Regulation 548/2014 in a nutshell

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Transformers Ecodesign stakeholder meeting

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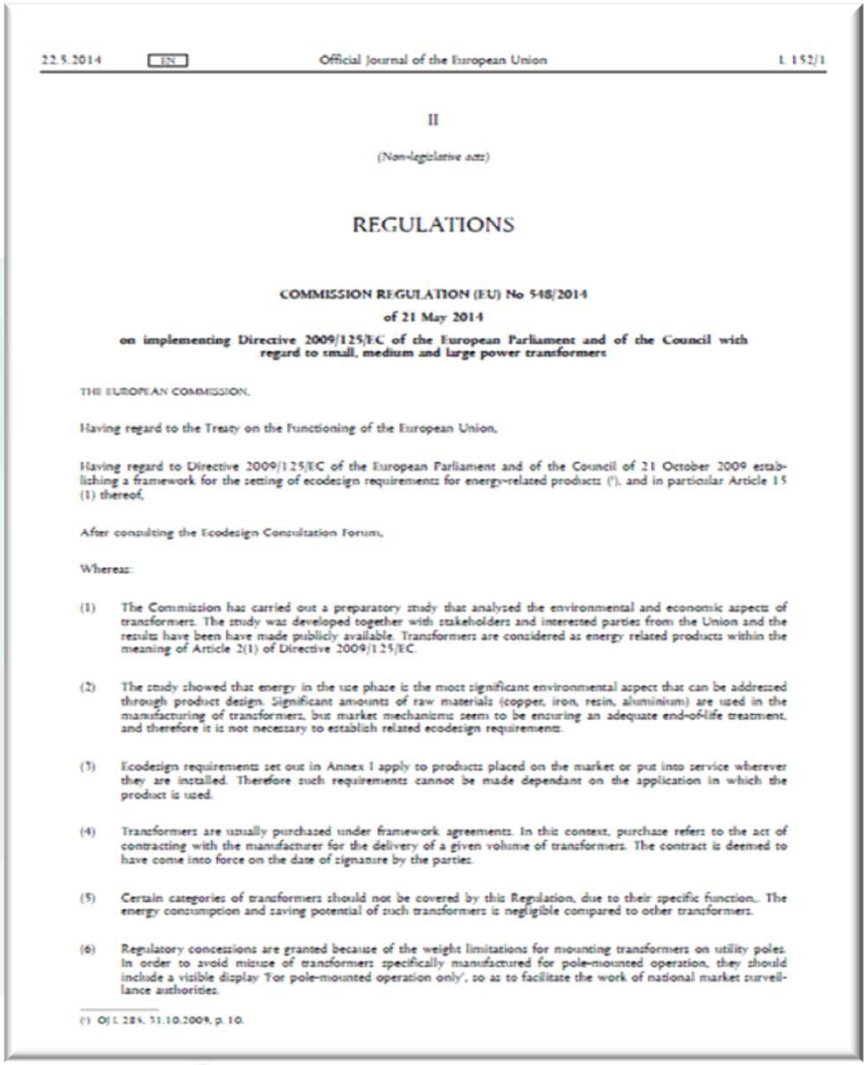
Overview

- This presentation gives a summary of the Regulation 548/2014



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II

(Non-legislative acts)

REGULATIONS

COMMISSION REGULATION (EU) No 548/2014

of 21 May 2014

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 Union 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.

(1) OJ L 285, 31.10.2009, p. 10.

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Background

- Europe originally initiated a voluntary effort to promote energy-efficient transformers through the European norm 50464-1, which covers the same liquid-filled units that were previously included in the Harmonised Document HD 428
- For dry-type transformers, the European norm was EN 50541-1, which was based on HD 538. In these voluntary standards, maximum loss levels were associated with ratings of A, B and C, using subscripts ‘o’ for no-load losses and ‘k’ for load losses
- This approach was meant to facilitate transformer specification, such that customers could choose a combination of no-load and load losses, such as ‘AoBk’

Scope of Regulation 548/2014

- In May 2014, Ecodesign Regulation 548/2014 for ‘small, medium and large power transformers’ was adopted which imposed minimum energy performance and information requirements
- The 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 50 Hz 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

Not in scope of Regulation 548/2014

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,

Not in scope of Regulation 548/2014

- **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 (1)
- transformers specifically designed for **deep water** (submerged) applications, — medium Voltage (MV) to Medium Voltage (MV) interface transformers up to 5 MVA

Not in scope of Regulation 548/2014

- 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.

Requirements for three-phase liquid-immersed medium power transformers ≤ 3150kVA

with one winding with Um ≤ 24 kV and the other one with Um ≤ 1.1 kV

Rated power (kVA)	Tier 1 (from 1 July 2015)		Tier 2 (from 1 July 2021)	
	Maximum no-load losses P_o (W)*	Maximum load losses P_k (W)*	Maximum no-load losses P_o (W)*	Maximum load losses P_k (W)*
≤25	A_o (70)	C_k (900)	A_o - 10% (63)	A_k (600)
50	A_o (90)	C_k (1100)	A_o - 10% (81)	A_k (750)
100	A_o (145)	C_k (1750)	A_o - 10% (130)	A_k (1250)
160	A_o (210)	C_k (2350)	A_o - 10% (189)	A_k (1750)
250	A_o (300)	C_k (3250)	A_o - 10% (270)	A_k (2350)
315	A_o (360)	C_k (3900)	A_o - 10% (324)	A_k (2800)
400	A_o (430)	C_k (4600)	A_o - 10% (387)	A_k (3250)
500	A_o (510)	C_k (5500)	A_o - 10% (459)	A_k (3900)
630	A_o (600)	C_k (6500)	A_o - 10% (540)	A_k (4600)
800	A_o (650)	C_k (8400)	A_o - 10% (585)	A_k (6000)
1000	A_o (770)	C_k (10 500)	A_o - 10% (693)	A_k (7600)
1250	A_o (950)	B_k (11 000)	A_o - 10% (855)	A_k (9500)
1600	A_o (1200)	B_k (14 000)	A_o - 10% (1080)	A_k (12 000)
2000	A_o (1450)	B_k (18 000)	A_o - 10% (1305)	A_k (15 000)
2500	A_o (1750)	B_k (22 000)	A_o - 10% (1575)	A_k (18 500)
3150	A_o (2200)	B_k (27 500)	A_o - 10% (1980)	A_k (23 000)

* Maximum losses for kVA ratings that fall between the ratings given in this table shall be obtained by linear interpolation

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Requirements for three-phase dry-type medium power transformers ≤ 3150kVA

with one winding with Um ≤ 24 kV and the other one with Um ≤ 1.1 kV

Rated power (kVA)	Tier 1 (from 1 July 2015)		Tier 2 (from 1 July 2021)	
	Maximum no-load losses P_o (W)*	Maximum load losses P_k (W)*	Maximum no-load losses P_o (W)*	Maximum load losses P_k (W)*
≤50	A_o (200)	B_k (1700)	A_o - 10% (180)	A_k (1500)
100	A_o (280)	B_k (2050)	A_o - 10% (252)	A_k (1800)
160	A_o (400)	B_k (2900)	A_o - 10% (360)	A_k (2600)
250	A_o (520)	B_k (3800)	A_o - 10% (468)	A_k (3400)
400	A_o (750)	B_k (5500)	A_o - 10% (675)	A_k (4500)
630	A_o (1100)	B_k (7600)	A_o - 10% (990)	A_k (7100)
800	A_o (1300)	A_k (8000)	A_o - 10% (1170)	A_k (8000)
1000	A_o (1550)	A_k (9 000)	A_o - 10% (1195)	A_k (9000)
1250	A_o (1800)	A_k (11 000)	A_o - 10% (1620)	A_k (11 00)
1600	A_o (2200)	A_k (13 000)	A_o - 10% (1980)	A_k (13 000)
2000	A_o (2600)	A_k (16 000)	A_o - 10% (2340)	A_k (16 000)
2500	A_o (3100)	A_k (19 000)	A_o - 10% (2790)	A_k (19 000)
3150	A_o (3800)	A_k (22 000)	A_o - 10% (3420)	A_k (22 000)

* Maximum losses for kVA ratings that fall between the ratings given in this table shall be obtained by linear interpolation

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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 ≤ 3 150 kVA)

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

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 ≤ 3 150 kVA)

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 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.

Requirements for medium power transformers ≤ 3150kVA

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 (the tow previous tables) 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.

Requirements for liquid-immersed medium power transformers > 3150kVA

Minimum Peak Efficiency Index (PEI) values

Rated power (kVA)	Tier 1 (from 1 July 2015)	Tier 2 (from 1 July 2021)
	Minimum Peak Efficiency Index (%)	
3 150 < Sr ≤ 4 000	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

* Maximum losses for kVA ratings that fall between the ratings given in this table shall be obtained by linear interpolation

Requirements for dry-type medium power transformers > 3150kVA

Minimum Peak Efficiency Index (PEI) values

Rated power (kVA)	Tier 1 (from 1 July 2015)	Tier 2 (from 1 July 2021)
	Minimum Peak Efficiency Index (%)	
3 150 < Sr ≤ 4 000	99,348	99,382
5000	99,354	99,387
6300	99,356	99,389
8000	99,357	99,390
>10000	99,357	99,390

* Maximum losses for kVA ratings that fall between the ratings given in this table shall be obtained by linear interpolation

Requirements for liquid-immersed medium power pole transformers with 25 > kVA ≤ 315

Rated power (kVA)	Tier 1 (from 1 July 2015)		Tier 2 (from 1 July 2021)	
	Maximum no-load losses (W)*	Maximum load losses (W)*	Maximum no-load losses (P_o; W)*	Maximum load losses (W)*
25	A_o (70)	C_k (900)	A_o (70)	B_k (725)
50	A_o (90)	C_k (1100)	A_o (90)	B_k (875)
100	A_o (145)	C_k (1750)	A_o (145)	B_k (1475)
160	C_o (300)	C_k + 32% (3102)	C_o - 10% (270)	C_k + 32% (3102)
250	C_o (356)	C_k (2750)	B_o (310)	B_k (2333)
250	C_o (425)	C_k (3250)	B_o (360)	B_k (2750)
315	C_o (520)	C_k (3900)	B_o (440)	B_k (3250)

* Maximum losses for kVA ratings that fall between the ratings given in this table shall be obtained by linear interpolation

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Requirements for liquid immersed large power transformers

Minimum Peak Efficiency Index (PEI) values

Rated power (MVA)	Tier 1 (from 1 July 2015)	Tier 2 (from 1 July 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

* Maximum losses for kVA ratings that fall between the ratings given in this table shall be obtained by linear interpolation

Requirements for dry-type large power transformers

Minimum Peak Efficiency Index (PEI) values

Rated power (MVA)	Tier 1 (from 1 July 2015)	Tier 2 (from 1 July 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

* Maximum losses for kVA ratings that fall between the ratings given in this table shall be obtained by linear interpolation

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 3 150 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**

Review

- 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.**

Question to stakeholders

- Are there any other aspects of the regulation which were not mentioned in Article 7 (review) that should be considered for review?

Links and Contacts

Lot 2 Ecodesign study for small, medium and large power transformers

https://transformers.vito.be

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Additional slides

Definitions

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) ‘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

Definitions

(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

Definitions

(10)‘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.

(11) ‘High-voltage winding’ refers to the winding having the highest rated voltage.

(12) ‘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.

(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.

Definitions

(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.

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.

Verification tolerances for market surveillance purposes

- 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

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 %.

Product information requirements

From 1 July 2015, the following product information requirements for transformers included in the scope of this Regulation 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;
- (b) for medium power (where applicable) and large power transformers, the value of the Peak Efficiency Index and the power at which it occurs;
- (c) for dual voltage transformers, the maximum rated power at the lower voltage, according to Table I.3;
- 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) 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.

Technical documentation requirements

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

(a) manufacturer'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 point 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..

Verification procedure for market surveillance purposes

- (1) Member States authorities shall test one single unit per model; (2) 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 the Table of this Annex;
- (3) If the results referred to in point 2 are not achieved, the model shall be considered not to comply with this Regulation.
- 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.