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Technical Specification E

Compliance tests

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1 Principle

Compliance testing is the periodical checking of the values declared by the manufacturer by the Acermi lead member. This verification is based firstly on measurements made by this lead member, together with a statistical calculation to check the reliability of the declared value in relation to the test values obtained.

2 Compliance criteria of the declared thermal value

The declaration of the thermal value is based on:

- the thickness of the product
- the effect of ageing
- the influence of humidity
- the density of the product
- emissivity

The conditions relating to these criteria are defined in the technical product standards.

For the thermal characteristics, compliance is checked according to one of the following methods.

2.1 Compliance test for products with a single thermal conductivity

2.1.1 Measurements

The number of samples taken for a product or group of products for which a single thermal conductivity value is declared by the manufacturer depends on the number of lines in which the product or group of products is manufactured:

- 1 to 4 lines: 4 samples are taken (covering all the lines).
- Beyond 4 lines: the number of samples taken is equal to the number of lines.

The value λ_i of each sample is obtained from the arithmetical mean of the measurements from *m* test specimens or pairs of specimens (for measuring devices having two), cut to the dimensions of the measuring device, *m* being dependant on the surface area S of the test specimens, such that:

m = 1	$S \geq 0.5\ m^2$
m = 2	$0.06\ m^2 \leq S < 0.5\ m^2$
m = 4	$0.01\ m^2 \leq S < 0.06\ m^2$

The results are rounded to the nearest 0.1 mW/(m.K).

2.1.2 Calculation

For *n* samples taken by the lead member, the mean value and standard deviation for thermal conductivity are calculated as follows:

$$\bar{\lambda} = \frac{\sum_{i=1}^{n} \lambda_i}{n} \qquad s = \sqrt{\frac{\sum_{i=1}^{n} (\lambda_i - \bar{\lambda})^2}{n-1}}$$

The λi used are the values before rounding

The parameter α is defined, given in the following table according to the number of samples:

n	4	5	6	7
α	0.44	0.52	0.58	0.61

Depending on the basis opted for by the manufacturer to calculate the declared thermal resistances, the thermal conductivity used for the calculation is:

- λ_D, the thermal conductivity value declared by the manufacturer when this value is used to calculate the declared thermal resistance(s) R_D
- $\lambda_{90/90}$, the conductivity value at fractile 90/90 determined in agreement with the lead member, rounded to the nearest 0.1 mW/(m.K), when this is used to calculate the declared thermal resistance(s) R_D
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The product is then deemed compliant if the following inequation is checked:

$$\lambda_D \geq \bar{\lambda} + \alpha * s$$
or
$$\lambda_{90/90} \geq \bar{\lambda} + \alpha * s$$

Moreover, if the manufacturer wishes to obtain key-mark certification for its product, the key-mark rules apply.

2.2 Compliance test for products characterised by several thermal conductivity ranges ("multi-lambda" test)

This is the case for manufactured products in which the layers are not all thermally identical (products with multiple thermal conductivity), and bulk products for which the thermal conductivity is defined by density range.

In these situations, for products in slabs, panels and rolls, a single test is performed per product, both for admission and follow-up. For bulk products, the compliance test selected is

that in paragraph 2.1 for each density range for acceptance, whereas a single test is performed per product for follow-up purposes, according to the methods described below.

This test takes into account the different thermal conductivity ranges, and the number of samples required is therefore increased in relation to paragraph 2.1.

The compliance test is only possible if the population spread is identical in each factory (product manufactured in several factories) and/or each thermal conductivity range.

2.2.1 Measurements

The number of samples "N" for the test is determined according to the total number of lines or production factories "L" (as defined in the corresponding product standard), and the total number of different thermal conductivity ranges of reference "P".

$$N = \max(4; L) + P - 1$$

The measured value λ_i of each sample is obtained by applying the procedures in § 2.1.1.

2.2.2 Calculation

For the calculation, thermal conductivity $\lambda_{ref,i}$ is used for the thermal conductivity range for sample *i*. Depending on the basis selected by the manufacturer to calculate the declared thermal resistances, for each range, the conductivity $\lambda_{ref,i}$ corresponds to:

- the thermal conductivity value declared by the manufacturer for this range
- the conductivity value at fractile 90/90 for this range, rounded to the nearest 0.1 mW/(m.K)

For each sample i, calculate: $\lambda_{r,i} = \dfrac{\lambda_i}{\lambda_{ref,i}}$

For the *N* samples, calculate:

$$\overline{\lambda}_r = \frac{1}{N} \cdot \sum_{i=1}^{N} \lambda_{r,i} \qquad \text{and} \qquad s_r = \sqrt{\frac{1}{N-1} \cdot \sum_{i=1}^{N} \left(\lambda_{r,i} - \overline{\lambda}_r\right)^2}$$

The parameter α is defined, given in the following table according to the number of samples *N*:

N	4	5	6	7
α	0.44	0.52	0.58	0.61

The product is then deemed compliant if the following inequality is checked:

$$\overline{\lambda}_r + (\alpha \times s_r) \leq 1$$

2.3 Compliance test for products for which only the thermal resistance R can be certified

For a product for which only the thermal resistance can be expressed (e.g. multi-layer product), the thermal compliance test is performed for each thickness of the product.

2.3.1 Measurements

The number of samples "N" for the test is determined according to the total number of lines or production factories "L".

$$N = \max(4; L)$$

The thermal resistance value R_i of each sample i ($1 \leq i \leq N$) is obtained from the arithmetical mean of the measurements from m test specimens or pairs of specimens (for measurement devices having two), cut to the dimensions of the measuring device, m being dependant on the surface area S of the test specimens, such that:

m = 1	S ≥ 0.5 m²
m = 2	0.06 m² ≤ S < 0.5 m²
m = 4	0.01 m² ≤ S < 0.06 m²

The results are rounded to the nearest 0.01 m².K/W.

2.3.2 Calculation

Using R_D to symbolise the declared thermal resistance for the thickness under consideration, calculate for each sample i:

$$R_{r,i} = \frac{R_i}{R_D}$$

For the N samples, calculate:

$$\overline{R}_r = \frac{1}{N} \cdot \sum_{i=1}^{N} R_{r,i} \qquad \text{and} \qquad s_r = \sqrt{\frac{1}{N-1} \cdot \sum_{i=1}^{N} \left(R_{r,i} - \overline{R}_r\right)^2}$$

The parameter α is defined, given in the following table according to the number of samples N:

N	4	5	6	7
α	0.44	0.52	0.58	0.61

The product is then deemed compliant if the following inequation is checked:

$$\overline{R}_r - (\alpha \times s_r) \geq 1$$

2.4 Compliance test for bulk products for which the thermal conductivity is modelled according to the density

For these products, the declared thermal conductivity value is established on the basis of a thermal conductivity curve according to the density.

The principle of the compliance test is to check the modelling curve $\lambda = f(\rho)$ defined based on a law of the following type:

$$\lambda(\rho) = A + B\rho + \frac{C}{\rho}$$

In the case where the product is manufactured on several production lines, the compliance test is only possible if the population spread is identical in each factory (product manufactured in several factories) and/or on each thickness range.

2.4.1 Measurements

The number of samples "N" for the test is determined according to the total number of lines "L".

$N = 6L$ for acceptance

$N = 1 + 2L$ for follow-up

In each case, an additional sample may be necessary for calculation, and this sample should be taken and the test specimens prepared at the same time as the others.

For each sample *i* constituted i1 and i2

- Determine the density ρ_1 and ρ_2 of thermal conductivity specimens.
- Measure the thermal conductivity $\lambda_{mes\ 1}$ and $\lambda_{mes\ i2}$.

2.4.2 Calculation

Based on the modelling curve $\lambda = f(\rho)$, determine for each sample *i1 and i2* the thermal conductivity value $\lambda_{mod\ i1}$ et $\lambda_{mod\ i2}$ corresponding to the density ρ_1 and ρ_2:

$$\lambda_{\mathrm{mod}i1} = f(\rho_{i1}) \text{ and } \lambda_{\mathrm{mod}i2} = f(\rho_{i2})$$

For each sample *i1 and i2*, determine the limit B_{i1} et B_{i2}:

$$B_{i1} = \frac{\lambda_{mesi1} - \lambda_{\mathrm{mod}i1}}{\lambda_{\mathrm{mod}i1}} \text{ and } B_{i2} = \frac{\lambda_{mesi2} - \lambda_{\mathrm{mod}i2}}{\lambda_{\mathrm{mod}i2}}$$

Then the limit B_i of the sample:

$$B_i = \left| \frac{B_{i1} + B_{i2}}{2} \right|$$

For the *N* samples, determine the indicator *S*:

$$S = \frac{\sum_{i=1}^{N}\left(\frac{\lambda_{mesi1} - \lambda_{modi1}}{\lambda_{modi1}}\right) + \sum_{i=1}^{N}\left(\frac{\lambda_{mesi2} - \lambda_{modi2}}{\lambda_{modi2}}\right)}{2N}$$

The product is deemed to be compliant if:

- the indicator $S \leq 0.03$ and if no value for the limits $B_i > 0.06$
  or
- the indicator $S \leq 0.03$ and if a single value for the limits $B_i > 0.06$ but for the additional sample measured $B_{N+1} \leq 0.06$

The product is deemed to be non-compliant if:

- the indicator $S > 0.03$
  or
- if at least two values of the limits $B_i > 0.06$
  or
- if a single value for the limits $B_i > 0.06$ but for the additional sample measured $B_{N+1} > 0.06$