UN environment

SUPPLEMENT TO THE TRANSFORMERS POLICY GUIDE:
«ACCELERATING THE GLOBAL ADOPTION OF ENERGY-EFFICIENT TRANSFORMERS»

MODEL REGULATION GUIDELINES

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ENERGY PERFORMANCE REQUIREMENTS FOR DISTRIBUTION TRANSFORMERS

U4E United for Efficiency

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UN Environment – Global Environment Facility | United for Efficiency (U4E)

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Foreword

The model regulation is a supplement to the UN Environment United for Efficiency (U4E) Transformers Policy Guide "Accelerating the Global Adoption of Energy-Efficient Transformers."[1] It is intended for use by regulatory authorities in developing and emerging economies[2] with 50 – 60 Hz power systems that are considering a legislative framework[3] to promote energy-efficient transformers, or those that have a legislative framework but have not yet developed regulations for energy-efficient transformers.

The model regulation includes means to regulate a transition from inefficient distribution power transformers in the 5 - 3150 kVA range to the international best practice energy performance level. This model regulation does not cover transformers outside the mentioned range or transformers designed for special applications. In the future, U4E intends to develop and publish similar guidance on model regulation documents to cover some of these. It includes all the key elements that are needed: definitions, scope, performance requirements, information requirements, applicable test methods and compliance criteria.

The installed global stock of transformers is expected to increase by a compounded annual growth rate of 3.7%, more than a doubling the number of transformers between 2015 and 2040. Africa has the highest projected annual growth rate over this period of 4.9%, with the installed stock in Africa more than tripling. Using more efficient transformers can save nearly 5% of global electricity consumption. By 2040, annual electricity savings of over 750 TWh are possible (equivalent to the annual electricity generated by over 100 coal-fired power plants with a capacity of 1,000 MW), saving more than 450 million tonnes of greenhouse gas (GHG) emissions.

Using this model regulation, countries that do not have a significant domestic distribution power transformer manufacturing industry and import almost all of them, can choose to leapfrog to a Level 2 high energy performance option, the international best practice. Other countries that do have a significant domestic distribution power transformer manufacturing industry can choose a graduated transition via a Level 1 basic energy performance option, in order to provide it with additional time for technology upgradIng.

This model regulation is a supplement to the Transformers Policy Guide[1] which is one of a series of United for Efficiency reports along with lighting, room air conditioners, residential

[1] Please visit the "United for Efficiency Policy Guide on Energy-Efficient Transformers" for more information. (https://united4efficiency.org/resources/accelerating-global-adoption-energy-efficient-transformers/)

[2] This model regulation is not intended for governments that already have effective regulations and policy processes for energy-efficient transfomers in their country or region.

[3] An effective legislation framework consists of regulatory requirements which can be verified and enforced. In this sense, it's recommended that the regulation include a collection of requirements which are based primarily on testing protocols and requirements set by the International Electrotechnical Commission (IEC) or their national mirror standards.

refrigerators, and electric motors. As is described further in the Transformers Policy Guide, United for Efficiency encourages countries to implement an integrated policy approach, which includes the following components:

- Standards and regulations;
- Supporting policies (e.g. communication, information and education campaigns);
- Finance and financial delivery mechanisms;
- Monitoring, verification, and enforcement; and
- Environmentally sound management.

Please visit http://united4efficiency.org/ for more information about United for Efficiency.

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Disclaimer

Subject Matter and Structure

This model regulation addresses the following for distribution power transformers in the 5 - 3150 kVA rated power range; voltage Um up to 36 kV at 50 and/or 60 Hz; and continuous duty operation:

- energy performance requirements;
- product information reporting and labelling requirements;
- demonstrating compliance with the requirements; and
- market surveillance and enforcement of the requirements.

This model regulation does not cover requirements on mechanical construction, functional performance, safety, hazardous substances or warranty, since these requirements are not primarily related to energy performance and are typically covered by relevant International Electrotechnical Commission (IEC) standards and their corresponding mirror national standards, or parallel regulations on these same products. When developing these requirements, countries should investigate and confirm that these other requirements are covered in parallel regulations; if not they could be considered for inclusion in this regulation.

The model regulation includes two options, to facilitate use by governments when initiating their national consultative policy-making processes. Countries would choose either:

- Level 1 basic energy performance option: offering a draft policy framework to other countries that do have a significant domestic distribution power transformer manufacturing industry and opt for a graduated transition to the high energy-performance option, in order to provide industry with additional time for technology updating.
- Level 2 high energy performance option: offering a draft policy framework designed to leapfrog directly to high energy-performance, which is the international best practice policy. This is suitable for countries that do not have a significant domestic distribution power transformer manufacturing industry and import almost all of them.

The U4E programme encourages countries to use the Level 2 Option because it offers greater energy savings potential and the availability of worldwide standardised products.

This model regulation provides two technical standard rating alternatives according with IEC (Alternative A) and IEEE (Alternative B) practices. In accordance with the relevant regional practices applicable the corresponding alternative parts are to be selected or deleted.

The policy guidance presented in this document is meant to be a starting point for policy-makers in developing and emerging economies, to encourage regional harmonisation where possible, lowering costs and removing barriers to trade. The work presented in this supplement represents the best available information at the time of publication, however the authors recognise that the IEC standards that underpin the metrics and requirements set out in this report are evolving, thus countries are encouraged to investigate current requirements and standards at the time of adoption.

Mutual recognition among countries within a region is encouraged.

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Acronyms

CAR	Conformity Assessment Report
ICA	International Copper Association
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
GHG	greenhouse gas emissions
Hz	hertz
kVA	kilovolt-ampere
MV	Medium Voltage
MW	megawatt
PCB	Polychlorinated biphenyls
UN	United Nations
UNEP	United Nations Environment Programme
UNDP	United Nations Development Programme
U4E	United for Efficiency

Article 1. Scope of Covered Products

1.1 Scope

This regulation applies to all distribution power transformers that are manufactured in, or imported into the country/region, and are either sold, installed or put into service as standalone equipment or as a component of a system, and which meet the following criteria:

The distribution power transformers

- have 2 windings and
- have a rated power equal to or higher than 5 kVA but equal to or lower than 3150 kVA and
- have a highest voltage for equipment higher than 1,1 kV, but not exceeding 36 kV and
- are used or to be used in electricity networks or for industrial applications

Distribution power transformers regardless of when they were first placed on the market or put into service, shall be reassessed for conformity and comply with this Regulation if they are subject to replacement operations both of the core (or part thereof) and one (or more) of the complete windings.

1.2 Exclusions

This regulation does not apply to

- instrument transformers, specifically designed to transmit an information signal to measuring instruments, meters, relays and other similar apparatus, or
- transformers with low-voltage windings specifically designed for use with rectifiers to provide a DC supply, or
- transformers specifically designed to be directly connected to a furnace, or
- transformers specifically designed for offshore applications and floating offshore applications, or
- transformers specially designed for emergency installations, or
- transformers and auto-transformers specifically designed for railway feeding systems, or
- earthing or grounding transformers, this is, three-phase transformers intended to provide a neutral point for system grounding purposes, or
- traction transformers mounted on rolling stock, this is, transformers connected to an AC or DC contact line, directly or through a converter, used in fixed installations of railway applications, or
- starting transformers, specifically designed for starting three-phase induction motors so as to eliminate supply voltage dips, or

- testing transformers, specifically designed to be used in a circuit to produce a specific voltage or current for the purpose of testing electrical equipment, or
- welding transformers, specifically designed for use in arc welding equipment or resistance welding equipment, or
- transformers specifically designed for explosion-proof and underground mining applications, or
- transformers specifically designed for deep water (submerged) applications, or
- Medium Voltage (MV) to Medium Voltage (MV) interface transformers up to 5 MVA.

Article 2. Terms and Definitions

(a) 'Electric energy converter' means a device for changing one or more characteristics associated with electric energy.

(b) 'Transformer' means an electric energy converter without moving parts that changes voltages and currents associated with electric energy without change of frequency.

(c) 'Power transformer' means a transformer with the purpose of transmitting electrical power which converts a system of alternating voltage and current into another system of alternating voltage and current at the same frequency.

(d) 'Liquid-immersed transformer' means a power transformer in which the active parts are immersed in liquid.

(e) 'Dry-type transformer' means a power transformer in which the active parts are not immersed in an insulating liquid.

(f) 'Fire standard transformer' means a power transformer in which no special measures are taken to limit flammability.

(g) 'Fire safer transformer' means a power transformer in which flammability is restricted and the emission of toxic substances and opaque smoke is minimised.

(h) 'Winding' refers to the assembly forming an electrical circuit associated with one of the voltages assigned to the transformer.

(i) 'Rated voltage of a winding' (Ur) is the voltage assigned to be applied, or developed at no-load, between the terminals of an untapped winding, or of a tapped winding connected on the principal tapping.

(j) 'High-voltage winding' refers to the winding having the highest rated voltage.

(k) 'Highest voltage for equipment' (Um) applicable to a transformer winding is the highest r.m.s phase-to-phase voltage in a three-phase system for which a transformer winding is designed in respect of its insulation.

(l) 'Load loss' (Pk) means the absorbed active power at rated frequency and reference temperature associated with a pair of windings when the rated current (tapping current) is flowing through the line terminal(s) of one of the windings and the terminals of the other windings are in short-circuit with any winding fitted with tappings connected to its principal tapping, while further windings, if existing, are open-circuited.

(m) 'No load loss' (Po) means the active power absorbed at rated frequency when the transformer is energised and the secondary circuit is open. The applied voltage is the rated voltage, and if the energized winding is fitted with a tapping, it is connected to its principal tapping.

(n) 'IEC Standard' means an international standard that is published by the International Electrotechnical Commission denoted by the letters "IEC" and identifying number and/or letters.

(o) 'SI unit' means any of the units adopted for international use under the Système International d'Unités.

(p) 'instrument transformer' means any transformer as defined in subclause 3.1.1 of IEC 61869-1:2007, even if it supplies energy for the operation of connected equipment.

(q) 'transformer with low-voltage windings specifically designed for use with rectifiers to provide a DC supply' means any transformer specifically designed and intended to supply power electronic or rectifier loads specified according to IEC 61378-1.

Note 1: The term "low-voltage winding" refers to the winding having the lowest rated voltage as per IEC 60076-1, whatever its voltage level.
Note 2: This definition does not include:
- transformers which are intended to provide AC from DC sources such as transformers for wind turbine and photo voltaic applications;
- transformers designed for DC transmission and distribution applications.

(r) 'transformers specifically designed for offshore applications and floating offshore applications' means any transformer to be installed on fixed or floating offshore platforms, offshore wind turbines or on board of ships and all kind of vessels.

(s) 'transformers specially designed for emergency installations' means any transformer designed only to provide cover for a specific time limited situation when the normal power supply is interrupted either due to an unplanned occurrence such as failure or a station refurbishment, but not to permanently upgrade an existing substation.

Note: Such transformer could have some specific features that make it suitable for emergency or temporary use as opposed to normal use. Examples of some specific features include:

- multiple windings making it suitable for use at several locations;
- special low weight or dimensions for easy transport, or special capability to be disassembled into smaller units for transport;
- increased overload capability achieved by the use of special materials;
- permanent mounting on a transporter arrangement.

(t) 'transformers and auto-transformers specifically designed for railway feeding systems' means any transformer as defined in EN 50329.

(u) 'earthing or grounding transformers, this is, three-phase transformers intended to provide a neutral point for system grounding purposes' means any transformer as defined in subclause 3.1.10 of IEC 60076-6:2007.

(v) 'traction transformer' means any transformer installed on board of rolling stock inserted in the traction and auxiliary circuits of rolling stock and in the scope of IEC 60310.

(w) 'starting transformers, specifically designed for starting three-phase induction motors so as to eliminate supply voltage dips' means any transformer that is de energized during normal operation, used for the purpose of starting a rotating machine.

(x) 'Medium Voltage (MV) to Medium Voltage (MV) interface transformers' means any transformer used in network voltage conversion program and placed at the junction between two voltage levels of two MV networks and which needs to be able to cope with emergency overloads.

(y) 'Rated power Sr' is a conventional value of apparent power assigned to a winding which, together with the rated voltage of the winding, determines its rated current according with IEC 60076-1 on which P_k is based.

(z) 'Rated power Su' is the rated power of the transformer or autotransformer as defined in IEEE C57.12.80 on which Pk is based.
Note: IEEE C57.12.80 is based on liquid immersed winding temperature of 55°C and dry-type winding temperature of 75°C.

Article 3. Requirements

All distribution power transformers in the scope of this regulation as defined in Article 1, that are manufactured in, undergo repair (as defined in the scope) in or are imported into the country/region, shall meet the minimum energy performance requirements of Article 3.1, the PCB requirements of Article 3.2, the product and technical information requirements of Articles 3.3 and 3.4, and the certification and registration requirements of Article 3.5. The related reference test standards, compliance certification and surveillance testing requirements are as listed in Article 3.6.

3.1 Energy Performance Requirements

Transformers in the scope of this regulation shall comply with the maximum allowed load and no-load losses values set out in the following tables.

If not otherwise specified, three phase or single phase power transformers shall be evaluated against the rated power of the individual unit.

Maximum allowable losses rated powers that fall in between the given values shall be obtained by linear interpolation.

ALTERNATIVE ENERGY PERFORMANCE REQUIREMENTS TO BE SELECTED IN ACCORDANCE WITH REGIONAL PRACTICES (IEC or IEEE)

BEGINNING OF ALTERNATIVE A – Power rating according with IEC 60076-1

Table 1: Fire standard distribution power transformers – Maximum load losses (LL) and no-load losses (NL)

Single or three phase, 50 or 60 Hz 2 windings, MV Um≤24kV, LV Um ≤1.1kV, OLTC range ≤ 5%						
Rated Power IEC 60076-1	**Level 1**			**Level 2**		
	LL	**NL**	**EIA50**	**LL**	**NL**	**EIA50**
kVA	**W**	**W**	**%**	**W**	**W**	**%**
≤25	900	70	97,640	600	63	98,296
50	1100	90	98,540	750	81	98,926
100	1750	145	98,835	1250	130	99,115
160	2350	210	99,003	1750	189	99,217
250	3250	300	99,110	2350	270	99,314
315	3900	360	99,152	2800	324	99,350
400	4600	430	99,210	3250	387	99,400
500	5500	510	99,246	3900	459	99,426
630	6500	600	99,294	4600	540	99,463
800	8400	650	99,313	6000	585	99,479
1000	10500	770	99,321	7600	693	99,481
1250	11000	950	99,408	9500	855	99,483
1600	14000	1200	99,413	12000	1080	99,490
2000	18000	1450	99,405	15000	1305	99,495
2500	22000	1750	99,420	18500	1575	99,504
3150	27500	2200	99,424	23000	1980	99,509

Table 2 – Fire safer distribution power transformers – Maximum load losses (LL) and no-load losses (NL)

Single or three phase, 50 or 60 Hz 2 windings, MV Um≤24kV, LV Um ≤1.1kV, OLTC range ≤ 5%						
Rated Power IEC 60076-1	**Level 1**			**Level 2**		
	LL	**NL**	**EIA50**	**LL**	**NL**	**EIA50**
kVA	**W**	**W**	**p.u.**	**W**	**W**	**p.u.**
≤ 50	1700	200	97,500	1500	180	97,780
100	2050	280	98,415	1800	252	98,596
160	2900	400	98,594	2600	360	98,738
250	3800	520	98,824	3400	468	98,946
400	5500	750	98,938	4500	675	99,100
630	7600	1100	99,048	7100	990	99,122
800	8000	1300	99,175	8000	1170	99,208
1000	9000	1550	99,240	9000	1395	99,271
1250	11000	1800	99,272	11000	1620	99,301
1600	13000	2200	99,319	13000	1980	99,346
2000	16000	2600	99,340	16000	2340	99,366
2500	19000	3100	99,372	19000	2790	99,397
3150	22000	3800	99,410	22000	3420	99,434

The losses given in Table 1 and 2 above can be weighted by the correction factors given in Table 3 below, in order to take account of variations related to the highest voltage for equipment values.

The level of losses given in Table 1 and 2 above shall be weighted by the correction factors given in Table 4 below, in order to take account of variations related to dual voltage windings.

For power transformers having dual voltage on both windings for which both voltages on one winding are fully rated in combination with one of the voltages on the other winding, the levels of losses shall be based on the highest power and the values indicated in Table 1 and 2 above can be increased by 15 % for no load losses and by 10 % for load losses. The level of losses shall refer to the highest voltages of both windings. This remains valid even if further voltage combinations are available.

For a power transformer having an insulation level according to Table 3 below and having dual voltage according to Table 4 below the loss level shall take into account both corrections.

Table 3 — Correction of load loss and no load loss applicable to other insulation levels

Ref	Highest voltage for equipment values	Correction of load loss and no load loss
1	One winding with 1,1 kV < U_m ≤ 24 kV and the other with 1,1 kV < U_m ≤ 24 kV	The maximum losses indicated in Table 1 and 2 can be increased by 10 % for no load loss and by 10 % for load loss.
2	One winding with 24 kV < U_m ≤ 36 kV and the other with U_m ≤ 1,1 kV	The maximum losses indicated in Table 1 and 2 can be increased by 15 % for no load loss and by 10 % for load loss and short circuit impedance unless otherwise specified should be increased by adding a value of 0,5 %.
3	One winding with 24 kV < U_m ≤ 36 kV and the other with U_m > 1,1 kV	The maximum levels of losses indicated in Table 1 and 2 can be increased by 20 % for no load loss and by 15 % for load loss and short circuit impedance unless otherwise specified should be increased by adding a value of 0,5 %.

Table 4 — Correction of load loss and no load loss applicable to dual voltage

Ref	Dual voltage	Correction of load loss and no load loss
A	One winding	In the case of power transformers with one high-voltage winding and two voltages available from tapped low-voltage winding, losses shall be calculated based on the higher low-voltage and shall comply with the levels indicated in Table 1 and 2. The maximum available power on the lower low-voltage on such power transformers shall be no more than 0,85 times its rated power. In the case of power transformers with one high-voltage winding with two voltages available from a tap, the maximum available power on the lower high-voltage on such power transformer shall be limited to 0,85 of its nominal rated power. In the case where the full rated power is available regardless of the combination of voltages, the levels of losses indicated in Table 1 and 2 can be increased by 15 % for no load loss and by 10 % for load loss. Such levels of losses shall refer to the highest voltage.
B	Both windings	The maximum allowable losses indicated in Table 1 and 2 can be increased by 20 % for no load losses and by 20 % for load losses for power transformers with dual voltage on both windings if the rated power is the same regardless of the combination of voltages. The level of losses shall refer to the highest voltages of both windings. This remains valid even if further voltage combinations are available.

END OF ALTERNATIVE A – Power rating according with IEC 60076-1

BEGINNING OF ALTERNATIVE B – Power rating according with IEEE C57.12.80

Table 5: Fire standard distribution power transformers – Maximum load losses (LL) and no-load losses (NL)

Single or three phase, 50 Hz 2 windings						
Rated Power IEEE C57.12.80	**Level 1**			**Level 2**		
	LL	**NL**	**EIB50**	**LL**	**NL**	**EIB50**
kVA	**W**	**W**	**%**	**W**	**W**	**%**
≤25	563	140	97,849	411	102	98,429
50	703	175	98,657	521	130	99,004
100	1125	281	98,925	860	215	99,178
160	1544	386	99,078	1221	305	99,271
250	2159	539	99,175	1675	418	99,36
315	2592	648	99,214	1998	499	99,394
400	3070	767	99,267	2345	586	99,44
500	3664	916	99,3	2806	701	99,464
630	4327	1081	99,344	3305	826	99,499
800	5327	1331	99,364	4062	1015	99,515
1000	6575	1643	99,372	5047	1261	99,518
1250	7185	1796	99,451	6282	1570	99,52
1600	9130	2282	99,455	7941	1985	99,526
2000	11539	2884	99,449	9842	2460	99,53
2500	14057	3514	99,463	12068	3017	99,539
3150	17613	4403	99,466	15040	3760	99,544

Single phase 60 Hz 2 windings						
Rated Power IEEE C57.12.80	**Level 1**			**Level 2**		
	LL	**NL**	**EIB50**	**LL**	**NL**	**EIB50**
kVA	**W**	**W**	**%**	**W**	**W**	**%**
≤10	137	34	98,62	130	32	98,7
15	185	46	98,76	177	44	98,82
25	272	68	98,91	262	65	98,95
37,5	371	92	99,01	356	89	99,05
50	459	115	99,08	445	111	99,11
75	622	155	99,17	607	151	99,19
100	769	192	99,23	749	187	99,25
167	1252	313	99,25	1118	279	99,33
250	1700	425	99,32	1525	381	99,39
333	2131	532	99,36	1898	474	99,43
500	2900	725	99,42	2550	637	99,49
667	3601	900	99,46	3201	800	99,52
833	4248	1062	99,49	3748	937	99,55

Three phase 60 Hz 2 windings						
Rated Power IEEE C57.12.80	**Level 1**			**Level 2**		
	NL	**LL**	**EIB50**	**NL**	**LL**	**EIB50**
kVA	**W**	**W**	**%**	**W**	**W**	**%**
≤15	246	61	98,36	202	50	98,65
30	413	103	98,62	351	87	98,83
45	557	139	98,76	486	121	98,92
75	817	204	98,91	727	181	99,03
112,5	1113	278	99,01	1001	250	99,11
150	1380	344	99,08	1260	315	99,16
225	1867	466	99,17	1732	433	99,23
300	2309	577	99,23	2190	547	99,27
500	3749	937	99,25	3250	812	99,35
750	5100	1275	99,32	4499	1124	99,4
1000	6399	1599	99,36	5699	1424	99,43
1500	8700	2175	99,42	7799	1949	99,48
2000	10800	2700	99,46	9799	2449	99,51
2500	12750	3187	99,49	11750	2937	99,53

Table 6: Fire safer power transformers – Maximum load losses (LL) and no-load losses (NL)

Single phase orThree phase 50 Hz 2 windings						
Rated Power	**Level 1**			**Level 2**		
IEEE C57.12.80	**LL**	**NL**	**EIB50**	**LL**	**NL**	**EIB50**
kVA	**W**	**W**	**%**	**W**	**W**	**%**
≤50	1200	300	97,707	1069	267	97,958
100	1540	385	98,529	1367	341	98,694
160	2189	547	98,693	1968	492	98,825
250	2866	716	98,905	2573	643	99,017
400	4150	1037	99,009	3526	881	99,158
630	5871	1467	99,11	5409	1352	99,18
800	6483	1620	99,226	6215	1553	99,258
1000	7476	1869	99,286	7162	1790	99,316
1250	8952	2238	99,316	8573	2143	99,345
1600	10739	2684	99,359	10270	2567	99,387
2000	12984	3246	99,38	12439	3109	99,406

Single phase 60 Hz **2 windings**																		
EP Level	**Level 1**									**Level 2**								
LI	**<60kV**			**≥60kV ≤95kV**			**>95kV**			**<60kV**			**≥60kV ≤95kV**			**>95kV**		
Rated Power IEEE C57.12.80	**LL**	**NL**	**EIB50**	**LL**	**NL**	**EIB50**	**LL**	**NL**	**EIB50**	**LL**	**NL**	**EIB50**	**LL**	**NL**	**EIB50**	**LL**	**NL**	**EIB50**
kVA	**W**	**W**	**%**	**W**	**W**	**%**	**W**	**W**	**%**	**W**	**W**	**%**	**W**	**W**	**%**	**W**	**W**	**%**
≤15	285	71	98,1	321	80	97,86				285	71	98,1	321	80	97,86			
25	417	104	98,33	469	117	98,12				417	104	98,33	469	117	98,12			
37,5	566	141	98,49	637	159	98,3				566	141	98,49	637	159	98,3			
50	700	175	98,6	790	197	98,42				700	175	98,6	790	197	98,42			
75	952	238	98,73	1072	268	98,57	1102	275	98,53	952	238	98,73	1072	268	98,57	1102	275	98,53
100	1180	295	98,82	1330	332	98,67	1370	342	98,63	1180	295	98,82	1330	332	98,67	1370	342	98,63
167	1736	434	98,96	1953	488	98,83	2004	501	98,8	1736	434	98,96	1953	488	98,83	2004	501	98,8
250	2325	581	99,07	2624	656	98,95	2725	681	98,91	2325	581	99,07	2624	656	98,95	2725	681	98,91
333	2863	715	99,14	3230	807	99,03	3363	840	98,99	2863	715	99,14	3230	807	99,03	3363	840	98,99
500	3900	975	99,22	4399	1099	99,12	4550	1137	99,09	3900	975	99,22	4399	1099	99,12	4550	1137	99,09
667	4869	1217	99,27	5469	1367	99,18	5669	1417	99,15	4869	1217	99,27	5469	1367	99,18	5669	1417	99,15
833	5747	1436	99,31	6414	1603	99,23	6664	1666	99,2	5747	1436	99,31	6414	1603	99,23	6664	1666	99,2

Three phase 60 Hz 2 windings																		
EP Level	**Level 1**									**Level 2**								
LI	**<60kV**			**≥60kV ≤95kV**			**>95kV**			**<60kV**			**≥60kV ≤95kV**			**>95kV**		
Rated Power IEEE C57.12.80	**LL**	**NL**	**EIB50**	**LL**	**NL**	**EIB50**	**LL**	**NL**	**EIB50**	**LL**	**NL**	**EIB50**	**LL**	**NL**	**EIB50**	**LL**	**NL**	**EIB50**
kVA	**W**	**W**	**%**	**W**	**W**	**%**	**W**	**W**	**%**	**W**	**W**	**%**	**W**	**W**	**%**	**W**	**W**	**%**
≤15	375	93	97,5	422	105	97,18				375	93	97,5	422	105	97,18			
30	629	157	97,9	711	177	97,63				629	157	97,9	711	177	97,63			
45	855	213	98,1	962	240	97,86				855	213	98,1	962	240	97,86			
75	1252	313	98,33	1409	352	98,12				1252	313	98,33	1402	350	98,13			
112,5	1698	424	98,49	1912	478	98,3				1665	416	98,52	1845	461	98,36			
150	2100	525	98,6	2370	592	98,42				2024	506	98,65	2234	558	98,51			
225	2857	714	98,73	3217	804	98,57	3307	826	98,53	2655	663	98,82	2947	736	98,69	3217	804	98,57
300	3540	885	98,82	3989	997	98,67	4110	1027	98,63	3209	802	98,93	3570	892	98,81	3930	982	98,69
500	5200	1300	98,96	5850	1462	98,83	6000	1500	98,8	4550	1137	99,09	5050	1262	98,99	5550	1387	98,89
750	6975	1743	99,07	7874	1968	98,95	8175	2043	98,91	5925	1481	99,21	6599	1649	99,12	7350	1837	99,02
1000	8599	2149	99,14	9700	2425	99,03	10100	2525	98,99	7199	1800	99,28	8000	2000	99,2	8900	2225	99,11
1500	11700	2925	99,22	13199	3299	99,12	13650	3412	99,09	9449	2362	99,37	10500	2625	99,3	11850	2962	99,21
2000	14600	3650	99,27	16400	4099	99,18	16999	4249	99,15	11399	2849	99,43	12799	3199	99,36	14400	3599	99,28
2500	17250	4312	99,31	19249	4812	99,23	20000	5000	99,2	13249	3312	99,47	14750	3687	99,41	16750	4187	99,33

END OF ALTERNATIVE B – Power rating according with IEEE C57.12.80

3.2 PCB Contamination Requirements

Transformers within the scope of this regulation shall comply with the Stockholm Convention on Persistant Organic Pollutants and shall not contain PCB (Polychlorinated biphenyls) fluids or other hazardous materials as defined in the relevant international, regional and national regulations.

3.3 Product Information Requirements

The following product information requirements for power transformers included within the scope of this regulation shall be included in any related product documentation, including free access websites of manufacturers:

(a) information on rated power
(b) load loss and no-load loss
(c) the electrical power of any cooling system required
(d) information on the weight of all the main components of a power transformer (including at least the conductor, the nature of the conductor and the core material)
(e) manufacturer/repairer name
(f) year of manufacturing/reparing
(g) serial number

The above mentioned information shall also be durably marked on or near the rating plate of the power transformer.

3.4 Technical Documentation Requirements

The following information shall be included in the technical documentation of power transformers:

(a) manufacturer's/repairer's name and address
(b) model identifier, the alphanumeric code to distinguish one model from other models of the same manufacturer
(c) the information required under Article 3.3 above.

3.5 Compliance Certification and Registration Requirements

The transformer's energy performance must be tested in accordance with the requirements set by IEC 60076-1.

The transformer's fire performance must be tested in accordance with the requirements set by a suitable recognized test standard. For dry-type trasformers for example IEC 60076-11.

TEST CERTIFICATES
Test certificates from the following laboratories are accepted:
1) Manufacturers' in-house test laboratories;
2) Third party test laboratories

that have been accredited by their respective national accreditation bodies or by an International accreditation body for a measurement expanded uncertainty, as defined in EN 60076-19 and referring to a coverage factor k = 2 (i.e. to a confidence level of about 95 % assuming a normal distribution), not exceeding 5 %.

REGISTRATION

Importers and manufacturers/repairers of transformers covered by this regulation must register themselves with the designated authority, following the prescribed procedure, accompanied by the required documents and information and the applicable fees.

Transformer designs covered by this regulation must be registered with the designated authority through the submission of the full product and technical information as required under Articles 3.3 and 3.4, together with the test certificates as required by the Test Certificates clause above.

[Optional clause: Transformer designs that are already registered with other countries that are members of a recognised official "Regional Energy Efficiency Certificate Mutual Recognition Agreement"[4] or equivalent may be registered by providing the registration certificate of the respective country.]

3.6 Referenced Test Standards, Compliance Certification and Surveillance Testing

The metrics, referenced standards, compliance certification, and surveillance testing criteria are set out in this section.

Main Reference

- IEC 60076-1 ed3.0 (2011-04) Power transformers - Part 1: General

Table 7: Supplementary References

Standard	Title
IEC 60076-2 ed3.0 (2011-02)	Power transformers - Part 2: Temperature rise for liquid-immersed transformers
IEC 60076-3 ed3.0 (2013-07)	Power transformers - Part 3: Insulation levels, dielectric tests and external clearances in air
IEC 60076-4 ed1.0 (2002-06)	Power transformers - Part 4: Guide to the lightning impulse and switching impulse testing- Power transformers and reactors
IEC 60076-5 ed3.0 (2006-02)	Power transformers - Part 5: Ability to withstand short circuit
IEC 60076-6 (2007)	Power transformers - Part 6: Reactors
IEC 60076-7 ed1.0 (2005-12)	Power transformers - Part 7: Loading guide for oil-immersed power transformers
IEC 60076-8 ed1.0 (1997-10)	Power transformers - Part 8: Application guide

[4] It is suggested that countries should enter into such an agreement with neighbouring countries within the region for multiple equipment and appliances, including motors. Please refer to the U4E Guidance Notes on Registration.

Standard	Title
IEC 60076-10 ed1.0 (2001-05)	Power transformers - Part 10: Determination of sound levels
IEC 60076-10-1 ed1.0 (2005-10)	Power transformers - Part 10-1: Determination of sound levels - Application guide
IEC 60076-11 ed2.0 (2018-11)	Power transformers - Part 11: Dry-type transformers
IEC 60076-13 ed1.0 (2006-05)	Power transformers - Part 13: Self-protected liquid-filled transformers
IEC 60076-14 (2013-09)	Power transformers - Part 14: Design and application of liquid-immersed power transformers using high-temperature insulation materials
IEC/TS 60076-19 ed1.0 (2013-03)	Power transformers - Part 19: Rules for the determination of uncertainties in the measurement of losses in power transformers and reactors
IEC/TS 60076-20 ed1.0	Power transformers - Energy efficiency
IEC 60137 (2008)	Insulated bushings for alternating voltages above 1000 V
IEC 60296 (2003)	Fluids for electro technical applications – Unused mineral insulating oils for transformers and switchgear
EN 50329	Railway applications – Fixed installations – Traction transformers
IEC 61378-1	Converter transformers - Part 1: Transformers for industrial applications
IEC 61869-1:2007	Instrument transformers - Part 1: General requirements
IEEE C57.12.80-2010	IEEE Standard Terminology for Power and Distribution Transformers

Article 4. Entry into Force

The energy performance requirements set out in Article 3 shall take effect as follows:

- Level 1 from 1 January 2020
- Level 2 from 1 January 2025

All other requirements set out in Article 3 shall take effect from 1 January 2020.

Article 5. Declaration of Conformity

Compliance with the requirements of this regulation shall be demonstrated in accordance with the provisions of Article 3. Suppliers (i.e. importers and manufacturers/repairers) shall provide the information and technical documentation necessary for the market surveillance authority to assess conformity and verify compliance and any additional optional claims. This information and technical documentation can be provided by the supplier as a Conformity Assessment Report (CAR) and/or entered into the relevant product registration database or supplied in any other format as reasonably determined by the market surveillance authority. The conformity assessment information and documentation should:

(1) demonstrate that the product model fulfils the requirements of this Regulation;

(2) provide any other information required to be present in the technical documentation file;
(3) specify the reference settings and conditions in which the product complies with this Regulation.

The information shall be submitted to the designated authority by the supplier for review prior to placing the product on the market. If the CAR or application for registration for the designated model is approved, which is confirmed by written correspondence from the designated authority and/or listing of the product on the relevant product registration system, the model may be placed on the market. If a CAR or application for registration is rejected, a written explanation shall be provided to the submitter. All aspects identified in the written explanation must be addressed in any revised CAR or application for registration. Until the CAR or application for registration is approved, the product is ineligible for placement on the market. The duration of product CAR or registration validity shall be as reasonably determined by the market surveillance authority. The supplier is obliged to check and update product conformity information, including informing the market surveillance authority of pertinent information as defined by the authority related to product compliance without undue delay.

Article 6. Market Surveillance and Enforcement

In order to verify the claimed energy performance of a power transformer covered by this regulation, the designated market surveillance authority can test any one single unit to be picked at any time directly from the market or where appropriate the premises of manufacturer, at its sole discretion, according to the test method prescribed above.

For the purpose of compliance with the requirements of this Regulation, measurements shall be made using a reliable, accurate and reproducible measurement procedure, which takes into account the generally recognised state of the art measurement methods.

When performing market surveillance the designated market surveillance authority shall apply the following verification procedures for the set out requirements:

(a) The designated market surveillance authority shall test one single unit per model;
(b) The model shall be considered to comply with the applicable requirements set out by this Regulation if the values in the technical documentation comply with the requirements set out in Articles 3.2 and 3.4, and if the measured parameters meet the requirements set out in Article 3.1 within the indicated verification tolerances set by IEC 60076-1;
(c) If the results referred to in point (b) are not achieved, the model shall be considered not to comply with this Regulation. If a decision of non-compliance is taken, the market surveillance authority may inform other government authorities to take consequential enforcement actions against the manufacturer and / or importer, as

well as inform other authorities in the region of the decision being taken to help protect against the widespread sale of the same model.

Given the weight and size limitations in the transportation of power transformers, the designated authorities may decide to undertake the verification procedure at the premises of manufacturer(s), before they are put into service in their final destination. The verification tolerances set out in this Annex relate only to the verification of the measured parameters by designated authorities and shall not be used by the manufacturer or importer as an allowed tolerance to establish the values in the technical documentation.

Any person, persons or firm manufacturing, importing, storing for sale, supplying, selling, or distributing distribution power transformers in the scope of this regulation, which do not meet the specified minimum energy performance requirements after the date of entry into force of this regulation shall be liable for penal actions including, but not limited to warnings, sanctions, fines, penalties, public naming, delisting etc. as may be determined by the designated authority.

Further, the entity in possession of a distribution power transformer within the scope of this regulation, other than an end-user, that does not meet the specified requirements shall ensure that it is rendered unusable and dispose of it as scrap within three months from the date that the non-conformance is first detected.

An exception shall be allowed for new distribution power transformers which have been placed on the market (i.e. supplied by a manufacturer or importer for distribution and sale) prior to the entry into force of this regulation. Existing stocks of such transformers in the distribution chain may continue to be sold even after the entry into force of this regulation, up to a maximum period of two years or until the stocks of such transformers are exhausted, whichever is earlier.

Article 7. Revision

It is anticipated that this Regulation shall be reviewed after not more than 7 years after it's entry into force, so as to take into account technological progress and any other relevant matters. It is recommended that any subsequent review or revision to this Regulation take into consideration the following topics:

- setting more stringent energy performance requirements for distribution power transformers;
- combining this regulation with other transformer-related regulations;
- setting specific minimum requirements in the context sustainable transformers (Ecodesign).

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