EUROPEAN
COMMISSION

Brussels, XXX
D030891/02
[…](2014) XXX draft

COMMISSION REGULATION (EU) No …/..

of XXX

on implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to small, medium and large power transformers

COMMISSION REGULATION (EU) No …/..

of XXX

on implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to small, medium and large power transformers

THE EUROPEAN COMMISSION,

Having regard to the Treaty on the Functioning of the European Union,

Having regard to Directive 2009/125/EC of the European Parliament and of the Council of 21 October 2009 establishing a framework for the setting of ecodesign requirements for energy-related products ([1]) and in particular Article 15(1) thereof,

After consulting the Ecodesign Consultation Forum,

Whereas:

(1) The Commission has carried out a preparatory study that analysed the environmental and economic aspects of transformers. The study was developed together with stakeholders and interested parties from the Community and the results have been have made publicly available. Transformers are considered as energy related products within the meaning of Article 2 (1) of Directive 2009/125/EC.

(2) The study showed that energy in the use phase is the most significant environmental aspect that can be addressed through product design. Significant amounts of raw materials (copper, iron, resin, aluminium) are used in the manufacturing of transformers, but market mechanisms seem to be ensuring an adequate end-of-life treatment, and therefore it is not necessary to establish related ecodesign requirements.

(3) Ecodesign requirements set out in Annex I apply to products placed on the market or put into service wherever they are installed. Therefore such requirements cannot be made dependant on the application in which the product is used.

(4) Transformers are usually purchased under framework agreements. In this context, purchase refers to the act of contracting with the manufacturer for the delivery of a given volume of transformers. The contract is deemed to have come into force on the date of signature by the parties.

(5) Certain categories of transformers should not be covered by this Regulation, due to their specific function,. The energy consumption and saving potential of such transformers is negligible compared to other transformers.

(6) Regulatory concessions are granted because of the weight limitations for mounting transformers on utility poles. In order to avoid misuse of transformers specifically manufactured for pole-mounted operation, they should include a visible display “For pole-mounted operation only”, so as to facilitate the work of national market surveillance authorities.

(7) Regulatory concessions are granted to transformers equipped with equipment capable of performing voltage regulation functions to integrate distributed generation from

[1] OJ L 285 31.10.2009 p.10

renewable sources into the distribution grid. Such concessions should gradually be phased out as this emerging technology matures and measurement standards become available to separate the losses associated to the core transformer from those associated to the equipment performing additional functions.

(8) Ecodesign requirements for the energy performance/efficiency of medium power transformers and for the energy efficiency of large power transformers should be set with a view to harmonising ecodesign requirements for these devices throughout the Community. Such requirements would also contribute to the efficient functioning of the internal market and to improving Member States' environmental performance.

(9) Establishment of ecodesign requirements for medium and large power transformers is also necessary to increase the market penetration of technologies and design options improving their energy performance or efficiency. Total losses of the transformers fleet in the EU27 in 2008 amounted to 93.4 TWh per year. The cost-effective improvement potential through more efficient design has been estimated in about 16.2 TWh per year in 2025, which corresponds to 3.7 Mt of C02 emissions.

(10) It is necessary to provide for a staged entry into force of the ecodesign requirements in order to provide an appropriate timeframe for manufacturers to redesign their products. Time limits for the implementation of those requirements should be set taking into account impacts on the costs for manufacturers, in particular small and medium size enterprises, while ensuring timely achievement of the policy objectives.

(11) To allow an effective implementation of the regulation, National Regulating Authorities are strongly advised to take account of the effect of minimum efficiency requirements on the initial cost of the transformer and to allow for the installation of more efficient transformers than the regulation requires, whenever these are economically justified on a whole life cycle basis, including an adequate evaluation of losses reduction.

(12) To facilitate compliance checks, manufacturers should be asked to provide information in the technical documentation referred to in Annexes IV and V to Directive 2009/125/EC.

(13) The measures provided for in this Regulation are in accordance with the opinion of the Committee established by Article 19(1) of Directive 2009/125/EC.

HAS ADOPTED THIS REGULATION:

Article 1

Subject matter and scope

1. This Regulation establishes ecodesign requirements for placing on the market or putting into service power transformers with a minimum power rating of 1 kVA used in 50Hz electricity transmission and distribution networks or for industrial applications. The Regulation is only applicable to transformers purchased after the entry into force of the Regulation.

2. This Regulation shall not apply to transformers specifically designed and used for the following applications:

- instrument transformers, specifically designed to supply measuring instruments, meters, relays and other similar apparatus;
- transformers with low-voltage windings specifically designed for use with rectifiers to provide a DC supply;

- transformers specifically designed to be directly connected to a furnace;
- transformers specifically designed for offshore applications and floating offshore applications;
- transformers specially designed for emergency installations;
- transformers and auto-transformers specifically designed for railway feeding systems;
- earthing or grounding transformers, this is, three-phase transformers intended to provide a neutral point for system grounding purposes;
- 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;
- starting transformers, specifically designed for starting three-phase induction motors so as to eliminate supply voltage dips;
- testing transformers, specifically designed to be used in a circuit to produce a specific voltage or current for the purpose of testing electrical equipment;
- welding transformers, specifically designed for use in arc welding equipment or resistance welding equipment;
- transformers specifically designed for explosion-proof and underground mining applications[2];
- transformers specifically designed for deep water (submerged) applications;
- medium Voltage (MV) to Medium Voltage (MV) interface transformers up to 5 MVA;
- large power transformers where it is demonstrated that for a particular application, technically feasible alternatives are not available to meet the minimum efficiency requirements set out by this Regulation;
- large power transformers which are like for like replacements in the same physical location/installation for existing large power transformers, where this replacement cannot be achieved without entailing disproportionate costs associated to their transportation and/or installation;

except as regards the product information requirements and technical documentation set out in Annex I, points 3 and 4.

Article 2

Definitions

For the purpose of this Regulation and its annexes the following definitions shall apply.

(1) "Power transformer" means a static piece of apparatus with two or more windings which, by electromagnetic induction, transforms a system of alternating voltage and current into another system of alternating voltage and current usually of different values and at the same frequency for the purpose of transmitting electrical power.

[2] Equipment intended for use in potentially explosive atmospheres is covered by Directive 94/9/EC of 19.04.94 (O.J. L 100/1, 19.04.94)

(2) “Small power transformer” means a power transformer with a highest voltage for equipment not exceeding 1.1 kV.

(3) “Medium power transformer” means a power transformer with a highest voltage for equipment higher than 1.1 kV, but not exceeding 36 kV and a rated power equal to or higher than 5 kVA but lower than 40 MVA.

(4) “Large power transformer” means a power transformer with a highest voltage for equipment exceeding 36 kV and a rated power equal or higher than 5 kVA, or a rated power equal to or higher than 40 MVA regardless of the highest voltage for equipment.

(5) “Liquid-immersed transformer” means a power transformer in which the magnetic circuit and windings are immersed in liquid.

(6) “Dry-type transformer” means a power transformer in which the magnetic circuit and windings are not immersed in an insulating liquid.

(7) Medium power pole mounted transformer” means a power transformer with a rated power of up to 315 KVA suitable for outdoor service and designed to be mounted on the support structures of overhead power lines.

(8) “Voltage Regulation Distribution Transformer” means a medium power transformer equipped with additional components, inside or outside of the transformer tank, to automatically control the input or output voltage of the transformer for on-load voltage regulation purposes.

(9) “Winding” refers to the assembly of turns forming an electrical circuit associated with one of the voltages assigned to the transformer.

(10) “Rated voltage of a winding” (U_r) 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.

(11) “High-voltage winding” refers to the winding having the highest rated voltage.

(12) “Highest voltage for equipment” (U_m) 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.

(13) “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.

(14) “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.

(15) “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.

(16) “Peak Efficiency Index” (PEI) means the maximum value of the ratio of the transmitted apparent power of a transformer minus the electrical losses to the transmitted apparent power of the transformer.

Article 3

Eco-design requirements

Small power transformers, medium power transformers and large power transformer shall meet the ecodesign requirements set out in Annex I.

Article 4

Conformity Assessment

Conformity assessment shall be carried out applying the internal design control procedure set out in Annex IV to Directive 2009/125/EC or the management system procedure set out in Annex V to that Directive.

Article 5

Verification procedure for market surveillance purposes

When performing the market surveillance checks referred to in Directive 2009/125/EC, Article 3(2), Member State authorities shall apply the verification procedure set out in Annex III to this Regulation.

Article 6

Indicative Benchmarks

The indicative benchmarks for the best-performing transformers technologically possible at the time of adoption of this Regulation are identified in Annex IV.

Article 7

Review

No later than three years after the entry into force, the Commission shall review this Regulation in the light of technological progress and present the results of this review to the Consultation Forum. Specifically, the review will assess, at least, the following issues:

- The possibility to set out minimum values of the Peak Efficiency Index for all medium power transformers, including those with a rated power below 3150 kVA;
- The possibility to separate the losses associated to the core transformer from those associated with other components performing voltage regulation functions, where this is the case;
- The appropriateness of establishing minimum performance requirements for single-phase power transformers, as well as for small power transformers;
- Whether concessions made for pole-mounted transformers and for special combinations of winding voltages for medium power transformers are still appropriate;
- The possibility of covering environmental impacts other than energy in the use phase;

Article 8

Entry into force

The Regulation shall enter into force on the 20th day following its publication in the Official Journal of the European Union.

This Regulation shall be binding in its entirety and directly applicable in all Member States.

Done at Brussels,

For the Commission
The President

EUROPEAN
COMMISSION

Brussels, XXX
[…](2014) XXX draft

ANNEXES 1 to 4

ANNEXES

to the Commission Regulation (EU) No.../...

of XXX

on implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to small, medium and large power transformers

ANNEXES

to the Commission Regulation (EU) No.../...

of XXX

on implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to small, medium and large power transformers

- **ANNEX I**

Ecodesign requirements

1) Minimum energy performance or efficiency requirements for medium power transformers

Medium power transformers shall comply with the maximum allowed load and no-load losses or the Peak Efficiency Index (PEI) values set out in Tables I.1 to I.5, excluding medium power pole-mounted transformers, which shall comply with the maximum allowed load and no load losses values set out in Table I.6.

1.1) Requirements for three-phase medium power transformers with rated power ≤3150kVA

Table I.1: Maximum load and no-load losses (in W) for three-phase **liquid-immersed** medium power transformers with one winding with U_m ≤24kV and the other one with U_m ≤1.1kV

	Tier 1 (from 1 July 2015)		**Tier 2 (from 1 July 2021)**	
Rated Power (kVA)	**Maximum load losses Pk (W) ***	**Maximum no-load losses Po (W)***	**Maximum load losses Pk (W)***	**Maximum no-load losses Po (W)***
≤25	Ck (900)	Ao(70)	Ak(600)	Ao-10% (63)
50	Ck (1100)	Ao(90)	Ak(750)	Ao-10%(81)
100	Ck (1750)	Ao(145)	Ak(1250)	Ao-10%(130)
160	Ck (2350)	Ao(210)	Ak(1750)	Ao-10%(189)
250	Ck (3250)	Ao(300)	Ak(2350)	Ao-10%(270)
315	Ck (3900)	Ao(360)	Ak(2800)	Ao-10%(324)
400	Ck (4600)	Ao(430)	Ak(3250)	Ao-10%(387)
500	Ck (5500)	Ao(510)	Ak(3900)	Ao-10%(459)
630	Ck (6500)	Ao(600)	Ak(4600)	Ao-10%(540)

800	Ck (8400)	Ao(650)	Ak(6000)	Ao-10%(585)
1000	Ck (10500)	Ao(770)	Ak(7600)	Ao-10% (693)
1250	Bk (11000)	Ao(950)	Ak(9500)	Ao-10%(855)
1600	Bk(14000)	Ao(1200)	Ak(12000)	Ao-10%(1080)
2000	Bk (18000)	Ao(1450)	Ak(15000)	Ao-10%(1305)
2500	Bk (22000)	Ao(1750)	Ak(18500)	Ao-10%(1575)
3150	Bk (27500)	Ao(2200)	Ak(23000)	Ao-10%(1980)

*Maximum losses for kVA ratings that fall in between the ratings given in Table I.1 shall be obtained by linear interpolation.

Table I.2: Maximum load and no-load losses (in W) for three –phase **dry-type** medium power transformers with one winding with $U_m \leq 24kV$ and the other one with $U_m \leq 1.1kV$.

	Tier 1 (1 July 2015)		**Tier 2 (1 July 2021)**	
Rated Power (kVA)	**Maximum load losses Pk (W)***	**Maximum no-load losses Po (W)***	**Maximum load losses Pk (W)***	**Maximum no-load losses Po (W)***
≤50	Bk (1700)	Ao(200)	Ak(1500)	Ao-10%(180)
100	Bk (2050)	Ao(280)	Ak(1800)	Ao-10%(252)
160	Bk (2900)	Ao(400)	Ak(2600)	Ao-10%(360)
250	Bk (3800)	Ao(520)	Ak(3400)	Ao-10%(468)
400	Bk (5500)	Ao(750)	Ak(4500)	Ao-10%(675)
630	Bk (7600)	Ao(1100)	Ak(7100)	Ao-10%(990)
800	Ak (8000)	Ao(1300)	Ak(8000)	Ao-10%(1170)
1000	Ak (9000)	Ao(1550)	Ak(9000)	Ao-10%(1395)
1250	Ak (11000)	Ao(1800)	Ak(11000)	Ao-10%(1620)
1600	Ak (13000)	Ao(2200)	Ak(13000)	Ao-10%(1980)
2000	Ak (16000)	Ao(2600)	Ak(16000)	Ao-10%(2340)
2500	Ak (19000)	Ao(3100)	Ak(19000)	Ao-10%(2790)

3150	Ak (22000)	Ao(3800)	Ak(22000)	Ao-10%(3420)

*Maximum losses for kVA ratings that fall in between the ratings given in Table I.2 shall be obtained by linear interpolation.

Table I.3: Correction of load and no load losses in case of other combinations of winding voltages or dual voltage in one or both windings **(**rated power ≤ 3150kVA)

One winding with $U_m \leq$ 24 kV and the other with $U_m >$ 1.1 kV	The maximum allowable losses in Tables I.1 and I.2 shall be increased by 10% for no load losses and by 10% for load losses
One winding with U_m = 36 kV and the other with $U_m \leq$ 1.1 kV	The maximum allowable losses in Tables I.1 and I.2 shall be increased by 15% for no load losses and by 10% for load losses
One winding with U_m = 36 kV and the other with $U_m >$ 1.1 kV	The maximum allowable losses indicated in Tables I.1 and I.2 shall be increased by 20% for no load losses and by 15% for load losses
Case of dual voltage on one winding	In case of transformers with one high-voltage winding and two voltages available from a tapped low-voltage winding, losses shall be calculated based on the higher voltage of the low-voltage winding and shall be in compliance with the maximum allowable losses in Tables I.1 and 1.2. The maximum available power on the lower voltage of the low-voltage winding winding on such transformers shall be limited to 0.85 of the rated power assigned to the low-voltage winding at its higher voltage.
	In case of transformers with one low-voltage winding with two voltages available from a tapped high-voltage winding, losses shall be calculated based on the higher voltage of the high-voltage winding and shall be in compliance with the maximum allowable losses in Tables I.1 and I.2., The maximum available power on the lower voltage of the high-voltage winding on such transformer shall be limited to 0.85 of the rated power assigned to the high-voltage winding at its higher voltage.
	If the full nominal power is available regardless of the combination of voltages, the levels of losses indicated in Tables I.1 and I.2 can be increased by 15% for no load losses and by 10% for load losses.
Case of dual voltage on both windings	The maximum allowable losses in Tables I.1 and I.2 can be increased by 20% for no load losses and by 20% for load losses for transformers with dual voltage on both windings. The level of losses is given for the highest possible rated power and on the basis that the rated power is the same

	regardless of the combination of voltages.

1.2) Requirements for medium power transformers with rated power >3150kVA

Table I.4: Minimum Peak Efficiency Index (PEI) values for **liquid immersed** medium power transformers

Rated Power (kVA)	Tier 1 (01.07.2015)	Tier 2 (01.07.2021)
	Minimum Peak Efficiency Index (%)	
3150 < Sr ≤ 4000	99.465	99.532
5000	99.483	99.548
6300	99.510	99.571
8000	99.535	99.593
10000	99.560	99.615
12500	99.588	99.640
16000	99.615	99.663
20000	99.639	99.684
25000	99.657	99.700
31500	99.671	99.712
40000	99.684	99.724

Minimum PEI values for kVA ratings that fall in between the ratings given in Table I.4 shall be calculated by linear interpolation

Table I.5: Minimum Peak Efficiency Index (PEI) values for **dry type** medium power transformers

Rated Power (kVA)	Tier 1 (01.07.2015)	Tier 2 (01.07.2021)
	Minimum Peak Efficiency Index (%)	
3150 < Sr ≤ 4000	99.348	99.382
5000	99.354	99.387
6300	99.356	99.389
8000	99.357	99.390
≥10000	99.357	99.390

Minimum PEI values for kVA ratings that fall in between the ratings given in Table I.5 shall be calculated by linear interpolation

1.3) Requirements for medium power transformers with rated power ≤ 3150kVA equipped with tapping connections suitable for operation while being energised or on-load for voltage adaptation purposes. Voltage Regulation Distribution Transformers are included in this category.

The maximum allowable levels of losses set out in Tables I.1 and I.2 of this Annex I shall be increased by 20% for no load losses and 5% for load losses in Tier 1 and by 10% for no load losses in Tier 2.

1.4) Requirements for medium power pole-mounted transformers

The levels of load and no load losses indicated in Tables I.1 and I.2 are not applicable to liquid immersed pole-mounted transformers with power ratings between 25 kVA and 315 kVA. For these specific models of medium power pole-mounted transformers, the maximum levels of allowable losses are set out in Table I.6.

Table I.6 Maximum load and no-load losses (in W) for medium power liquid immersed pole-mounted transformers

	Tier 1 (1.07.2015)		**Tier 2 (1.07.2021)**	
Rated Power(kVA)	**Maximum load losses (in W) ***	**Maximum no-load losses (in W)***	**Maximum load losses (in W)***	**Maximum no-load losses (in W)***
25	Ck (900)	Ao (70)	Bk (725)	Ao (70)
50	Ck (1100)	Ao (90)	Bk (875)	Ao (90)
100	Ck (1750)	Ao (145)	Bk (1475)	Ao (145)
160	Ck+32% (3102)	Co (300)	Ck+32% (3102)	Co-10% (270)
200	Ck (2750)	Co (356)	Bk (2333)	Bo (310)
250	Ck (3250)	Co (425)	Bk (2750)	Bo (360)
315	Ck (3900)	Co (520)	Bk (3250)	Bo (440)

*Maximum allowable losses for kVA ratings that fall in between the ratings given in Table I.6 shall be obtained by linear interpolation

2) Minimum energy efficiency requirements for large power transformers

The minimum efficiency requirements for large power transformers are set out in Tables I.7 and I.8.

Table I.7 Minimum Peak Efficiency Index requirements for liquid immersed large power transformers

Rated Power (MVA)	Tier 1 (01.07.2015)	Tier 2 (01.07.2021)

	Minimum Peak Efficiency Index (%)	
≤ 4	99.465	99.532
5	99.483	99.548
6.3	99.510	99.571
8	99.535	99.593
10	99.560	99.615
12.5	99.588	99.640
16	99.615	99.663
20	99.639	99.684
25	99.657	99.700
31.5	99.671	99.712
40	99.684	99.724
50	99.696	99.734
63	99.709	99.745
80	99.723	99.758
≥100	99.737	99.770

Minimum PEI values for MVA ratings that fall in between the ratings given in Table I.7 shall be calculated by linear interpolation

Table I.8 Minimum Peak Efficiency Index requirements for dry-type large power transformers

Rated Power (MVA)	Tier 1 (01.07.2015)	Tier 2 (01.07.2021)
	Minimum Peak Efficiency Index (%)	
≤ 4	99.158	99.225
5	99.200	99.265
6.3	99.242	99.303
8	99.298	99.356
10	99.330	99.385

12.5	99.370	99.422
16	99.416	99.464
20	99.468	99.513
25	99.521	99.564
31.5	99.551	99.592
40	99.567	99.607
50	99.585	99.623
≥ 63	99.590	99.626

Minimum PEI values for MVA ratings that fall in between the ratings given in Table I.8 shall be calculated by linear interpolation

3) Product information requirements

From 1 July 2015, the following product information requirements for transformers included in the scope of this Regulation (Article 1) shall be included in any related product documentation, including free access websites of manufacturers:

(a) information on rated power, load loss and no-load loss and the electrical power of any cooling system required at no load;

for medium power (where applicable) and large power transformers, the value of the Peak Efficiency Index and the power at which it occurs;

for dual voltage transformers, the maximum rated power at the lower voltage, according to Table I.3;

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);

For medium power pole mounted transformers, a visible display "For pole-mounted operation only".

The information under a); c) and d) shall also be included on the rating plate of the power transformers

4) Technical documentation

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

(b) manufacturer's name and address;

(c) model identifier, the alphanumeric code to distinguish one model from other models of the same manufacturer;

(d) the information required under 3).

If (parts of) the technical documentation is based upon (parts of) the technical documentation of another model, the model identifier of that model shall be provided and the technical documentation shall provide the details of how the information is derived from the technical documentation of the other model, e.g. on calculations or extrapolations, including the tests undertaken by the manufacturer to verify the calculations or extrapolations undertaken.

ANNEX II

Measurement and calculation methods

Measurement method

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, including methods set out in documents the reference numbers of which have been published for that purpose in the Official Journal of the European Union.

Calculation methods

The methodology for calculating the Peak Efficiency Index (PEI) for medium and large power transformers is based on the ratio of the transmitted apparent power of a transformer minus the electrical losses to the transmitted apparent power of the transformer.

$$PEI = 1 - \frac{2(P_0 + P_{c0})}{S_r \sqrt{\frac{P_0 + P_{c0}}{P_k}}}$$

Where:

P_0 is the no load losses measure at rated voltage and rated frequency, on the rated tap

P_{c0} is the electrical power required by the cooling system for no load operation

P_k is the measured load loss at rated current and rated frequency on the rated tap corrected to the reference temperature

S_r is the rated power of the transformer or autotransformer on which P_k is based

- **ANNEX III**

Verification procedure

When performing the market surveillance checks referred to in Article 3(2) of Directive 2009/125/EC, the authorities of the Member States shall apply the following verification procedure for the requirements set out in Annex I.

(14) Member States authorities shall test one single unit per model;

The model shall be considered to comply with the applicable requirements set out in Annex I of this Regulation if the values in the technical documentation comply with the requirements set out in Annex I , and if the measured parameters meet the requirements set out in Annex I within the verification tolerances indicated in Table 1 of this Annex;

If the results referred to in point 2 are not achieved, the model shall be considered not to comply with this Regulation. The Member States authorities shall provide all relevant information, including the test results if applicable, to the authorities of the other Member States and the Commission within one month of the decision being taken on the non-compliance of the model.

Member States authorities shall use the measurement methods and calculation methods set out in Annex II.

Given the weight and size limitations in the transportation of medium and large power transformers, Member States authorities may decide to undertake the verification procedure at the premises of manufacturers, 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 Member States authorities and shall not be used by the manufacturer or importer as an allowed tolerance to establish the values in the technical documentation.

Table 1.

Measured parameter	**Verification tolerances**
Load losses	The measured value shall not be greater than the declared value by more than 5 %.
No load losses	The measured value shall not be greater than the declared value by more than 5 %.
The electrical power required by the cooling system for no load operation	The measured value shall not be greater than the declared value by more than 5 %.

- **ANNEX IV**

Indicative Benchmarks

At the time of adoption of this Regulation, the best available technology on the market for medium power transformers was identified as follows:

Liquid-immersed medium power transformers: Ao-20%, Ak-20%

Dry-type medium power transformers: Ao-20%, Ak-20%

Medium power transformers with amorphous steel core: Ao-50%, Ak-50%

The availability of material to manufacture transformers with amorphous steel core needs further development, before such values of losses can be considered to become minimum requirements in the future.