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**Sub: Examination of International Best Practices/Standards for DTs and Comparison of Indian Standards with International Standards**

**Ref: AITMA Submission on Sub-Committee Meeting (Action Point 3) Held on 9th January 2025**

Dear Mr. Sharma,

We refer to the Sub-Committee meeting held on 9th January 2025, where the objective was to study international best practices and standards for Distribution Transformers (DTs) and to compare Indian standards with their international counterparts.

As per the discussions during the meeting, associations were requested to share their views on the presentations made during the Sub-Committee meeting.

AITMA submits the following points for the consideration of the Sub-Committee:

1. Canada mandates specific loss levels for dry-type transformers while maintaining voluntary standards for liquid-filled transformers.
2. China provides separate standards for Cold Rolled Grain Oriented (CRGO) and Amorphous oil-immersed transformers, demonstrating a tailored approach.
3. We have proposed to lower the losses in existing star labelling at 100%.

Please refer to the Annexure to this letter in support of serial no. 1 to 3 above.

4. Unlike other countries, India considers losses at both 50% and 100% load for the same transformer label. This dual consideration is complementary and it complicates the standardization process, as highlighted in the presentation by CPRI.
5. We are a country where we load our transformers at not less than 80%. In fact, it is usually loaded even above 100%. The losses or efficiency should be compared at 100% and not at 50%. In fact, perusal of the chart in the presentation clearly brings out that in developed countries mainly the 50% criterion is being considered for loading. In these countries the loading is almost idle for quite some time in a day while it is high for the rest of the day.

6. A comparison of losses indicates that Indian standards surpass Level 1 of IEC 60076-20, and in many cases, our Level 1 standards are superior to Level 2 of the same standard.

We trust that our above submissions will be considered by the Sub-Committee.

With warm regards,

Sudeep Sarkar  
Director General  
All India Transformer Manufacturers Association (AITMA)

Attachments: Annexure

Table 6 - Brazil's MEPS for Liquid-Filled Distribution Transformers

kVA	15 kV		24.2 kV		36.2 kV	
	Max Core Loss (Watts)	Max Total Loss (Watts)	Max Core Loss (Watts)	Max Total Loss (Watts)	Max Core Loss (Watts)	Max Total Loss (Watts)
<b>Single-Phase</b>						
5	35	140	40	155	45	160
10	50	245	55	265	60	270
15	65	330	75	365	80	380
25	90	480	100	520	105	545
37.5	135	665	145	740	150	740
50	165	780	190	925	200	935
75	205	1,110	225	1,210	240	1,225
100	255	1,445	275	1,495	280	1,480
<b>Three-Phase</b>						
15	85	410	95	470	100	460
30	150	695	160	790	165	775
45	195	945	215	1055	230	1,075
75	295	1,395	315	1,550	320	1,580
112.5	390	1,890	425	2,085	440	2,055
150	485	2,335	520	2,610	540	2,640
225	650	3,260	725	3,605	750	3,600
300	810	4,060	850	4,400	900	4,450

In addition to the mandatory MEPS requirements, Brazil has also adopted a labeling program for liquid-filled distribution transformers. The objectives of these policy measures are to establish a maximum acceptable level of loss and to encourage the specification and purchasing of more energy-efficient liquid-filled distribution transformers, new and reconditioned.

The label is formatted in a specific way and applied to all transformers where it will be visible to the user, as defined by the national energy conservation label (ENCE), in compliance with Brazilian national law No 10.295/2001, concerning the National Policy for the conservation and rational use of energy. The labeling program for distribution transformers includes the manufacturer, model, type, kVA rating, and voltage class. The label also presents the watts of losses at no load and total watts of loss at full load, temperature rise and BIL (Basic-Impulse Insulation Level) of the transformer at both the nominal tap and the 'critical' tap (meaning the one furthest from the nominal). An image of the label is shown in Figure 10.

**Table 7 - Single Phase Dry-type Transformer MEPS in Canada**

Single Phase kVA Rating	20 to 45 kV BIL (% efficiency)*	>45 to 95 kV BIL (% efficiency)	>95 to 199 kV (% efficiency)
15	98.10	97.86	97.60
25	98.33	98.12	97.90
37.5	98.49	98.30	98.10
50	98.60	98.42	98.20
50	98.60	98.42	98.20
75	98.73	98.57	98.53
100	98.82	98.67	98.63
167	98.96	98.83	98.80
250	99.07	98.95	98.91
333	99.14	99.03	98.99
500	99.22	99.12	99.09
667	99.27	99.18	99.15
833	99.31	99.23	99.20

\*Percentage efficiency at 50% nominal load. BIL means basic impulse insulation level.

**Table 8 - Three-phase Dry-type Transformer MEPS in Canada**

Three-phase kVA Rating	20 to 45 kV BIL (% efficiency)*	>45 to 95 kV BIL (% efficiency)	>95 to 199 kV (% efficiency)
15	97.50	97.18	96.80
30	97.90	97.63	97.30
45	98.10	97.86	97.60
75	98.33	98.12	97.90
112.5	98.49	98.30	98.10
150	98.60	98.42	98.20
225	98.73	98.57	98.53
300	98.82	98.67	98.63
500	98.96	98.83	98.80
750	99.07	98.95	98.91
1,000	99.14	99.03	98.99
1,500	99.22	99.12	99.09
2,000	99.27	99.18	99.15
2,500	99.31	99.23	99.20
3,000	99.34	99.26	99.24
3,750	99.38	99.30	99.28
5,000	99.42	99.35	99.33
7,500	99.48	99.41	99.39

\*Percentage efficiency at 50% nominal load. BIL means basic impulse insulation level.

In addition to the mandatory program for dry-type distribution transformers, Canada conducted a market and technology assessment on liquid-filled distribution transformers and determined that MEPS would not be needed to ensure energy-efficient transformers were installed in the market. The Canadian electric utilities were already evaluating losses and purchasing highly efficient models, and therefore in place of a mandatory standard, the Canadian Standards Association (CSA) harmonized the Canadian standard with the NEMA voluntary standards based on NEMA TP 1. A voluntary agreement between National Resources Canada (NRCan) and the Canadian Electricity Association (CEA) to adopt the minimum efficiency level based on the CSA C802.1-00 standard is being used for liquid-filled transformers. More information about Canada standards and labeling program is available at: <http://www.nrcan.gc.ca>.

Even though the above standard is voluntary, a recent market analysis found that the nine provincial electric utilities had already incorporated energy efficiency into their transformer procurement practices. As a result of these practices, more than 95 percent of the liquid-filled distribution transformers sold in Canada already met the NEMA TP 1 efficiency levels (USDOE, 2013).

Canada is currently reviewing whether to adopt MEPS for liquid-filled distribution transformers, however no decision has been made at this time.

Table 9 gives the specifications of the voluntary agreement.

**Table 9 - Voluntary Standard for Liquid-Type Distribution Transformers in Canada**

kVA	Min. Low Voltage	Efficiency	kVA	Min. Low Voltage	Efficiency
10	120/240	98.20	15	208Y/120	97.89
15	120/240	98.41	30	208Y/120	98.20
25	120/240	98.63	45	208Y/120	98.41
50	120/240	98.84	75	208Y/120	98.63
75	120/240	98.94	150	208Y/120	98.84
100	120/240	98.94	225	208Y/120	98.94
167	120/240	99.05	300	208Y/120	98.94
250	120/240	99.15	500	208Y/120	99.05
333	120/240	99.01	750	208Y/120	99.15
333	277/480Y	99.15	1,000	208Y/120	99.06
500	277/480Y	99.26	1,000	480Y/277	99.15
667	277/480Y	99.37	1,500	480Y/277	99.26
833	277/480Y	99.37	2,000	480Y/277	99.37
			2,500	480Y/277	99.37
			3,000	480Y/277	99.37

Amendment E

**Table 9 Maximum Total Losses Upto 11 KV Class Transformers**

(Clauses 8.8.1.1, 8.8.1.2 and 8.8.1.3)

Sl No.	Rating (KVA)	Voltage (kV)	Al/Cu	Impedance (Percent)	Our proposed Maximum Total Losses (W) at 100 % Load	Reduction in losses at 100 % Load	
						In Watt	In Percent (%)
(i)	5	11/0.250	Alum.	2.50	90	5	5.26
(ii)	10	11/0.250	Alum.	4.00	153	17	10.00
(iii)	16	11/0.250	Alum.	4.00	204	20	8.93
(iv)	25	11/0.250	Alum.	4.00	275	25	8.33
(v)	50	11/0.250	Alum.	4.00	540	50	8.47
(vi)	75	11/0.250	Alum.	4.00	810	70	7.95
(vii)	100	11/0.250	Alum.	4.00	970	170	14.91

**Table 3 Maximum Total Losses Upto 11 KV Class Transformers**

(Clauses 6.8.1.1, 6.8.1.2, 6.8.1.3 and 6.8.2)

SI No.	Rating (KVA)	Voltage (kV)	Al/Cu	Impedance (Percent)	Our proposed Maximum Total Losses (W) at 100 % Load	Reduction in losses at 100 % Load	
						In Watt	In Percent (%)
(i)	6.3	11/0.433	Alum.	4.00	158	15	8.67
(ii)	10	11/0.433	Alum.	4.50	218	22	9.17
(iii)	16	11/0.433	Alum.	4.50	405	35	7.95
(iv)	20	11/0.433	Alum.	4.50	480	47	8.92
(v)	25	11/0.433	Alum.	4.50	550	85	13.39
(vi)	40	11/0.433	Alum.	4.50	749	85	10.19
(vii)	63	11/0.433	Alum.	4.50	950	190	16.67
(viii)	100	11/0.433	Alum.	4.50	1360	290	17.58
(ix)	160	11/0.433	Alum.	4.50	1825	125	6.41
(x)	200	11/0.433	Alum.	4.50	2050	250	10.87

**Table 6 Maximum Total Losses Upto 11 KV Class Transformers**

(Clauses 7.8.1.1)

Sl No.	Rating (KVA)	Voltage (kV)	Al/Cu	Impedance (Percent)	Our proposed Maximum Total Losses (W) at 100 % Load	Reduction in losses at 100 % Load	
						In Watt	In Percent (%)
(i)	250	11/0.433	Copper	4.50	2775	155	5.29
(ii)	315	11/0.433	Copper	4.50	2800	300	9.68
(iii)	400	11/0.433	Copper	4.50	3300	150	4.35
(iv)	500	11/0.433	Copper	4.50	4125	175	4.07
(v)	630	11/0.433	Copper	4.50	5050	250	4.72
(vi)	800	11/0.433	Copper	5.00	6300	103	1.61
(vii)	1000	11/0.433	Copper	5.00	7600	100	1.30
(viii)	1250	11/0.433	Copper	5.00	9000	200	2.17
(ix)	1600	11/0.433	Copper	6.00	11400	400	3.39
(x)	2000	11/0.433	Copper	6.00	14400	600	4.00
(xi)	2500	11/0.433	Copper	6.25	17800	700	3.78

Table 10 – Voluntary Energy-Efficiency Levels for Liquid-Type Distribution Transformers in Chile

Single-Phase Liquid-Filled		Three-Phase Liquid-Filled	
kVA	(% efficiency)	kVA	(% efficiency)
10	98.4	15	98.1
15	98.6	30	98.4
25	98.7	45	98.6
38	98.8	75	98.7
50	98.9	112.5	98.8
75	99.0	150	98.9
100	99.0	225	99.0
167	99.1	300	99.0
250	99.2	500	99.1
333	99.2	750	99.2
500	99.3	1,000	99.2
667	99.4	1,500	99.3
833	99.4	2,000	99.4
		2,500	99.4

Note: Efficiency is defined at 55°C and 50% load factor

Table 11 – Voluntary Energy-Efficiency Levels for Dry-Type Distribution Transformers in Chile

kVA Rating	Single Phase			kVA Rating	Three Phase		
	Low Voltage	Medium Voltage			Low Voltage	Medium Voltage	
		≤60 kV BIL	>60 kV BIL			≤60 kV BIL	>60 kV BIL
15	97.7	97.6	97.6	15	97.0	96.8	96.8
25	98.0	97.9	97.9	30	97.5	97.3	97.3
37.5	98.2	98.1	98.1	45	97.7	97.6	97.6
50	98.3	98.2	98.2	75	98.0	97.9	97.9
75	98.5	98.4	98.4	112.5	98.2	98.1	98.1
100	98.6	98.5	98.5	150	98.3	98.2	98.2
167	98.7	98.8	98.7	225	98.5	98.4	98.4
250	98.8	98.9	98.8	300	98.6	98.6	98.5
333	98.9	99.0	98.9	500	98.7	98.8	98.7
500	-	99.1	99.0	750	98.8	98.9	98.8
667	-	99.2	99.0	1,000	98.9	99.0	98.9
833	-	99.2	99.1	1,500	-	99.1	99.0
				2,000	-	99.2	99.0
				2,500	-	99.2	99.1

Note: Efficiency is defined at 75°C and 35% load factor for low voltage, 50% load factor for medium voltage

## People's Republic of China

### Scope of Coverage

China has mandatory energy efficiency standards for distribution transformers - both liquid-filled and dry-type. The national standards apply to liquid-filled distribution transformers of 30 kVA-1600 kVA and dry type of rated capacity of 30 kVA-2500 kVA.

### Test Standard

Many Chinese national GB standards are adopted from ISO, IEC or other international standards developers, and distribution transformers are no exception. For distribution transformers, China covers and regulates both liquid-filled and dry-type. The test standard for measuring the efficiency of the transformer is the family of GB 1094 national standards, which are harmonized with IEC 60076.

### Energy Efficient Distribution Transformer Policies

The national standard GB 20052-2013 establishes maximum allowable losses in three grades for three-phase distribution transformers. This standard is maintained by the China National Institute of Standardization (CNIS). It specifies the maximum allowable losses and sets test standards for liquid-filled and dry-type three-phase distribution transformers. The three grades of maximum losses are structured such that Grade 3 has the highest losses (i.e., least efficient) and Grade 1 has the lowest losses (i.e., most efficient) for silicon-core steel transformers. In addition, the standard has two separate product classes under Grade 1 and 2 for amorphous-core distribution transformers. More information about China's standards and labeling program is available at: <http://www.cnis.gov.cn>.

Table 12 summarizes the requirements contained in the National Chinese distribution transformer standard GB 20052-2013.

Table 12 - Summary of National Efficiency Standard for Three-phase Distribution Transformers in China

Type	Grade 3	Grade 2		Grade 1	
		Silicon	Amorphous	Silicon	Amorphous
Liquid-filled	S11	S13	S15	-No-load loss is equivalent to S13 -Loading loss is 20% lower than that of S13	-No-load loss is equivalent to S15 -Loading loss is 10% lower than S15
Dry-type	SC10	SC12	SCH 15	-No-load loss is 10% lower than SC 12 -Loading loss is 10% lower than SC12	-No-load loss is equivalent to SCH15 -Loading loss is 5% lower than SCH15

The standards have been regularly updated since 1999 with the Standard S7 and then S9. S9 has since been replaced by the current standard, S11 (Grade 3 above), which defines maximum levels for no-load and load losses. S11 will soon be replaced by S13, which will specify lower maximum loss levels (i.e., more energy-efficient).

The following tables present the Chinese requirements (in maximum losses) for liquid-filled and dry-type distribution transformers. The liquid-filled table provides one set of values for coil losses (i.e., load loss) measured at 100% of rated capacity and three different sets of values for core losses (i.e., no load loss).

Table 13 presents the standards for three-phase liquid-filled distribution transformers built with conventional silicon steel (cold-rolled, grain oriented - CRGO).

Table 13 - Maximum Core and Coil Losses for 3-Phase Liquid-Filled Transformers using Silicon Core Steel (CRGO) – China, GB 20052-2013

kVA	Grade 3, CRGO		Grade 2, CRGO		Grade 1, CRGO	
	Max No Load Loss (W)	Max Load Loss (W)	Max No Load Loss (W)	Max Load Loss (W)	Max No Load Loss (W)	Max Load Loss (W)
30	100	600	80	600	80	480
50	130	870	100	870	100	695
63	150	1,040	110	1,040	110	830
80	180	1,250	130	1,250	130	1,000
100	200	1,500	150	1,500	150	1,200
125	240	1,800	170	1,800	170	1,440
160	280	2,200	200	2,200	200	1,760
200	340	2,600	240	2,600	240	2,080
250	400	3,050	290	3,050	290	2,440
315	480	3,650	340	3,650	340	2,920
400	570	4,300	410	4,300	410	3,440
500	680	5,150	480	5,150	480	4,120
630	810	6,200	570	6,200	570	4,960
800	980	7,500	700	7,500	700	6,000
1,000	1,150	10,300	830	10,300	830	8,240
1,250	1,360	12,000	970	12,000	970	9,600
1,600	1,640	14,500	1,170	14,500	1,170	11,600

Table 14 presents the standards for three-phase liquid-filled distribution transformers built with amorphous material in the transformer core.

Table 14 -Maximum Losses for 3-Phase Liquid-Filled Distribution Transformers using Amorphous material - China, GB 20052-2013

kVA	Grade 2, Amorphous Core		Grade 1, Amorphous Core	
	Max No Load Loss (W)	Max Load Loss (W)	Max No Load Loss (W)	Max Load Loss (W)
30	33	600	33	540
50	43	870	43	785
63	50	1,040	50	935
80	60	1,250	60	1,125
100	75	1,500	75	1,350
125	85	1,800	85	1,620
160	100	2,200	100	1,980
200	120	2,600	120	2,340
250	140	3,050	140	2,745
315	170	3,650	170	3,285
400	200	4,300	200	3,870
500	240	5,150	240	4,635
630	320	6,200	320	5,580
800	380	7,500	380	6,750
1,000	450	10,300	450	9,270
1,250	530	12,000	530	10,800
1,600	630	14,500	630	13,050

Similarly, for dry-type three-phase distribution transformers, the Chinese standard has three different levels of maximum no-load (i.e., core) losses - Grade 3 to Grade 1, with the latter being the lowest or most efficient. However, the standard also maintains a classification of load (i.e., winding) losses that vary with the designed temperature rise of the windings. For example, class B windings are the most efficient with a 100°C temperature rise and class H are the least efficient with a 145°C temperature rise. For ease of presentation in this report, the temperature rise "F" losses are presented in the following tables, which represent a 120°C temperature rise.