New requirements for transformers in EU (Ecodesign)

Legislation and implementation objectives

On June 11th 2014 EU Commission Regulation No. 548/2014 on implementing Directive 2009/125/EC concerning Ecodesign with regard to small, medium and large power transformers, came into force in all 28 countries of the European Union.

New legislation imposes, within EU, maximum level of losses (or minimum efficiency) for transformers placed on the market or put into service from July 1st 2015, and purchased after June 11th 2014.

After June 11th 2014, manufacturers and customers should not engage in new framework contracts for transformers not meeting minimum requirements outlined in the Regulation.

Framework contracts signed before 11th June 2014 can run till the end date, even with deliveries after July 1st 2015.

Ecodesign objectives include improved energy efficiency and general environmental compatibility, thus reducing CO2 emissions. Ecodesign Regulation is focused on reducing transformers' electrical losses (1st step in 2015 / 2nd step in 2021), and to clarify and make more visible indication of performance.

Impact on transformer design

With the new Regulation, maximum level of losses for distribution transformers is set throughout EU, and for the first time minimum efficiency requirement is given for power transformers over 3.15 MVA.

Tolerances on guaranteed losses, as prescribed in IEC 60076-1, are no longer considered.

Regulation establishes Ecodesign requirements for power transformers with a minimum power rating of 1 kVA used in 50 Hz electricity transmission and distribution networks or for industrial applications. Some new definitions are introduced for the purpose of Regulation.

Table 1: Application of Ecodesign requirements.

Transformer definition in the Regulation	Highest voltage for equipment (Um)	Rated power (Sr)
'Small power transformer'	Um ≤ 1.1 kV	Any
'Medium power transformer'	1.1 kV< Um ≤36 kV	5 kVA ≤ Sr < 40 MVA
'Large power transformer'	Um > 36 kV	Sr ≥ 5 kVA
	Any	Sr ≥ 40 MVA

The Regulation does not apply on transformers for the following applications:

- instrument transformers,
- rectifier transformers,
- furnace transformers,
- offshore transformers,
- transformers for emergency installations,
- transformers and auto-transformers for railway feeding systems,
- earthing (grounding) transformers,
- traction transformers,
- starting transformers, designed for starting three-phase induction motors,
- testing transformers,
- welding transformers,
- transformers for explosion-proof and underground mining applications,
- transformers for deep water applications,
- MV to 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,
- large power transformers for the 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.

Level of losses according to Ecodesign requirements

Distribution transformers (medium power transformers ≤ 3150 kVA)

Ecodesign Regulation specifies the amount of losses on the basis of following Standards: EN 50464-1/A1 (Three-phase oil immersed distribution transformers, 50 Hz from 50 kVA to 2500 kVA with highest voltage for equipment not exceeding 36 kV), and EN 50541-1 (Three-phase dry-type distribution transformers 50 Hz, from 100 kVA to 3150 kVA, with highest voltage for equipment not exceeding 36 kV).

Table 2. Maximum losses (MV ≤ 24 kV and LV ≤ 1.1 kV).

Type	Rated power (kVA)	Tier 1 (1.7.2015.)		Tier 2 (1.7.2021.)	
		No-load losses	Load losses	No-load losses	Load losses
Pole-mounted liquid immersed	25, 50, 100	A0	Ck	A0	Bk
	160	C0	Ck + 32%	C0-10%	Ck + 32%
	200, 250, 315	C0	Ck	B0	Bk
Other liquid immersed	≤ 1000	A0	Ck	A0-10%	Ak
	> 1000	A0	Bk	A0-10%	Ak
Dry-type	≤ 630	A0	Bk	A0-10%	Ak
	> 630	A0	Ak	A0-10%	Ak

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

Table 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 ≤ 3 150 kVA).

Requirement	No-load losses	Load losses
MV winding Um ≤ 24 kV LV winding Um > 1.1 kV	+ 10%	+ 10%
MV winding Um = 36 kV LV winding Um ≤ 1.1 kV	+ 15%	+ 10%
MV winding Um = 36 kV LV winding Um > 1.1 kV	+ 20%	+ 15%
Dual voltage on LV winding	No correction, but on lower voltage of LV winding max. power is limited to 85% of rated power of LV winding at higher voltage	
Dual voltage on MV winding	No correction, but on lower voltage of MV winding max. power is limited to 85% of rated power of MV winding at higher voltage	
Dual voltage on one winding (if full power on all voltages)	+ 15%	+ 10%
Dual voltage on both windings	+ 20%	+ 20%
Transformers with tappings for operation while being energised or on-load (e.g. Voltage Regulation Distribution Transformers)	+ 20% (Tier 1, 1.7.2015.) + 10% (Tier 2, 1.7.2021.)	+ 5%

Power transformers (medium power transformers > 3150kVA and large power transformers)

For medium power transformers with rated power > 3150 kVA and ≤ 40 MVA, as well as large power transformers, the Regulation does not directly define maximum no-load and load losses. It defines minimum Peak Efficiency Index (PEI), in (%):

$$PEI = 1 - \frac{2\,(P_o + P_{co})}{Sr \sqrt{\frac{P_o + P_{co}}{P_k}}}$$

where: **P0 is the no-load losses measured at rated voltage and rated frequency, on the rated tap,**

Pc0 is the electrical power of the cooling system for no-load operation,

Pk is the measured load losses at rated current and rated frequency on the rated tap corrected to the reference temperature acc. EN 60076-1,

Sr is the rated power of the transformer on which Pk is based

Table 4: Minimum PEI (%) for liquid immersed power transformers.

Rated power (MVA)	Tier 1 (1.7.2015.)	Tier 2 (1.7.2021.)
≤ 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 ratings that fall in between the ratings given in Table 2 shall be obtained by linear interpolation.

Minimum PEI values are given also for range of dry-type power transformers, although not mentioned here.

Product information and CE marking

Rated power, load and no-load losses and electrical power of the cooling system at no-load operation must be indicated in all product documentation and on the rating plate. Where applicable, the value of the PEI and the power at which it is reached must be indicated in the documentation. Information about the weight of all main components of the transformer must be provided in all product information. For dual voltage transformers, the maximum rated power at the lower voltage should be given.

From July 1st 2015 all transformers which comply to Ecodesign requirements should also have a clear CE marking, as a proof of compliance. Certificate of compliance with Ecodesign requirements should be issued, as well.

Končar - D&ST and Ecodesign

Following market trends and customer requirements in previous years, Končar - D&ST put a lot of effort into design of transformers with increased efficiency. Continuous R&D, using new materials and technology, allows us to comply with all Ecodesign requirements. We are already producing and delivering transformers according to first stage of Ecodesign rules. Also, in the past years we supplied significant quantity of transformers for various EU customers with the same or lower losses than required by Ecodesign. At the moment, it is possible to design and deliver even more efficient transformers (Tier 2), and in the future focus will be on further reduction of losses.

For more information on Ecodesign regulation please visit: http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2014.152.01.0001.01.ENG

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