1 The transformer shall be capable of withstanding the power frequency and impulse test voltage for the appropriate voltage class as given in IS 2026 (Part 3) : 1981.

15 LIMITS OF TEMPERATURE-RISE

15.1 The permissible temperature-rise shall not exceed the limits of 55°C (when measured by resistance method) for transformer winding and 45°C (measured by thermometer) in top oil when tested in accordance with IS 2026 (Part 2) : 1977.

16 LOSSES AND IMPEDANCE VALUES

16.1 Losses

For transformers without taps, the no-load and load losses shall not exceed the values given below:

Rating	*No-Load Loss* (Fixed Loss)	*Load Loss at 75°C*
kVA	W	W
16	80	475
25	100	685
63	180	1 235
100	260	1 760

NOTE — For transformer with taps, permissible values for no-load losses shall be five percent higher than those for transformer without taps. The values of load losses given here shall be applicable to such transformer at principal tapping.

16.2 Impedance

The recommended impedance at 75°C is 4·5 percent.

17 TOLERANCES

17.1 The tolerance on electrical performance (excluding losses) shall be as given in 11 of IS 2026 (Part 1) : 1977.

18 ABILITY OF TRANSFORMERS TO WITHSTAND EXTERNAL SHORT-CIRCUIT

18.1 The performance of transformer under external short-circuit conditions shall be in accordance with 8 and 9 of IS 2026 (Part 1) : 1977.

19 EFFICIENCY AND REGULATION

19.1 When statements of efficiency and regulations are required they shall be based on loading at the rated kVA and unity power factor (and other power factors, if agreed between the purchaser and the manufacturer) and computed in accordance with Annex B and C respectively.

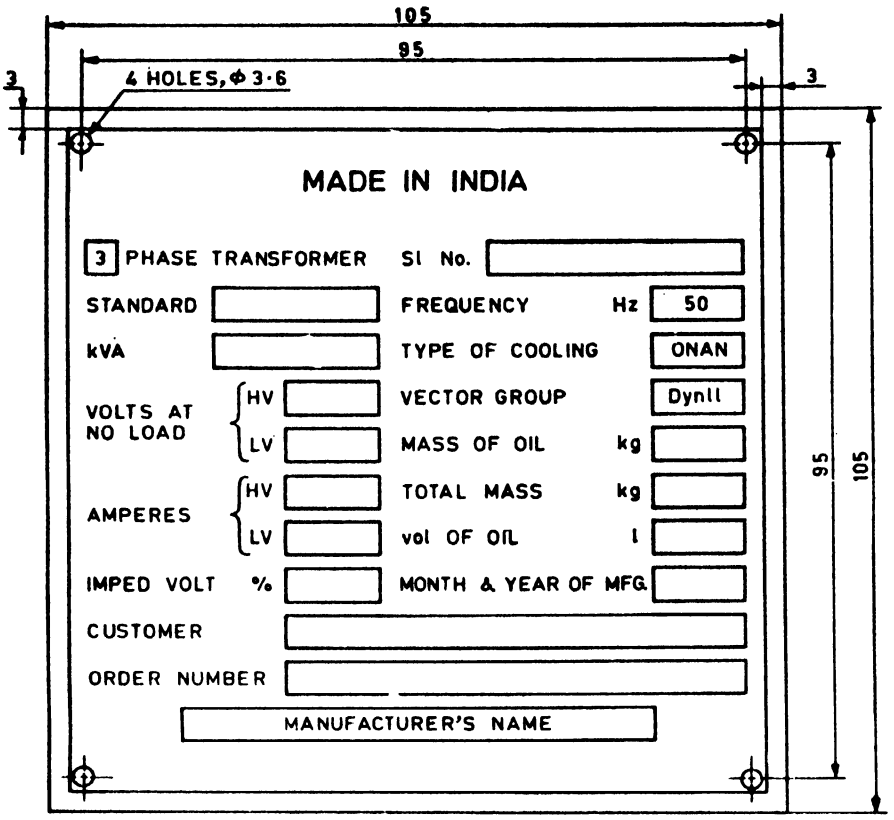
20 MARKING

20.1 Rating Plate

Each transformer shall be provided with non-detachable rating plate of weather proof material, fitted, in a visible position, showing the information given in Fig. 2. The entries on the rating plate shall be indelibly marked (for example, by etching, engraving or stamping).

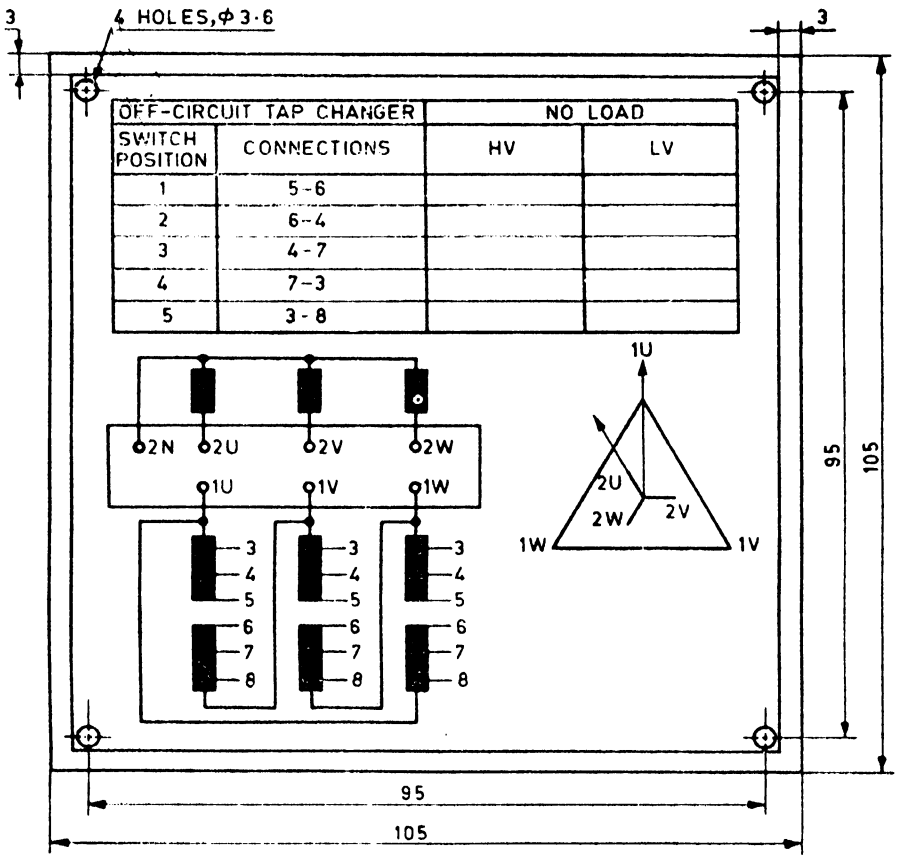
20.2 Terminal Marking Plate

Each transformer shall be provided with a terminal marking plate in accordance with Fig. 3 or 4 whichever is applicable.



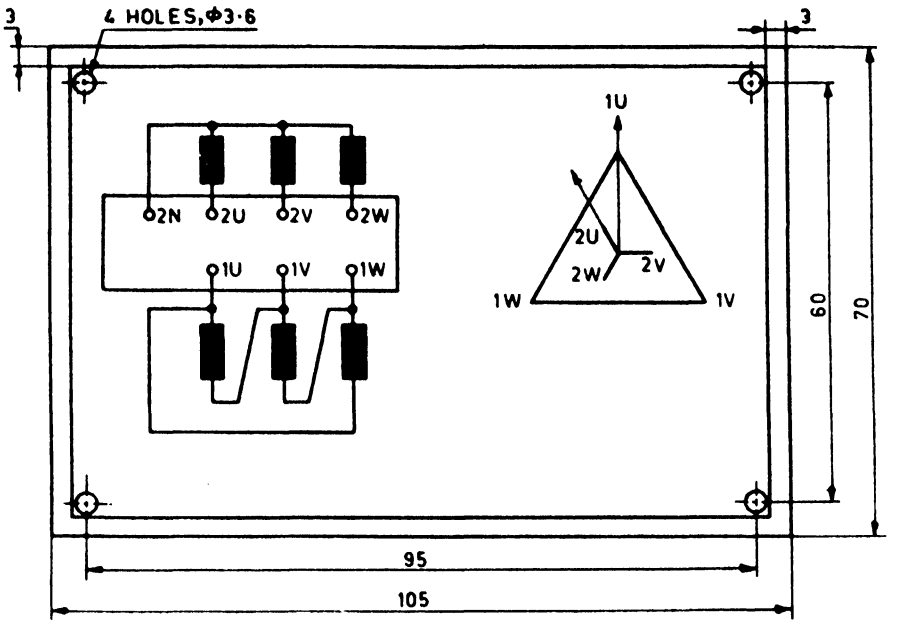
All dimensions in millimetres.

FIG. 2 RATING PLATE



All dimensions in millimetres.

FIG. 3 TERMINAL MARKING PLATE FOR TRANSFORMERS WITH TAPS



All dimensions in millimetres.

FIG. 4 TERMINAL MARKING PLATE FOR TRANSFORMERS WITHOUT TAPS

20.3 The rating and terminal marking plates may be combined into one plate at the option of the manufacturer.

21 INFORMATION REQUIRED WITH ENQUIRY AND ORDER

21.1 The information to be supplied to the manufacturer and the form of enquiry by the purchaser shall be in accordance with Annex B of IS 2026 (Part 1) : 1977.

22 TESTS

22.1 General

The requirements given in **16.1** of IS 2026 (Part 1) : 1977 shall apply.

22.2 All the tests listed under **22.3** and **22.4** shall be carried out in accordance with the provisions of the clauses and standards given in the parenthesis.

22.3 Type Tests

The following shall constitute the type tests:

a) Measurement of winding resistance [IS 2026 (Part 1) : 1977];

b) Measurement of voltage ratio and check of voltage vector relationship [IS 2026 (Part 1) : 1977];

c) Measurement of impedance voltage/short-circuit impedance (principal tapping, when applicable) and load loss [IS 2026 (Part 1) : 1977];

d) Measurement of no-load loss and current [IS 2026 (Part 1) : 1977];

e) Measurement of insulation resistance [IS 2026 (Part 1) : 1977];

f) Induced overvoltage withstand test [IS 2026 (Part 3) : 1981];

g) Separate-source voltage withstand test [IS 2026 (Part 3) : 1981];

h) Lightning impulse test [IS 2026 (Part 3) : 1981];

j) Temperature-rise test [IS 2026 (Part 2) : 1977];

k) Short-circuit test [IS 2026 (Part 1) : 1977];

m) Air pressure test (*see* **22.5**); and

n) Permissible flux density and overfluxing (*see* **22.6**).

22.4 Routine Tests

The following shall constitute the routine tests:

a) Measurement of winding resistance [IS 2026 (Part 1) : 1977];

b) Measurement of voltage ratio and check of voltage vector relationship [IS 2026 (Part 1) : 1977];

c) Measurement of impedance voltage/short-circuit impedance (principal tapping, when applicable) and load loss [IS 2026 (Part 1) : 1977];

d) Measurement no-load loss and current [IS 2026 (Part 1) : 1977];

e) Measurement of insulation resistance [IS 2026 (Part 1) : 1977];

f) Induced overvoltage withstand test [IS 2026 (Part 3) : 1984];

g) Separate-source voltage withstand test [IS 2026 (Part 3) : 1984];

22.5 Air Pressure Test

The tank shall be fixed with a dummy cover with all fittings including bushings in position and shall be subjected to air pressure of 35 kPa above atmospheric pressure for 30 minutes. The permanent deflection of flat plate, after pressure has been released, shall not exceed the values given below:

Length of Plate	*Deflection*
Up to 750 mm	5 mm
751 to 1 250 mm	6·5 mm

22.6 Permissible Flux Density and Overfluxing

The flux density at rated voltage and frequency shall not exceed 1·69 tesla. The no-load current at rated voltage and 112·5 percent rated voltage shall not exceed values gives below:

kVA Rating	*Percentage of Rated Full Load Current*	
	At 100 Percent Rated Voltage	*At 112·5 Percent Rated Voltage*
16	4	8
25	3·5	7
63	3	6
100	2·5	5

NOTE — The design calculations in support of flux density shall be furnished by the supplier. For finding out the magnetising current, average values of all the three limbs (phases) should be taken into consideration.

ANNEX A

(*Clause* 2.1)

LIST OF REFERRED INDIAN STANDARDS

IS No.	*Title*
IS 335 : 1983	Specification for new insulating oils for transformers and switchgear (*third revision*)
IS 554 : 1975	Dimensions for pipe threads where pressure tight joints are required on the threads (*second revision*)
IS 1885 (Part 38) : 1977	Electrotechnical vocabulary: Part 38 Transformers (*first revision*)
IS 2026	Specification for power transformers:
(Part 1) : 1977	General (*first revision*)
(Part 2) : 1977	Temperature rise (*first revision*)
(Part 3) : 1977	Insulation level and dielectric test (*second revision*)
(Part 4) : 1981	Terminal markings, tappings and connections (*first revision*)
IS : 2099 : 1986	Specification for bushings for alternative voltages above 1 000 volts (*second revision*)
IS : 3347	Dimensions for porcelain transformer bushings for use in normal and polluted atmosphere:
(Part 1/Sec 1 & 2) : 1979	Part 1 Up to and including 1 kV bushings, Section 1 Porcelain parts, and Section 2 Metal parts
(Part 2/Sec 1 & 2) : 1979	Part 2 3·6 kV bushings, Section 1 Porcelain parts, and Section 2 Metal parts
(Part 3/Sec 1 & 2) : 1982	Part 3 12 and 17·5 kV bushings, Section 1 Porcelain parts, and Section 2 Metal parts
IS 7421 : 1974	Specification for porcelain bushings for alternating voltages up to and including 1 000 V
IS 8999 : 1979	Gauging practice for pipe threads where pressure tight joints are required on the threads
IS 10561 : 1983	Application guide for power transformers

ANNEX B

(*Clause* 19.1)

METHOD OF DECLARING EFFICIENCY

B-1 EFFICIENCY

B-1.1 The efficiency to be declared is the ratio of the output in kW to the sum of the output in kW and the following losses:

a) No-load loss, which is considered to be constant at all loads; and

b) Load loss, which varies with load.

The total loss, on load is the sum of (a) and (b).

ANNEX C

(*Clause* 19.1)

CALCULATION OF INHERENT VOLTAGE REGULATION

C-1 INHERENT VOLTAGE REGULATION

C-1.1 The inherent voltage regulation from no-load to a load of any assumed value and power factor may be computed from the impedance voltage and corresponding load loss measured with rated current in the winding (*see also* IS 10561 : 1983).

Let

I = rated current in winding excited;

E = rated voltage of winding excited;

I_{SC} = current measured in winding excited;

E_{ZSC} = voltage measured across winding excited (impedance voltage);

P_{SC} = watts measured across winding excited;

E_{XSC} = reactance voltage $= \sqrt{E^2_{ZSC} - \left(\frac{P_{SC}}{I_{SC}}\right)^2}$;

P = P_{SC} corrected to 75°C, and from current I_{SC} to I;

$Ex = E_{XSC} \times \frac{I}{I_{SC}}$;

$Er = \frac{P}{I}$

C-1.2 For rated load at unity power factor, the percentage regulation is approximately equal to :

$$Er\,\% + \frac{(Ex\,\%)^2}{200}$$

$Ex\% = 100\ Ex/E$;

$Er\% = 100\ Er/E$;

$n = Ia/I$; and

Ia = current in the winding excited during the short circuit tests corresponding to that obtained when loading at the assumed load on the output side and with rated voltage on the input side.

C-1.3 For rated load any power factor $\cos \phi$, the percentage regulation is approximately equal to:

$$Er\% \cos \phi + Ex\% \sin \phi + \frac{(Ex\% \cos \phi - Er\% \sin \phi)^2}{200}$$

C-1.4 For any assumed load other than rated load and unity power factor, the percentage regulation is approximately equal to:

$$n.\ Er\% + \frac{(n.\ Ex\%)^2}{200}$$

C-1.5 For any assumed load other than rated load and at any power factor $\cos \phi$, the percentage regulation is approximately equal to:

$$n.\ Er\% \cos \phi + n.\ Ex\% \sin \phi + \frac{(n.\ Ex\% \cos \phi - n.\ Er\% \sin \phi)^2}{200}$$

C-1.6 The above formulae are sufficiently accurate for transformers covered by this specification.

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Review of Indian Standards

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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Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

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