TECHNICAL SPECIFICATIONS

TRANSFORMERS

3.1 SCOPE

This section covers the detailed requirements regarding supply, installation, testing, commissioning and handing over of transformers required for the sub-station.

Conventionally oil cooled transformers were being used for electrical sub-station. However due to presence of oil for cooling of transformers, an inherent fire risk is involved in the use of oil cooled transformers.

After repeated fire accidents due to burning of oil in oil cooled transformers, I.E. Rules have been amended to provide for use of only dry type transformers where a sub-station is planned inside the main building while oil cooled transformers can continue to be used if the sub-station is located in an independent building.

There are two types of dry type transformers viz. vacuum pressure impregnated (VPI) dry type transformers and cast resin dry type transformers. This section provide for use of both the type of dry type transformers where individual capacity of transformer does not exceed 400 KVA. Only cast resin dry type transformers shall be used for higher capacity.

3.2 OIL COOLED TRASFORMERS

Oil filled transformers may be used only in sub-stations located in separate single or two storied service buildings outside the main building structure and there shall at least be 6 meter clear distance between the adjoining buildings and sub-station such that fire tender is able to pass between the two structures. (NBC-2005 Part-8, Section 2 clause 4.2.1 j).

3.2.1 General Construction

The oil filled transformers shall comply with the following Indian Standards as amended upto date:

(i) IS 2026 - Part I to V - power transformers.

(ii) IS 335 - Transformer oil.

(iii) IS 10028 (Part II & III) - Installation and Maintenance of Transformers.

(iv) IS 2099 - Bushings.

(v) IS 2705 - Current Transformers.

(vi) IS 6600 - Guide for loading of oil immersed transformers.

3.2.2 Insulation Oil

Insulation oil shall conform to IS 335. Transformer oil to be supplied with initial fill of filtered oil.

3.2.3 General Requirements

The transformer shall be indoor or outdoor type as specified. Unless otherwise specified the transformer in addition shall have thermal and dynamic ability to withstand external short-circuit as per clause 9 of IS 2026 (Part I) : 1977.

3.2.4 Capacity and Rating

The KVA ratings for three phase transformers are given below: -

100	250	630	1600
125	315	800	& higher
160	400	1000	
200	500	1250	

Continuous rating specified shall be irrespective of tapping position.

TEMPERATURE RISE

The reference ambient temperatures assumed for the purpose of this specification are as follows: -

(a) Maximum ambient air temperature 50°C.

(b) Maximum daily average ambient air temperature 40°C.

(c) Maximum yearly weighted average ambient temperature 32°C.

(d) Minimum yearly weighted average ambient temperature (-)5°C.

The temperature rise at the above conditions and at the altitude not exceeding 1000 meters shall be as follows: -

By resistance method 55°C (maximum temperature being 95°C).

By thermometer 50°C.

If the site conditions indicated for a particular job is more severe than the refereed ambient temperature mentioned above, the temperature rise shall be suitably scaled down such that the hot spot temperature shall not exceed the values for the reference conditions.

3.2.5 Tap Changing Device

Tap changing device shall be provided on H.V side, circuit type, externally hand operated with necessary indications for tap position and locking arrangement at any

of the tapping positions. It shall be designed for bi-directional operation and shall be of self-positioning type and shall have the following steps: -

± 2.5% ± 5% -7.5% -10% (if required)

Note: Tap changing device shall normally be off load type. However NIT approving authority may use on load type Tap Changing Devices judiciously.

3.2.6 Voltage Ratio

Unless otherwise specified, the transformer shall be suitable for a voltage ratio of 11 KV/433 V.

VECTOR GROUP

In case of step down transformers, the winding connections shall conform to vector group dy. 11 unless otherwise specified.

In case of step up transformer the vector group unless otherwise specified shall be star/ delta.

3.2.7 Cooling

Unless otherwise specified, the transformer shall be oil immersed natural air-cooled type (ONAN).

3.2.8 Accessories

The transformer shall be a single tank type with termination on bushings or cable end box as specified both on HV and MV side. The MV side shall be suitable to receive bus bar trunking or MV cable inter-connection suitable for full load current of the transformer.

FITTINGS

The transformer shall be complete with the following fittings: -

(a) Oil conservator with oil level indicator, minimum level marking and drain plug for all transformers of capacity 50 KVA and above.

(b) Off circuit type tap changer with position indicator and locking arrangement for all transformers.

(c) Thermometer pocket with plug for all transformers of capacity 100 KVA and above.

(d) 100 mm dial type /stem type thermometer with metal guard Dial type thermo-meter may have max. temperature indicator and resetting device for all transformers of capacity 250 KVA and above.

(e) Lifting lugs for all transformers.

(f) Bi-directional /Unidirectional Rollers to be specified.

(g) Rating diagram and terminal marking plate for all transformers.

(h) Explosion vent for all transformers of capacity 400 KVA and above.

(i) Additional Neutral separately brought out on a bushing for earthing for all transformers.

(j) Earth terminals (2 Nos.) for body earthing for all transformers.

(k) Valves for filtration, drainage and filling etc. with necessary plugs for all transformers.

(l) Radiator assembly for all transformers.

(m) Silica gel breather for all transformers.

(n) Air release plug for all transformers.

(o) First filling of oil to IS 335:1993 including make-up fill during installation for all transformers.

(p) Facility to connect up Buchholtz relay for all transformers of capacity 800 KVA and above.

(q) Inspection covers on tank cover for access to terminal connections for all transformers.

(r) Bushing terminations or cable box terminations as specified.

(s) Necessary hardware, clamps, lugs etc. for termination on HV/MV etc. for all transformers.

3.2.9 Explosion Vent

Explosion vent or pressure relief device shall be provided of sufficient size for rapid release of any pressure that may be generated within the tank and which might result in damage to the equipment. The device shall operate at a static pressure less than the hydraulic test pressure for transformer tank. Means shall be provided to prevent the ingress of moisture and of such a design to prevent gas accumulation.

3.2.10 Accommodation for Auxiliary Apparatus

Where specified, such as, for restricted earth fault protection, facilities shall be provided for the mounting of a neutral current transformer.

RATING AND DIAGRAM PLATES

The following plates shall be fixed to Transformer in a visible position.

(a) A rating plate of weather proof material bearing the data specified in the appropriate clauses of IS 2026:1977.

(b) A diagram plate showing the internal connection and also the voltage vector relationship of the several windings in accordance with IS 2026:1977 and a plan view of the transformer giving the correct physical relationship of the terminals.

3.2.11 Joints and Gaskets

All gaskets used for making oil tight joints shall be of proven material such as granulated cork bonded with synthetic rubber gaskets or synthetic rubber or such other good material.

GAS AND OIL ACTUATED (BUCHHOLTZ) RELAYS

Buchholtz Relay shall be provided for transformers of capacity 800 KVA and above. The design of the relay mounting arrangements, the associated pipe work shall be such that mal-operation of the relays shall not take place under normal service. The pipe work shall be so arranged that all gas arising from the transformer shall pass through the gas and oil-actuated relay. The oil circuit through the relay shall not form a delivery path in parallel with any circulating oil pipe, nor shall it be tied into or connected through the pressure relief vent. Sharp bends in the pipe work shall be avoided.

All wiring connections, terminal boards, fuses and links etc. connected with gas actuated relays shall be suitable for tropical atmosphere. Any wiring liable to be in contact with oil shall have oil resistant insulation and the bared ends of stranded wire shall be sealed together to prevent seepage of oil entering connection boxes used for cables or wiring.

3.2.12 Cable Box

Cable box shall not be mounted on the tank covers. It shall be feasible to remove the tank covers for inspection during maintenance etc. without recourse to breaking the joints or disturbing the cables already terminated. Necessary removable links in oil approachable through inspection cover in tank cover etc. after lowering oil shall be provided for test purpose.

3.2.13 Parallel Operation

For parallel operation of transformers, the transformers shall have the same percentage impedance, same voltage ratio, same vector group, phase sequence etc.

3.2.14 Tests

3.2.14.1 Tests at Works :

All routine and other tests prescribed by IS 2026 shall be carried out at the manufacturer's works before dispatch of the transformer in the presence of inspecting officer if required. Copies of the test certificates shall be furnished to the department. In addition to the prescribed routine tests, temperature rise test shall be invariably done on one transformer of each design. A copy of the impulse test certificate done on the same type/ design of the transformer shall be furnished in accordance with IS for purpose of record. If no impulse test was done in an earlier unit of the same design and capacity, one transformer will be subjected to impulse test in consultation with the Inspector at the firm's cost.

Copies of the certificates for pressure test, test for bushings, and type test for short circuit shall be supplied to the Department.

3.2.14.2 Tests at Site :

In addition to tests at manufacturer's premises, all relevant pre-commissioning checks and tests conforming to IS code of practice No. 10028 (Part II & III) shall be done before energization. The following tests are to be particularly done before cable jointing or connecting up the bus bar trunking:

(a) Insulation test between HV to earth and HV to MV with 5000 volts Megger.

(b) Insulation test between MV to earth with 500 volts Megger.

(c) Di-electric strength Test on oil.

(d) Buchholtz relay operation by simulation test when fitted.

All test results are to be recorded and reports should be submitted to the department.

3.2.15 Installation and Commissioning

3.2.15.1 The transformer shall be installed in accordance with IS 10028 (Part II & III)-Code of practice for Installation and maintenance of transformer. Necessary support channels shall be grouted in the flooring.

3.2.15.2 The transformer shall be moved to its location and shall be correctly positioned. Transformer wheels shall be either locked or provided with wheel stoppers. All parts of the transformers which are supplied loose, such as conservator, radiator banks, Buchholtz relay, dial thermometer, bushing etc. shall be fitted on the transformer. Transformer oil supplied in drums shall be topped up into the transformer after duly testing/filtering upto the correct level required.

3.2.15.3 Wiring of devices such as Buchholtz relay, dial thermometer etc. shall be carried out as per drawings, Earthing of neutral and body of the transformer shall be done in accordance with section (7) of these specifications.

3.2.15.4 Drying out of transformer winding will be necessary when the di-electric strength of the oil is lower than the minimum value as per IS10028 or the transformer has not been energized within 6 months of leaving the works or where the radiator assembly is done at site. The transformer shall be dried out by one of the methods specified in IS 10028. Drying out with centrifugal or vacuum type filters will, however, be preferred. The contractor shall carry out the process of drying without interruption and shall maintain a log sheet indicating time, oil temperature and insulation resistance.

3.2.15.5 After complete drying out of the transformer, oil sample shall be collected by the contractor and shall be tested for di-electric strength as specified in IS 335:1993 with approved test kit.

3.2.15.6 All devices such as dial type thermometers, Buchholtz relays and main alarm and trip contacts shall be checked for satisfactory operation.

3.2.15.7 All tests specified in 3.2.14 of these specifications shall be carried out by the contractor in the presence of inspecting officer/consignee free of cost.

3.2.16 Maximum Allowable Power Transformer Losses

Power transformers of the proper ratings and design must be selected to satisfy the minimum acceptable efficiency at 50% and full load rating. In addition, the transformer must be selected such that it minimizes the total of its initial cost in addition to the present value of the cost of its total lost energy while serving its estimated loads during its respective life span.

Total losses for oil filled transformers should conform as per the IS 1180-1 amendment 4 or as per the applicable standards at the time of NIT notification, whichever is more stringent or as the table below

AMENDMENT NO. 4 MARCH 2021

IS 1180 (PART 1) : 2014 OUTDOOR/INDOOR TYPE OIL IMMERSED DISTRIBUTION TRANSFORMERS UPTO AND INCLUDING

2 500 kVA, 33kV — SPECIFICATION

PART 1 MINERAL OIL IMMERSED

(Fourth Revision)

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[*Page* 3*, Table* 3 (*see also Amendment Nos.* 1 *and* 3)] — Substitute the following for the existing table:

Table 3 Maximum Total Losses up to 11kV Class Transformers

(*Clauses* 6.8.1.1, 6.8.1.2, 6.8.1.3 *and* 6.8.2)

Sl No.	**Rating (kVA)**	**Impedance (Percent)**	**Maximum Total Loss (W)**									
			Energy Efficiency Level 1		*Energy Efficiency Level* 2		*Energy Efficiency Level* 3		*Energy Efficiency Level* 4		*Energy Efficiency Level* 5	
			50 Percent Load	100 Percent Load	50 Percent Load	100 Percent Load	50 Percent Load	100 Percent Load	50 Percent Load	100 Percent Load	50 percent Load	100 Percent Load
(1)	(2)	(3)	(4`)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
i)	16	4.5	135	440	120	400	108	364	97	331	87	301
ii)	25	4.5	190	635	175	595	158	541	142	493	128	448
iii)	63	4.5	340	1 140	300	1 050	270	956	243	870	219	791
iv)	100	4.5	475	1 650	435	1 500	392	1365	352	1 242	317	1 130
v)	160	4.5	670	1 950	570	1 700	513	1547	462	1 408	416	1 281
vi)	200	4.5	780	2 300	670	2 100	603	1911	543	1 739	488	1 582

NOTE — For non-preferred ratings of Table 1, maximum losses are subject to agreement between the user and the supplier.

(*Page* 4, *clause* **7.8.2**, *line* 2) — Substitute ‘is’ *for* ‘shall be’.

[*Page* 4*, Table* 6 (*see also Amendment Nos.* 1 *and* 3)] — Substitute the following for the existing table:

Table 6 Maximum Total Losses up to 11kV Class Transformers

(*Clause* 7.8.1.1)

Sl No.	**Rating (kVA)**	**Impedance (Percent)**	**Maximum Total Loss (W)**									
			Energy Efficiency Level 1		*Energy Efficiency Level* 2		*Energy Efficiency Level* 3		*Energy Efficiency Level* 4		*Energy Efficiency Level* 5	
			50 Percent Load	100 Percent Load	50 Percent Load	100 Percent Load	50 Percent Load	100 Percent Load	50 Percent Load	100 Percent Load	50 Percent Load	100 PercentLoad
(1)	(2)	(3)	(4`)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
i)	250	4.50	980	2 930	920	2 700	864	2 488	811	2293	761	2 113
ii)	315	4.50	1 025	3 100	955	2 750	890	2 440	829	2164	772	1 920
iii)	400	4.50	1 225	3 450	1 150	3 330	1080	3 214	1 013	3102	951	2 994
iv)	500	4.50	1 510	4 300	1 430	4 100	1354	3 909	1 282	3 727	1 215	3 554
v)	630	4.50	1 860	5 300	1 745	4 850	1 637	4 438	1 536	4 061	1 441	3 717
vi)	800	5.00	2 287	6 403	2 147	5 838	2 015	5 323	1 892	4 853	1 776	4 425
vii)	1 000	5.00	2 790	7 700	2 620	7 000	2 460	6 364	2 310	5 785	2 170	5 259
viii)	1 250	5.00	3 300	9 200	3 220	8 400	3 142	7 670	3 066	7 003	2 991	6 394
ix)	1 600	6.25	4 200	11 800	3 970	11 300	3 753	10 821	3 547	10 363	3 353	9 924
x)	2 000	6.25	5 050	15 000	4 790	14 100	4 543	13254	4 309	12 459	4 088	11 711
xi)	2 500	6.25	6 150	18 500	5 900	17 500	5 660	16 554	5 430	15 659	5 209	14 813

Table 9 Maximum Total Losses up to 11kV Class Transformers

(*Clauses* 8.8.1.1, 8.8.1.2 *and* 8.8.1.3)

Sl No.	**Rating (kVA)**	**Impedance (Percent)**	**Maximum Total Loss (W)**									
			Energy Efficiency Level 1		*Energy Efficiency Level* 2		*Energy Efficiency Level* 3		*Energy Efficiency Level* 4		*Energy Efficiency Level* 5	
			50 Percent Load	100 Percent Load	50 Percent Load	100 Percent Load	50 Percent Load	100 Percent Load	50 Percent Load	100 Percent Load	50 Percent Load	100 Percent Load
(1)	(2)	(3)	(4`)	(5)	(3)	(5)	(4)	(5)	(4)	(5)	(4)	(5)
i)	5	2.50	35	95	30	75	27	68	24	62	21	57
ii)	10	4.00	60	170	55	150	50	135	45	122	40	112
iii)	16	4.00	82	224	63	190	58	175	54	164	50	145
iv)	25	4.00	110	300	95	260	88	240	80	225	74	210
v)	50	4.00	210	590	190	520	177	480	160	451	148	420
vi)	75	4.00	310	880	285	780	265	720	242	670	223	625
vii)	100	4.00	410	1 140	375	1 030	350	964	320	900	299	842

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'ANNEX A

(*Clause* 2)

LIST OF REFERRED INDIAN STANDARDS

IS No.	*Title*
191 : 2007	Copper — Specification (*fourth revision*)
335 : 2018	New Insulating Oils —Specification(*fifth revision*)
554 : 1999	Pipe threads where pressure tight joints are required on the threads — Dimensions, tolerances and designation (*fourth revision*)
1576 : 1992	Solid pressboard for electrical purpose (*first revision*)
1608	Metallic materials — Tensile testing
(Part 1) : 2018	Method of test at room temperature (*fourth revision*)
(Part 3) : 2018	Method of test at low temperature
1747 : 1972	Nitrogen (*first revision*)
1885	Electrotechnical vocabulary
(Part 38) : 1993	Power transformers and reactors (*second revision*)
1897 : 2008	Copper strip for electrical purpose — Specification (*third revision*)
2026	Power transformers
(Part 1) : 2011	General (*second revision*)
(Part 2) : 2010	Temperature rise (*first revision*)
(Part 3) : 2018	Insulation levels, dielectric tests and external clearances in air (*fourth revision*)
(Part 5) : 2011	Ability to withstand short circuit (*first revision*)
(Part 7) : 2009	Loading guide for oil-immersed power transformers
(Part 8) : 2009	Application guide
(Part 10) : 2009	Determination of sound levels
3024 : 2015	Grain oriented electrical steel sheets and strip (*third revision*)
3347	Dimensions for porcelain transformer bushings for use in lightly polluted atmospheres
(Part 1/Sec 1) : 1979	Up to and including 1 kV, Section 1 Porcelain parts (*first revision*)
(Part 1/Sec 2) : 1979	Up to and including 1 kV – Section 2 Metal parts (*first revision*)
(Part 2/Sec 1) : 1979	3.6 kV bushings, Section 1 Porcelain parts (*first revision*)
(Part 2/Sec 2) : 1979	3.6 kV bushings, Section 2 Metal parts (*first revision*)
(Part 3/Sec 1) : 1988	17.5 kV bushings, Section 1 Porcelain parts (second *revision*)
(Part 3/Sec 2) : 1982	17.5 kV bushings, Section 2 Metal parts (*first revision*)
(Part 4/Sec 1) : 1988	24 kV bushings, Section 1 Porcelain parts (*second revision*)
(Part 4/Sec 2) : 1982	24 kV bushings, Section 2 Metal parts (*first revision*)
(Part 5/Sec 1) : 1979	36 kV bushings, Section 1 Porcelain parts (*second revision*)
(Part 5/Sec 2) : 1979	36 kV bushings, Section 2 Metal parts (*first revision*)
(Part 8/Sec 1) : 1988	52 kV Bushings, Section 1 Porcelain parts
(Part 8/Sec 2) : 1992	52 kV bushings, Section 2 Metal parts
3639 : 1966	Fittings and accessories for power transformers (*under revision*)
4253 (Part 2) : 2008	Cork composition sheet: Cork and rubber (*second revision*)

IS No.	Title
6162	Paper-covered aluminum conductors
(Part 1) : 1971	Round conductors
(Part 2) : 1971	Rectangular conductors
7404	Paper covered copper conductors —Specification
(Part1) : 1991	Round conductors (*first revision*)
7421 : 1988	Porcelain bushings for alternating voltages up to and including 1000 V (*first revision*)
8603 : 2008	Dimensions for porcelain transformer bushings for use in heavily polluted atmospheres 12/17.5 kV, 24 kV and 36 kV (*first revision*)
8603 (Part 4) : 2003	Dimensions for porcelain transformer bushings for use in heavily polluted atmospheres: Part 4 52 kV Bushings
8999 : 2003	Gauging practice for pipe threads where pressure tight joints are required on the threads
9335	Cellulosic papers for electrical purposes
(Part 1) : 1979	Definitions and general requirements
(Part 2) : 1998	Part 2Methods of test (*first revision*)
(Part 3/Sec 1) : 1984	Specifications for individual materials, Section 1 General purposes electrical paper
(Part 3/ Sec 3) : 1984	Specifications for individual materials, Section 3 Crepe paper
(Part 3/ Sec 5) : 1985	Specifications for individual materials, Section 5 Special papers
11149 : 1984	Specification for rubber gaskets
12444 : 2020	Copper wire rods for electrical applications — Specification (*first revision*)
13730	Specification for particular types of winding wires:
(Part 0/Sec 1) : 2018	General requirements, Section 1 Enamelled round copper wire (*secondrevision*)
(Part 0/Sec 2) : 2018	General requirements, Section 2 Enamelled rectangular copper wire (*secondrevision*)
(Part 0/Sec 3) : 2012	General requirements, Section 3 Enameled round aluminum wire (*first revision*)
(Part 17) : 2014	Polyvinyl acetal enameled rectangular copper wire, Class 105 (*first revision*)
(Part 27) : 2018	Paper tape covered rectangular copper wire (*first revision*)
IS/IEC 60137 : 2017	Insulated bushings for alternative voltages above 1 000 volts

3.2.17 Guaranteed Technical Data

Guaranteed technical particulars shall be supplied vide Schedule ‘C’ of Appendix III

3.2.18 AMORPHOUS CORE

IS 16585 shall be followed for the supply of the amorphous core material if used in place of CRGO Electrical Steel and due NABL IS certification shall be required.

Amorphous core has lower no load losses w.r.t. CRGO core.

CRGO is cheaper w.r.t to amorphous core in smaller ratings and costlier in higher ratings.

Equal opportunity shall be given to CRGO and Amorphous core for meeting the BIS standards of the energy efficiency as per IS 1180-1, however the amorphous core shall be preferred where there shall be more chances of no load conditions and NIT authority decision shall be final.

3.3 DRY TYPE DISTRIBUTION TRANSFORMERS

3.3.1 General Construction

3.3.1.1 The Transformers shall comply with the following Indian Standards as amended upto date:

(i) IS 11171 : 1985 - Dry type power transformers.

(ii) IS 10028 (Part II & III) - Installation and Maintenance of Transformers.

(iii) IS 2099 - Bushing

(iv) IS 2705 - Current Transformers.

3.3.1.2 Constructional Features

All the MS parts shall be either Hot dipped galvanized or cold galvanized to make them corrosion free. The core shall be made up of high grade low loss cold rolled grain oriented silicon steel. Both low & high voltage windings shall be made of copper conductor. The class of winding insulation shall correspond to class 'F'. The construction of the windings of the transformer shall be such that no creepage path is found even in dusty & corrosive ambient conditions. The core coil assembly shall be housed in a prefabricated enclosure. The enclosure shall be fabricated with mild steel CRCA sheets with adequate provision for ventilation. The enclosures shall under go the seven tank process. Finally the external and internal surfaces of the enclosure shall be powder coated with the required paint shade.

3.3.2 General Requirements

The transformer shall be indoor or outdoor type as specified. Unless otherwise specified

the transformer in addition shall have thermal and dynamic ability to withstand external short-circuit as per clause 9 of IS 2026 (Part I): 1977 and clause 5 of IS 11171: 1985.

3.3.3 Capacity and Rating

The KVA ratings for three phase transformers are given below: -

250	630	1600
315	800	& higher
400	1000	
500	1250	

Continuous rating specified shall be irrespective of tapping position.

3.3.4 Indoor transformers shall be suitable for IP-23 protection; out door transformers shall confirm to IP-33 protection.

3.3.5 Temperature Rise

The reference ambient temperatures assumed for the purpose of this specification are as follows:-

(a)	Maximum ambient air temperature	50°C.
(b)	Maximum daily average ambient air temperature	40°C.
(c)	Maximum yearly weighted average ambient temperature	32°C.
(d)	Minimum yearly weighted average ambient temperature	(-) 5°C.
(e)	Class of insulation	F

The temperature rise limit at the above conditions and at the altitude not exceeding 1000 meters shall be as specified.

If the site conditions indicated for a particular job is more severe than the referred ambient temperature mentioned above, the temperature rise above ambient shall be suitably scaled down such that the hot spot temperature shall not exceed the values for the reference conditions 90°C (F class insulation).

3.3.6 (A) Tap Changing Device

Preferred tapping range is +5% to -7.5% in 2.5 percent steps by means of off load tap changing links or tap switch. The device shall be provided on HV for HV Voltage to keep LV Voltage constant.

(B) Terminal Markings Connections

Relevant provisions of IS 2026 (Part-IV): 1977 shall be applicable.

3.3.7 Voltage Ratio

Unless otherwise specified, the transformer shall be suitable for a voltage ratio of 11 KV/ 433 V.

3.3.8 Vector Group

In case of step down transformers, the winding connections shall conform to vector group Dy 11 unless otherwise specified.

In case of step up transformer the vector group unless otherwise specified shall be star / delta.

3.3.9 Cooling

Unless otherwise specified the transformer cooling shall be air and naturally cooled (AN).

3.3.10 Accessories

The transformer shall be with enclosure or without enclosure with HV and MV terminations as specified both on HV and MV side. The MV side shall be suitable to receive bus bar trunking or MV cable inter-connection suitable for full load current of the transformer.

3.3.11 Fittings

The transformer shall be complete with the following fittings: -

(a) Off load type tap changing link or tap switch.

(b) RTD temperature controller.

(c) Lifting lugs for all transformers.

(d) Bi-directional / Unidirectional Rollers to be specified.

(e) Rating diagram and terminal marking plate for all transformers.

(f) Additional Neutral separately brought out on a bushing for earthing for all transformers.

(g) Earth terminals (2 Nos.) for body earthing for all transformers.

(h) Necessary hardware, clamps, lugs etc. for termination on HV/MV etc. for all transformers.

3.3.12 Rating Plates

A rating plate of weather proof material bearing the data specified in clause-8 of IS 11171: 1985.

3.3.13 Joints and Gaskets

All gaskets used for making gas tight joints shall be of proven material.

3.3.14 Parallel Operation

For parallel operation of transformers, the transformers shall have the same percentage impedance, same voltage ratio, same vector group, phase sequence etc.

Where ever more than one Transformer is to be installed in the same Sub-Station, capacity of each Transformer shall preferably be same.

3.3.15 Tests

3.3.15.1 Tests at Works

All routine and other tests prescribed in IS 11171 : 1985 shall be carried out at the manufacturer's works before the dispatch of the transformer in the presence of inspecting officer. Copies of the test certificates shall be furnished to the department. In addition to the prescribed routine tests, temperature rise test shall be invariably done on one transformer of each design. A copy of the impulse test certificate done on the same type/design of the transformer shall be furnished in accordance with IS 11171 : 1985 for purpose of record. If no impulse test was done in an earlier unit of the same design and type, one transformer will be subjected to impulse test in consultation with the Inspector at the firm's cost. Copies of the certificates of type test for short circuit shall be supplied to the Department.

3.3.15.2 Tests at Site

In addition to tests at manufacturer's premises, all relevant pre-commissioning checks and tests conforming to IS code of practice No. 10028 shall be done before energization. The following tests are to be particularly done before cable jointing or connecting up the bas bar trunking.

(a) Insulation test between HV to earth and HV to MV with a 5000 volts Megger.

(b) Insulation test between MV to earth with 500 volts Megger.

(c) All test results are to be recorded and reports should be submitted to the department.

3.3.16 Installation and Commissioning

3.3.16.1 The transformer shall be installed in accordance with IS 10028-Code of practice for Installation and maintenance of transformer. Necessary support channels shall be grouted in the flooring.

3.3.16.2 The transformer shall be moved to its location and shall be correctly positioned. Transformer wheels shall be either locked or provided with wheel stoppers.

3.3.16.3 Wiring of devices shall be carried out as per drawings; Earthing of neutral and body of the transformer shall be done in accordance with section (7) of these specifications.

3.3.16.4 All devices shall be checked for satisfactory operation.

3.3.16.5 All tests specified in 3.2.14 of these specifications shall be carried out by the contractor in the presence of inspecting officer/ consignee free of cost.

3.3.17 Maximum Allowable Power Transformer Losses

Power transformers of the proper ratings and design must be selected to satisfy the minimum acceptable efficiency at 50% and full load rating. In addition, the transformer must be selected such that it minimizes the total of its initial cost in addition to the present value of the cost of its total lost energy while serving its estimated loads during its respective life span.

Total losses for dry type distribution transformers should conform as per the following table:

Maximum allowable losses for dry type distribution transformer with highest voltage for equipment 24 kV, at 50% and 100% of the load		
Transformer Capacity (kVA)	*Maximum Allowable losses at 50% kVA or load*	*Maximum Allowable losses at full load/Rated kVA*
100	1.88%	2.44%
160	1.61%	2.07%
200	1.50%	1.90%
250	1.36%	1.73%
400	1.19%	1.51%
500	1.12%	1.45%
630	1.06%	1.40%
1000	0.90%	1.20%
1600	0.79%	1.05%
2000	0.75%	1.00%

Loss proposal for Dry Type Transformers - BIS (By Mr. Nagarjuna Babu)											
Rating	Imp.	EEL 1/Star 1 (Watts)		EEL 2/Star 2 (Watts)		EEL 3/Star 3 (Watts)		EEL 4/Star 4 (Watts)		EEL 5/Star 5 (Watts)	
KVA	%	50% Load	100% Load	50% Load	100% Load	50% Load	100% Load	50% Load	100% Load	50% Load	100% Load
50	4.50	719	1900	679	1790	638	1680	577	1515	534	1395
63	4.50	769	2012	726	1894	682	1777	617	1600	569	1473
100	4.50	920	2330	859	2191	807	2052	739	1844	672	1694
160	4.50	1290	3300	1196	3100	1124	2930	1028	2720	944	2512
200	4.50	1470	3753	1395	3550	1300	3347	1204	3091	1116	2836
250	4.50	1680	4320	1594	4094	1516	3868	1405	3524	1313	3273
315	4.50	1950	5156	1855	4817	1746	4478	1666	4109	1563	3785
400	4.50	2320	6250	2178	5763	2070	5275	2008	4850	1909	4530
500	4.50	2750	7315	2620	6907	2500	6499	2420	5962	2330	5549
630	4.50	3300	8700	3200	8395	3088	8090	2970	7386	2855	6850
800	5.00	3750	9300	3685	9235	3620	9170	3523	8900	3429	8580
1000	5.00	4350	10550	4275	10473	4192	10395	4066	10165	3934	9798
1250	5.00	5100	12800	5010	12710	4920	12620	4797	12369	4656	12015
1600	6.25	6200	15200	6090	15090	5980	14980	5808	14696	5649	14250
2000	6.25	7350	18600	7220	18470	7090	18340	6920	18022	6744	17550
2500	6.25	9020	22100	8825	21795	8515	21490	8300	20890	8097	20292
3150	6.75	11000	25800	10610	25610	10420	25420	9979	24400	9627	23410

NOTES:

1) Although the values in this table have been developed from 50 Hz transformer data, they are also applicable to 60 Hz transformers, if any.

2) Total loss values given in above table are applicable for thermal class F and have component of load loss at 75°C reference temperature. An increase of 7% on total for thermal class H is allowed. However, minium Thermal Class shall be F as per this applicable standard IS 1180 -Part 3 for Dry type transformers.

3) For transformers having voltage class above 11 kV and up to and including 22 kV, the permissible total loss values shall not exceed by 5% of the maximum total loss values mentioned in above Table.

4) For transformers having voltage class above 22 kV and up to and including 33 kV, the permissible total loss values shall not exceed by 7½% of the maximum total loss values mentioned in above Table.

	NIT information required
1	Application of Transformer e.g. normal Distribution Transformer, Solar duty, wind application, Motor starting etc.
2	Single or three phase unit;
3	Number of phases in system
4	Frequency
5	Indoor or outdoor type
6	Type of cooling
7	Rated power (in kVA)
8	Rated voltages (for each winding)
9	State if tappings are required and if on-load or off-circuit tap-changers, or links are required
10	Highest voltage for equipment (for each winding)
11	Method of system earthing (for each winding)
12	Insulation level (for each winding), power frequency test level/impulse level
13	Connection symbol
14	Neutral terminals, if required (for each winding) and their insulation level to earth;
15	Special requirements of installation, assembly, transport and handling
16	Fittings required and an indication of the side from which meters, rating plates, oil-level indicator, etc. may be readable
	Special requirements
1	If a lightning impulse voltage test is required, whether or not the test is to include chopped waves [see IS 2026 (Part 3)].
2	Impedance voltage at rated current, if specific value is required
3	Altitude above mean sea-level, if in excess of 1 000 m
4	Whether transformers will be subjected to frequent overcurrent, for example, furnace transformers and traction feeding transformers
5	Whether noise level measurement is to be carried out
6	Vacuum withstand of the transformer tank, if a specific value is required
7	Type of Tap-changer controls required (if OLTC is provided)
8	Type of mounting for example pole mounted, ground mounted etc.
	Standard fittings Clause 20.1 IS 1180 Part-1

	a) Two earthing terminals with the earthing symbol ⏚; b) Oil level gauge indicating oil level at minimum, 30°C and maximum operating temperature; NOTES 1 Minimum and maximum positions correspond to the operating temperature of –5°C and 90°C respectively (for non-sealed type transformer). 2 Only minimum position corresponding to the operating temperature of 30°C (for sealed type transformers). c) Air release device (for non-sealed type transformers); d) Rating and terminal marking plates; e) Dehydrating breather shall be provided for non-sealed type transformers; f) Drain-cum-sampling valve preferably steel with plug for three phase transformers (for ratings above 500 kVA); NOTE — Valve size shall be as per agreement between the user and the supplier
	g) Thermometer pocket with cap; h) Oil/Nitrogen/Air filling hole having (1¼" nominal size thread) with cover (for sealed type transformers without conservator); j) Lifting lugs for the complete transformer as well as for core and winding assembly; k) Pressure relief device or explosion vent [for sealed type transformers (for all ratings) and non-sealed type transformers (for ratings above 200 kVA)]; m) One filter valve on the upper side of the tank (for transformers above 200 kVA); n) HV side neutral grounding strip (where one of the HV bushing terminal is connected to earth); p) LV earthing arrangement for single phase transformers; q) Buchholz relay for transformers above 1 000 kVA; and r) Arcing horns for HT side (one number per phase).'
	Optional fittings Clause 20.2 IS 1180 Part-1

	OPTIONAL FITTINGS given under clause 20.2: Ø These fittings may be provided at the option of the user wherever specified. a) Dehydrating breather in lieu of plain breathing device for transformers up to 200 kVA; b) Filter valve for transformers up to 200 kVA; NOTE — Valve size shall be as per agreement between the user and the supplier.' a) Suitable rating lightning arrestors for HT side (one number per phase);' b) Bird guard; c) Terminal connectors d) Oil temperature indicator and winding temperature indicators for transformers above 200 kVA; e) Jacking pads (for transformer above 1 600 kVA); f) Buchholz relay (for transformers above 200 kVA); j) Magnetic oil level gauge (for transformer above 1 600 kVA) with low oil level alarm contact
	k) Non return valve (for conducting pressure test); m) Pressure relief device or explosion vent (up to 200 kVA for non-sealed type transformers); 'n) Protection relay for sealed type transformers for internal parameters that is pressure, temperature, oil level and gas detection;' p) 4 Nos anti-theft stainless steel fasteners with breakaway nut shall be provided at top cover (up to 200 kVA). NOTE — IS 3639 describes some of the fittings and accessories. q) Unidirectional flat rollers (for transformers above 200 kVA); r) Drain-cum-sampling valve preferably steel with plug for three phase transformers (for transformers up to 500 kVA); and NOTE — Valve size shall be as per agreement between the user and the supplier. s) Self protection/disconnection devices subject to agreement between the user and the supplier: 1) Thermo-magnetic circuit breaker as self protection device on secondary side as per IS/IEC 60947-2 : 2003; and 2) Expulsion fuse as disconnection device on primary side as per IS 9385 (Part 2) : 1980.
	ROUTINE TESTS (to be conducted on all units)

	a) Measurement of winding resistance [IS 2026 (Part 1)]. b) Measurement of voltage ratio and check of phase displacement [IS 2026 (Part 1)]. c) Measurement of short-circuit impedance (principal tapping, when applicable) and load loss at 50 percent and 100 percent load [IS 2026 (Part 1)]. d) Measurement of no-load loss and current [IS 2026 (Part 1)]. e) Measurement of insulation resistance [IS 2026 (Part 1)]. f) Induced over-voltage withstand test [IS 2026 (Part 3)]. g) Separate-source voltage withstand test [IS 2026 (Part 3)]. Note: For single phase transformer with 11/√3 or 22 / √3 or 33/√3 kilo volts and with 1.0 kV neutral bushing, this test shall be conducted at test voltage of neutral (3 kV rms for one minute).' h) Pressure test (see 21.5). j) Oil leakage test (see 21.5)
	TYPE TESTS (to be conducted on one unit)
	Lightning impulse test [IS 2026 (Part 3)]. b. Temperature-rise test [IS 2026 (Part 2)]. c. Short-circuit withstand test [IS 2026 (Part 5)] (up to 200 kVA). NOTE — Routine tests before and after short circuit test shall be conducted as per IS 2026 (Part 1). a. Pressure test – requirements given for both single phase as well as three phase transformers. i. Up to 200 kVA: Test requirements for corrugated tanks added Limits of deflection given. Permanent deflection is not applicable for corrugations ii. Beyond 200 kVA Test requirements for corrugated tanks added Limits of deflection given. Permanent deflection is not applicable for corrugations