4.1.7 Tank or enclosure finish

Temperature limits and tests shall be based on the use of a nonmetallic pigment surface paint finish. It should be noted that metallic-flake paints, such as aluminum and zinc, have properties that increase the temperature rise of voltage regulators, except in direct sunlight. Unless otherwise specified, the tank finish shall conform to Light Gray Number 70, Munsell Notation 5BG 7.0/0.4. Finishing of voltage regulators shall meet requirements specified in IEEE Std C57.12.31.[6]

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4.2 Loading at other than rated conditions

IEEE Std C57.91 provides guidance for loading at other than rated conditions including the following:

a) Ambient temperatures higher or lower than the basis of rating

b) Short-time loading in excess of nameplate kVA with normal life expectancy

c) Loading that results in reduced life expectancy

NOTE—IEEE Std C57.91 is a guide rather than a standard. It provides the best known general information for the loading of voltage regulators under various conditions based on typical winding insulation systems, and is based upon the best engineering information available at the time of preparation. The guide discusses limitations of ancillary components other than windings that may limit the capability of voltage regulators. When specified, ancillary components and other construction features (cables, bushings, tap changers, liquid expansion space, etc.) shall be supplied such that they in themselves will not limit the loading to less than the capability of the windings.

4.3 Unusual service conditions

Conditions other than those described in 4.1 are considered unusual service conditions and, when prevalent, should be brought to the attention of those responsible for the design and application of the voltage regulator. Examples of some of these conditions are discussed in 4.3.1 through 4.3.3.

4.3.1 Unusual temperature and altitude conditions

Voltage regulators may be used at higher or lower ambient temperatures or at higher altitudes than specified in 4.1, but special consideration should be given to these applications. Annex A and IEEE Std C57.91 provide information on recommended practices.

4.3.2 Insulation at high altitude

The dielectric strength of voltage regulators that depends in whole or in part upon air for insulation decreases as the altitude increases due to the effect of decreased air density. When specified, voltage regulators shall be designed with larger air spacing using the correction factors of Table 1 to obtain adequate air dielectric strength at altitudes above 1000 m (3300 ft).

4.3.2.1 Insulation level

The minimum insulation necessary at the required altitude can be obtained by dividing the standard insulation level at 1000 m (3300 ft) by the appropriate correction factor from Table 1.

[6] Information on references can be found in Clause 2.

TABLE 3 MAY BE DELETED IN INDIAN CONTEXT

Table 3—Preferred ratings for liquid-immersed 60 Hz step-voltage regulators (single phase)

Nominal system voltage	BIL (kV)	kVA	Line amperes
2400/4160Y	60	50	200
		75	300
		100	400
		125	500
		167	668
		250	1000
		333	1332
		416	1665
4800/8320Y	75	50	100
		75	150
		100	200
		125	250
		167	334
		250	500
		333	668
		416	833
7620/13 200Y	95	38.1	50
		57.2	75
		76.2	100
		114.3	150
		167	219
		250	328
		333	438
		416	546
		500	656
		667	875
		833	1093
		1000	1312
13 800	95	69	50
		138	100
		207	150
		276	200
		414	300
		552	400
		667	483
		833	604
		1000	725
14 400/24 940Y	150	72	50
		144	100
		288	200
		333	231
		432	300
		576	400
		667	463
		833	578
		1000	694
19 920/34 500Y	150	100	50
		200	100
		333	167
		400	201
		667	334
		833	418
		1000	502
34 500	200	173	50
		345	100
		518	150
		690	200

Table 4—Preferred ratings for liquid-immersed 50 Hz step-voltage regulators (single phase)

SECTION MAY BE DELETED IN INDIAN CONTEXT

Nominal system voltage	BIL (kV)	kVA	Line amperes
6600/11430Y	95	33	50
		66	100
		99	150
		132	200
		198	300
		264	400
		330	500
		396	600
		462	700
		528	800
11000	95	55	50
		110	100
		165	150
		220	200
		330	300
		440	400
		550	500
		660	600
		770	700
		880	800
15000/25980Y	150	75	50
		150	100
		225	150
		300	200
		450	300
		600	400
		750	500
		900	600
22000	150	110	50
		220	100
		330	150
		440	200
		660	300
		880	400
33000	170	165	50
		330	100
		495	150
		660	200

TABLE 5 MAY BE DELETED IN INDIAN CONTEXT

Table 5—Preferred ratings for liquid-immersed 60 Hz step-voltage regulators (three phase)

Nominal system voltage	BIL (kV)	Self-cooled		Self-cooled/forced-cooled	
		kVA	Line amperes	kVA	Line amperes
2400/4160Y	60	500	667	625	833
		750	1000	937	1250
		1000	1334	1250	1667
4800	60	500	577	625	721
		750	866	937	1082
		1000	1155	1250	1443
7620/13 200Y	95	500	219	625	274
		750	328	937	410
		1000	437	1250	546
		1500	656	2000	874
		2000	874	2667	1166
		2500	1093	3333	1458
		3000	1312	4000	1750
7970/13 800Y	95	500	209	625	261
		750	313	937	391
		1000	418	1250	523
		1500	628	2000	837
		2000	837	2667	1116
		2500	1046	3333	1394
		3000	1255	4000	1673
14 400/24 940Y	150	500	125.5	625	156.8
		750	188.3	937	235.4
		1000	251	1250	314
		1500	377	2000	502
		2000	502	2667	669
		2500	628	3333	837
		3000	694	4000	926
19 920/34 500Y	150	500	84	625	105
		750	125.5	937	156.8
		1000	167	1250	209
		1500	251	2000	335
		2000	335	2667	446
		2500	418	3333	557
		3000	502	4000	669

Table 6—Preferred ratings for liquid-immersed 50 Hz step-voltage regulators (three phase)

SECTION MAY BE DELETED IN INDIAN CONTEXT

Nominal system voltage	BIL (kV)	Self-cooled		Self-cooled/forced-cooled	
		kVA	Line amperes	kVA	Line amperes
6600/11430Y	95	500	253	625	316
		750	379	937	474
		1000	505	1250	631
		1500	758	2000	1010
11000	95	500	262	625	328
		750	394	937	492
		1000	525	1250	656
		1500	787	2000	1050
15000/25980Y	150	500	111	625	139
		750	167	937	208
		1000	222	1250	278
		1500	333	2000	444
		2000	444	2667	593
		2500	556	3333	741
22000	150	500	131	625	164
		750	197	937	246
		1000	262	1250	328
		1500	394	2000	525
33000	170	500	87	625	189
		750	131	937	164
		1000	175	1250	219

5.2.3 Supplementary voltage ratings

In addition to their rated voltage, as defined in 5.2.2, voltage regulators shall deliver rated kVA output without exceeding the specified temperature rise per Table 2 at the operating voltages given in Table 7.

Voltage regulators with multitapped voltage transformers and/or utility windings may be operated at voltages other than the rated voltage, as specified per the nameplate, and shall deliver rated line amperes without exceeding the temperature limits of Table 2 and as specified per the nameplate.

Table 7—Supplementary voltage ratings for 60 Hz voltage regulators

TABLE 7 MAY BE CHANGED TO VOLTAGES IN INDIAN CONTEXT

Number of phases	Rated voltage	Operating voltage
Single phase	7620	7200
	4330	4160
Three phase	5000	4800
	8660	8320
	13 200	12 470
	13 800	13 200

5.3 Supplementary continuous-current ratings

Single-phase step-voltage regulators rated up to 34.5 kV, inclusive, and rated 668 A and below shall have supplementary continuous-current ratings on intermediate ranges of steps as shown in Table 8. Maximum continuous current shall be 668 A.

Table 10 — Typical examples of operating voltage limits including all operating voltage tolerances

Nominal system voltage	Regulator voltage rating (V)		Voltage supply ratio[a]	Input voltage (V)			Output voltage (V)	
	Single phase	Three phase		Minimum	Maximum at rated-load amperes	Maximum at no-load	Minimum	Maximum at rated-load amperes or at no-load
2400	2500	—	20	1955	2625	2750	2070	2750
2400/4160Y	2500		20	1955	2625	2750	2070	2750
2400/4160Y	—	4330	34.6	3380	4550	4760	3580	4760
4800	5000	5000	40	3910	5250	5500	4140	5500
7200	7620	—	60	5870	8000	8250	6210	8250
7200		8660	60	5870	8250	8250	6210	8250
4800/8320Y	5000	—	40	3910	5250	5500	4140	5500
8320	—	8660	69.3	6775	9090	9525	7170	9525
11000	11000	—	91.7	8960	11 550	12 100	9490	12 100
6600/11 430Y	6600	—	55	5380	6930	7260	5690	7260
12 470	13 800	13 800	104	10 170	14 300	14 300	10 760	14 300
7200/12 470Y	7620	—	60	5870	8000	8250	6210	8250
7200/12 470Y	—	13 800	104	10 170	14 300	14 300	10 760	14 300
7620/13 200Y	7620	—	63.5	6210	8000	8380	6570	8380
7620/13 200Y	7620	—	66.3	6480	8000	8380	6860	8380
7620/13 200Y	—	13 200	110	10 750	13 860	14 520	11 400	14 520
7970/13 800Y	—	13 800	115	11 240	14 490	15 180	11 900	15 180
7970/13 800Y	7970	—	66.3	6480	8360	8760	6860	8760
13 200	13 800	13 800	110	10 750	14 490	15 125	11 400	15 125
14 400	13 800	13 800	120	11 730	14 490	15 180	12 420	15 180
22 000	22 000	—	183.3	17 920	23 100	24 200	18 975	24 200
14 400/24 940Y	14 400	—	120	11 730	15 120	15 840	12 420	15 840
15 000/25 980Y	15 000	—	120	11 730	15 750	16 500	12 420	16 500
19 920/34 500Y	19 920	—	166	16 230	20 920	21 910	17 180	21 910
14 400/24 940Y		24 940	208	20 330	26 190	27 435	21 530	27 435
33 000	33 000	—	275	26 880	34 650	36 300	28 460	36 300
19 920/34 500Y	—	34 500	287.5	28 100	36 225	37 950	29 760	37 950
34 500	34 500	—	287.5	28 100	36 225	37 950	29 760	37 950

NOTE—Example values are derived using procedures of 5.5.

[a] Where the listed voltage ratio is provided, an ancillary transformer may be required.

5.6 Voltage supply ratios

Values of voltage supply ratios are given in Table 11. When a voltage supply ratio is specified that is not a preferred value shown in Table 11, an ancillary transformer may be furnished in the unit or control to modify the preferred ratio.

TABLE 11 MAY BE CHANGED TO VOLTAGES IN INDIAN CONTEXT & 3.3 KV ALSO TO APEAR

Table 11 —Values of voltage supply ratios

Voltage regulator rating (V)		Values of voltage supply ratios
Single phase	Three phase	
2500		20, 20.8
	4330	34.6, 36.1
5000	5000	40, 41.7
6600		55
7620		60, 63.5
7970		66.4
	8660	69.3, 72.2
11 000		91.7
	13 200	110, 104
13 800	13 800	115, 110
14 400		120
15 000		120
19 920		166
22 000		183.3
	24 940	208
33 000		275
34 500	34 500	287.5

5.7 Insulation levels

Voltage regulators shall be designed to provide coordinated applied-voltage and lightning impulse insulation levels on line terminals, and applied-voltage insulation levels on neutral terminals. The identity of a set of coordinated levels shall be its basic impulse insulation level (BIL), as shown in Table 12.

NOTE—When single-phase voltage regulators are connected in wye, the neutral of the voltage regulator bank shall be connected to the neutral of the system. A closed or open delta connection of the voltage regulators is recommended when the system is three-wire ungrounded.

Table 12 —Interrelationships of dielectric insulation levels for voltage regulators used on systems with BIL ratings of 200 kV and below

BIL kV	Applied-voltage insulation level (kV rms)	Impulse levels		
		Full wave	Chopped wave	
		(kV crest)	(kV crest)	Min time to flashover (μs)
60	19	60	66	1.5
75	26	75	83	1.5
95	34	95	105	1.8
110	34	110	120	2.0
150	50	150	165	3.0
170	70	170	187	3.0
200	70	200	220	3.0

5.9 Short-circuit requirements

5.9.1 General

Step-voltage regulators shall be designed and constructed to withstand the mechanical and thermal stresses produced by external short circuits of a maximum value of 25 times the base rms symmetrical rated load current to a maximum requirement of 16 kA rms symmetrical.

a) The first-cycle asymmetrical peak current that the voltage regulator is required to withstand shall be determined as shown in Equation (1) and Table 13.

$$ISC(pk\ asym) = KISC(rms\ sym) \quad (1)$$

60 Hz MAY BE DLETED IN INDIAN CONTEXT

Table 13 —Values of K

Base rated kVA	K	
	60 Hz	50 Hz
< 165 (single phase)	2.26 [a]	2.19 [a]
≥ 165 (single phase) ≥ 500 (three phase)	2.60 [b]	2.55 [b]

[a] Value of the first-cycle asymmetrical peak current is based on an X/R ratio of 6 and 5, 60 and 50 Hz, respectively, which are common for distribution circuits.

[b] Value of the first-cycle asymmetrical peak current is based on an X/R ratio of 17 and 14, 60 and 50 Hz, respectively, which are common for substation circuits.

b) The short-circuit current shall be assumed to be a duration of 2 s to determine the thermal stresses.

It is recognized that short-circuit withstand capability can be adversely affected by the cumulative effects of repeated mechanical and thermal overstressing, as produced by short circuits and loads above the nameplate rating. Since means are not available to continuously monitor and quantitatively evaluate the degrading effects of such duty, short-circuit tests, when required, should be performed prior to placing the voltage regulator in service.

Voltage regulator components such as leads, bushings, and load tap changers that carry current continuously shall comply with all the requirements of 5.9.1. Load tap changers are not required to change tap position coincident with a short-circuit condition.

It is recommended that current-limiting reactors be installed by the user, where necessary, to limit the short-circuit current to a maximum of 25 times the base rated full-load current or 16 000 A, whichever is less.

NOTE 1—Larger kVA sizes for the same voltage rating should be considered if the available fault current exceeds the 25 times base rated current.

NOTE 2—User may specify a larger short-circuit withstand value due to unique system parameters. An example as such is a short-circuit withstand of 40 times the base rated load current or 20 000 A whichever is less. Application, limitations, design, and resulting cost are to be agreed upon by the user and the manufacturer.

5.9.2 Mechanical capability demonstration

It is not the intent of this subclause that every voltage regulator design is short-circuit tested to demonstrate adequate construction. When specified, tests of short-circuit mechanical capability shall be performed as described in 8.8.

Bushings for use in voltage regulators shall have impulse and applied-voltage insulation levels as listed in Table 14. Unless otherwise specified, the color of the bushings shall match Light Gray Number 70, Munsell Notation 5BG7.0/0.4, as described in IEEE Std C57.12.31. MAY BE DELETED

Table 14—Electrical characteristics of voltage regulator bushings (kV)

Regulator BIL (kV)	Creep distance (minimum) mm (in)	Applied-voltage withstand		Impulse full-wave dry withstand kV crest (1.2 × 50 μs)
		1 min dry (kV rms)	10 s wet [a] (kV rms)	
60	90 (3.5)	21	20	60
75	150 (6)	27	24	75
95	255 (10)	35	30	95
110	280 (11)	50	45	110
150	435 (17)	60	50	150
170	660 (26)	70	65	170
200	660 (26)	80	75	200

[a] Wet withstand values are based on water resistivity of 180 Ω·m (7000 Ω·in) and precipitation rate of 0.085 mm/s (0.2 in/min).

6.2 Terminal markings

6.2.1 Terminal markings for step-voltage regulators

Voltage regulator terminals that are connected to the load shall be designated by an *L*, and those that are connected to the source shall be designated by an *S*. For example, in the case of a single-phase voltage regulator, the terminals shall be identified by *S*, *L*, and *SL*. In the case of a three-phase voltage regulator, the terminals shall be identified S_1, S_2, S_3, L_1, L_2, L_3, and, if a neutral is provided, S_0L_0.

Single-phase voltage regulators, when viewed from the top, shall have the *S* terminal on the left, followed in sequence in a clockwise direction by the *L* terminal and the common terminal *SL*, as shown in Figure 3.

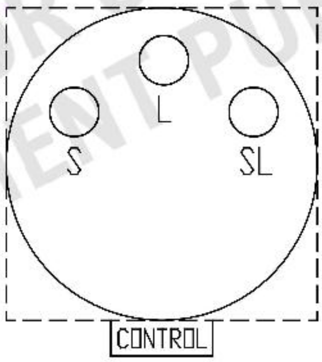

Figure 3—Single-phase voltage regulators

For three-phase voltage regulators, when facing the voltage regulator on the source side, the S_1 terminal shall be in front on the right, and the L_1 terminal shall be directly behind the S_1 terminal, as shown in Figure 4(a), or the S_1 terminal shall be in front on the right, and the L_1 terminal shall be directly to the left of the S_1 terminal, as shown in Figure 4(b). The other terminals shall be located as shown in Figure 4.

6.5.5.2 Maximum continuous rating 300 A or greater

Tank grounding provision shall consist, at a minimum, of one unpainted copper-faced steel or stainless-steel pad, 50 mm × 90 mm (2.0 in × 3.5 in), with two holes horizontally spaced on 44.5 mm (1.75 in) centers, tapped for 0.5 inch 13 NC thread and located near the bottom of the tank. Minimum thread depth of each hole shall be 13 mm (0.5 in). Minimum thickness of the copper facing, when used, shall be 0.4 mm (0.015 in).

6.6 Components and accessories

6.6.1 Components for full automatic control and operation

a) Control system.

b) Current and voltage transformers or the equivalent for supplying the control system.

c) Load tap changer equipment shall consist of a liquid-immersed arcing tap switch, a tap selector, and an arcing switch, or a tap selector with vacuum switch or other current interrupting facility, and motor mechanism. Equipment shall meet the requirements of either IEEE Std C57.131 or IEC 60214-1 as specified.

d) Internal power supply for tap changer motor.

e) Provision for disconnecting control power supply.

f) Position indicator for the load tap changer with maximum and minimum indicating hands and provision for resetting shall be provided. Adjustable range of regulation for the *raise* and *lower* ranges is to be provided for supplementary current ratings per 5.3. Mechanically actuated electric limit switches shall be provided to prevent travel beyond the maximum raise and lower positions.

6.6.2 Accessories for single-phase step-voltage regulators

a) Combination drain and lower filter valve with sampling device.

b) Fill plug located at the top of the tank above fluid level.

c) Liquid level indicator.

d) Bushing terminals shall be either clamp-type or threaded stud, depending on the nameplate line current ratings as shown in Table 15. The clamp-type terminals shall have at least the conductor range stated and shall be capable of accepting an aluminum or copper conductor. ~~Spade terminals shall have a pad with a minimum dimension of 101.6 mm × 101.6 mm (4.0 in × 4.0 in), with four 14.2 mm (0.5625 in) holes horizontally and vertically spaced on 44.5 mm (1.75 in) centers. Thickness of the pad is shown in Table 15.~~ The user has the responsibility of selecting the proper conductor size for use with the clamp-type or spade terminals. When selecting the conductor size, the user should consider factors such as additional current carrying capability with reduced regulation (see 5.3), supplementary voltage ratings (see 5.2.3) and loading at other than rated conditions (see 4.2).

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SPADE SIZE SHALL BE AS PER INDIA CONTEXT & RLEAVNT IS

Table 15 — Bushing terminal applications

Nameplate line current rating (A)	Conductor size range or 4-hole spade
150 or less	#8–4/0
151 to 300	#2–477 kCM
301 to 668	#2–800 kCM
669 to 1200	1-1/8–12 UNF-2A with 4-hole spade—9.5 mm (0.375 in) minimum thickness
1201 to 2000	1-1/2—12 UNF-2A with 4-hole spade—12.7 mm (0.5 in) minimum thickness

6.6.3 Accessories for three-phase step-voltage regulators

a) Combination drain and lower filter valve with sampling device.

b) Fill plug located at the top of the tank.

c) Liquid level indicator.

d) Clamp-type terminals in accordance with single-phase criteria [see item d) in 6.6.2].

e) Provision for thermometer.

f) Handholes or openings to permit inspection of core and coil and load tap changer.

7. Other requirements

Certain specific applications have voltage regulator requirements not covered in Clause 4, Clause 5, or Clause 6. Clause 7 comprises descriptions of the most frequently used requirements for such voltage regulators. They shall be provided only when specified in conjunction with the requirements of Clause 4 through Clause 6. Information in the following subclauses may be specified for some applications.

7.1 Other supplementary continuous-current ratings

When specified, other supplementary continuous-current ratings, 668 A maximum, for three-phase voltage regulators rated 8660 V and 13 200 V shall be provided as shown in Table 16 (see 5.3).

Table 16 — Other supplementary continuous-current ratings for three-phase voltage regulators

Range of voltage regulation (%)	Continuous-current ratings (%)
10.0	100
8.75	110
7.5	120
6.25	135
5.0	160

7.2 Other components and accessories

When specified, the other components and accessories listed in 7.2.1 and 7.2.2 may be provided.

associated turn insulation. T_f shall not exceed the limiting temperature in 5.9.3. All temperatures are in degrees Celsius.

$$T_f = (T_k + T_s)m(1 + E + 0.6m) + T_s \tag{26}$$

where

$$m = \frac{(W_s t)}{[C(T_k + T_s)]}$$

These equations are approximate formulas, and their use *should* be restricted to values of $m = 0.6$ or less.

For values of m in excess of 0.6, the following more nearly exact equation *should* be used:

$$T_f = (T_k + T_s)\left[\sqrt{\varepsilon^{2m} + E(\varepsilon^{2m} - 1)} - 1\right] + T_s \tag{27}$$

where

T_f is final winding temperature

T_k is 234.5 °C (copper) and 225 °C (aluminum)

Tk = 235 C in line with other parts of IS : 2026

NOTE—225 °C applies for pure or EC aluminum. T_k may be as high as 230 °C for alloyed aluminum. Where copper and aluminum windings are employed in the same voltage regulator, a value for T_k of 229 °C should be applied for the correction of losses.

T_s is the starting temperature equal to

a) A 30 °C ambient temperature plus the average winding rise plus the manufacturer's recommended hottest-spot allowance, or

b) A 30 °C ambient temperature plus the limiting winding hottest-spot temperature rise specified for the appropriate type of voltage regulator

ε is the base of natural logarithm, 2.718

E is the per unit eddy-current loss, based on resistance loss, W_s, at the starting temperature

$$E = E_r\left[\frac{T_k + T_r}{T_k + T_s}\right]^2 \tag{28}$$

where

E_r is the per-unit eddy-current loss at reference temperature

T_r is the reference temperature, which is 20 °C ambient temperature plus rated average winding rise

W_s is the short-circuit resistance loss of the winding at the starting temperature, in watts per weight of conductor material

Annex C

RELEVANT INDIAN STANDARDS SHALL BE INCORPORATED

(informative)

Bibliography

[B1] Accredited Standards Committee C2-2007, National Electrical Safety Code® (NESC®).[c]

[B2] ANSI C84.1, American National Standard Voltage Ratings (60 Hz) for Electric Power Systems and Equipment.[d]

[B3] ASTM D 117, Standard Methods of Testing and Specifications for Electrical Insulating Oils of Petroleum Origin.[e]

[B4] ASTM D 3487, Specifications for Mineral Insulating Oil Used in Electrical Apparatus.

[B5] IEC 60076-4, Power transformers—Part 4: Guide to the lightning impulse and switching impulse testing—Power transformers and reactors.[f]

[B6] IEC 60214-2, Tap Changers—Part 2: Application Guide.

[B7] IEC 61000-4-8, Electromagnetic compatibility (EMC)—Part 4-8: Testing and measurement techniques—Power frequency magnetic field immunity test.

[B8] IEC 61000-4-9, Electromagnetic compatibility (EMC)—Part 4-9: Testing and measurement techniques—Pulse magnetic field immunity test.

[B9] IEC 61000-4-10, Electromagnetic compatibility (EMC)—Part 4-10: Testing and measurement techniques—Damped oscillatory magnetic field immunity test.

[B10] IEC 61000-4-11, Electromagnetic compatibility (EMC)—Part 4-11: Testing and measurement techniques—Voltage dips, short interruptions and voltage variations immunity tests.

[B11] IEEE Std 62™, IEEE Guide for Diagnostic Field Testing of Electric Power Apparatus—Part 1: Oil Filled Power Transformers, Regulators, and Reactors.[g, h]

[B12] IEEE Std 315™, IEEE Standard Graphic Symbols for Electrical and Electronics Diagrams (Including Reference Designation Letters).

[B13] IEEE Std C57.12.00™, IEEE Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers.

[B14] IEEE Std C57.12.20™, IEEE Standard for Overhead Type Distribution Transformers, 500 kVA and Smaller: High Voltage, 34 500 V and below; Low Voltage, 7970/13 800y V and below.

[B15] IEEE Std C57.12.80™, IEEE Standard Terminology for Power and Distribution Transformers.

[c] The NESC is available from the Institute of Electrical and Electronics Engineers, 445 Hoes Lane, Piscataway, NJ 08854, USA (http://standards.ieee.org/).
[d] ANSI publications are available from the Customer Service Department, American National Standards Institute, 25 W. 43rd Street, 4th Floor, New York, NY 10036, USA (http://www.ansi.org/).
[e] ASTM publications are available from the American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959, USA (http://www.astm.org/).
[f] IEC publications are available from the Central Office of the International Electrotechnical Commission, 3, rue de Varembé, P.O. Box 131, CH-1211, Geneva 20, Switzerland (http://www.iec.ch/). IEC publications are also available in the United States from the Sales Department, American National Standards Institute, 25 West 43rd Street, 4th Floor, New York, NY 10036, USA (http://www.ansi.org/).
[g] IEEE publications are available from the Institute of Electrical and Electronics Engineers, 445 Hoes Lane, Piscataway, NJ 08854, USA (http://standards.ieee.org/).
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