

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

<u>ANNEX I</u>

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 ${\leq}3150 kVA$

Table I.1: Maximum load and no-load losses (in W) for three-phase <u>liquid-immersed</u> medium power transformers with one winding with $U_m \leq 24kV$ and the other one with $U_m \leq 1.1kV$

| | 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 <u>dry-type</u> 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 | 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 ≤ 3150 kVA)

| One winding with $U_m \le 24$ 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 $U_m \le 1.1$ 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 <u>liquid immersed</u> medium power transformers

| Datad Dawar (LVA) | Tier 1 (01.07.2015) | Tier 2 (01.07.2021) | |
|----------------------|-----------------------------------|---------------------|--|
| Kateu Power (KVA) | Minimum Peak Efficiency Index (%) | | |
| $3150 < Sr \le 4000$ | 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 <u>dry type</u> medium power transformers

| Deted Demon (I-VA) | Tier 1 (01.07.2015) | Tier 2 (01.07.2021) | |
|----------------------|-----------------------------------|---------------------|--|
| Kated Power (KVA) | Minimum Peak Efficiency Index (%) | | |
| $3150 < Sr \le 4000$ | 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 \leq 3150kVA equipped with tapping connections suitable for operation while being energised or onload 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 | tra | nsformers | | | | | | | | |

| Doted Dower (MVA) | Tier 1 (01.07.2015) | Tier 2 (01.07.2021) | | |
|-------------------|-----------------------------------|---------------------|--|--|
| Kated Power (MVA) | 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 |
|---------|------------|---------|------|------------|-------|--------------|-----|----------|-------|-------|
| transfo | orm | ers | | | | | | | | |

| Dated Dowon (MVA) | Tier 1 (01.07.2015) | Tier 2 (01.07.2021) | | |
|-------------------|-----------------------------------|---------------------|--|--|
| Kateu Power (MVA) | Minimum Peak Efficiency Index (%) | | | |
| <i>≤</i> 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;
- (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

4) Technical documentation

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 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:

 $P_{0}\xspace$ is the no load losses measure at rated voltage and rated frequency, on the rated tap

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

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

 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.

- (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 Table 1 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. 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.

| 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 %. |

| Table | 1. |
|-------|----|
| Lable | |

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:

- (a) Liquid-immersed medium power transformers: Ao-20%, Ak-20%
- (b) Dry-type medium power transformers: Ao-20%, Ak-20%
- (c) 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.