INSTITUTE OF ARCHITECTURE AND CONSTRUCTION OF KAUNAS UNIVERSITY OF TECHNOLOGY

LABORATORY OF BUILDING PHYSICS

LIETUVOS NACIONALINIS AKREDITACIJOS BIURAS

BANDYMAI ISO/IEC 17025 Nr. LA. 01.031

**TEST REPORT No. 068 -1 SF/16 U**

**Date: 27 of Juni 2016**



# Determination of thermal resistance of reflective insulation product according LST EN 16012:2012+A1:2015* and LST EN ISO 8990:1999

(test title)

**Test method:** LST EN 16012:2012+A1:2015*: Thermal insulation for buildings-Reflective insulation products-Determination of the declared thermal performance; LST EN ISO 8990:1999 Thermal insulation - Determination of steady-state thermal transmission properties - Calibrated and guarded hot box (ISO 8990:1994).

(number of normative document or test method, description of test procedure, test uncertainty)

**Specimen description:** Type of product: reflective insulation product
Names of product:

- TRISO HYBRID$^S$
- TETRIS

Nominal thickness (EN 823) – 56 mm

(name, description and identification details of a specimen)

**Customer:** ACTIS SA Avenue de Catalogne, 11300 Limoux, France

(name and address)

**Manufacturer:** ACTIS SA Avenue de Catalogne, 11300 Limoux, France

(name and address)

**Test results:**

| Name of the indicator and unit | Test method reference no. | Test result |
|---|---|---|
| Thermal resistance $R$, $(m^2 \cdot K)/W$ | LST EN ISO 8990:1999 | 4,180 |
| Corrected *R-core* thermal resistance, $(m^2 \cdot K)/W$ | LST EN ISO 16012:2012+A1:2015* | 2,907 |
| Position of specimen: vertical (direction of heat flow – horizontal) | | |
| *flexible scope | | |

**Tested at:** Laboratory of Building Physics, Institute of Architecture and Construction of Kaunas University of Technology

(name of the test laboratory)

**Specimen delivery date:** 2016-05-19 **Date of testing:** 2016-05-27

**Sampling:** The test specimen sampled by customer. Description N$_o$. 068-1/16-1A.

**Additional information:** Application 2016-02-23, drawing.

(any deviations, complementary tests, exceptions and any information related with particular test)

**Annexes:**
*Annex 1*. Test results;
*Annex 2*. Parameters of Guarded Hot Box measurement;
*Annex 3*. Specimen products and air gaps thermal properties;
*Annex 4*. Perimeter zone's linear thermal transmittance value of the specimen;
*Annex 5*. Specimen design data;
*Annex 6*. Scheme of climate chamber „Hot box“.

(indicate annex numbers and titles)

| | | |
|---|---|---|
| Head of Laboratory: (approves the test results) | (signature) | K. Banionis (n., surname) |
| Tested by: (technically responsible for testing) | (signature) | A. Burlingis (n., surname) |

S.P.

Lietuvos Respublika DOKUMENTAI Architektūros ir statybos institutas Kauno technologijos universitetas

Validity – the named data and results refer exclusively to the tested and described specimens.
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**Annex 1.** ***Test results:***

| Data element | unit | Value |
|---|---|---|
| Air velocity on warm side, downwards, $v_i$ | m/s | 0,14 |
| Air velocity on cold side, upwards, $v_e$ | m/s | 1,26 |
| Total power input to metering box, $\Phi_{in}$ | W | 11,463 |
| Heat flow density through a specimen, $q_{sp}$ | $W/m^2$ | 2,2764 |
| Corrected heat flow density through a specimen, $q_c$ | W/m2 | 2,3203 |
| Warm side air temperature, $\theta_{ci}$ | $^oC$ | 20,36 |
| Cold side air temperature, $\theta_{ce}$ | $^oC$ | 9,38 |
| Surface temperature of the warm side, $\theta_{ni}$ | $^oC$ | 19,649 |
| Surface temperature of the cold side, $\theta_{ne}$ | $^oC$ | 9,949 |
| Temperature difference, $\Delta_T$ | $^oC$ | 9,700 |
| Thermal resistance of specimen, $R$ | $m^2 \cdot K/W$ | 4,180 |
| Corrected, thermal resistance of specimen, $R_{core}$ | $m^2 \cdot K/W$ | 2,650 |
| Uncertainty of the measurement, $\Delta R$ | $m^2 \cdot K/W$ | ± 0,18025 |

Tested by: A. Burlingis *ABurling* Date: 2016-05-27

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**Annex 2.** ***Parameters of Guarded Hot Box measurement.***

***Table 1. TRISO HYBRID$^S$ insulation system's specimen measured at 20°C/10°C temperature regime***

| *Guarded Hot Box measurement. Parameters of "TRISO HYBRID$^S$" insulation system's specimen:* | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Specimen's area A, $m^2$ | | | | | 1,831 | Actual mean thickness of specimen, mm | | | | ≈ **148*** |
| Position of a specimen | | | | | vertical | Length of specimen perimeter L, m | | | | 5,44 |
| | | | | | Linear thermal transmittance of perimeter zone $\Psi_L$, W/(m·K) | | | | | -0,001525 |
| *Measurement data:* | | | | | | | | | | |
| *Insulation system with product "TRISO HYBRID$^S$":* | | | | | | | | | | ***Result:*** |
| Sample No. | Temperature regime, °C | Hot side ambience temperature $t_h$, °C | Hot side surface temperature $\tau_h$, °C | Cold side ambience temperature $t_c$, °C | Cold side surface temperature $\tau_c$, °C | Temperature difference $\Delta t = (t_h - t_c)$, °C | Temperature difference $\Delta\tau = (\tau_h - \tau_c)$, °C | Measured heat flow density **q**, W/$m^2$ | Corrected heat flow density $q_C$, W/$m^2$ | **R-value** of insulation system, $m^2$·K/W |
| 1 | 20 /10 | 20,377 | 19,6488 | 9,451 | 9,9492 | 10,925 | 9,6995 | 2,2764 | **2,3203** | **4,180±0,180** |

* Previous test has shown that when installed on real building the average thickness of product is slightly larger than its nominal value. To keep surfaces of test sample as parallel as possible in the test setup, it is decided to install the product in a frame. After internal validation, the thickness of the frame is representative of the average thickness of an installed product, as requested by LST EN ISO 8990.

**Annex 3.** ***Specimen product and air gaps thermal properties***

***Table 2. TRISO HYBRID$^S$ insulation specimen product R-core value measurement results***

| *Product* | *Thickness, d mm* | *Hot side temperature $\tau_h$, °C* | *Cold side temperature $\tau_c$, °C* | *Temperature diffrence $\Delta\tau$, °C* | *Heat flow density $q_c$, W/$m^2$* | *Product's R-core value, $m^2$·K/W* |
|---|---|---|---|---|---|---|
| TRISO HYBRID$^S$ | 88 | 17,9470 | 11,7985 | 6,1485 | 2,3203 | **2,650** |

*Note: the mean temperature at each surface is derived from 12 measuring points.*

***Table 3. TRISO HYBRID$^S$ insulation specimen air gaps corrected R-core values calculation results according to LST EN 16012:2012+A1:2015 and LST EN ISO 6946:2008***

| *Air gap number* | *Thickness d, mm* | *Measured temperature differences of surfaces, $\Delta\tau$, °C* | *Radiative heat transfer coefficient, $h_r$* | *Convective heat transfer coefficient, $h_a$* | *Air gap R- core value, $m^2$·K/W* |
|---|---|---|---|---|---|
| Air gap #1 | 30 | 1,7018 | 0,3352 | 1,25 | 0,6308 |
| Air gap #2 | 30 | 1,8493 | 0,3069 | 1,25 | 0,6423 |

***Table 4. TRISO HYBRID$^S$ insulation specimen products***

| *Specimen product* | *Specimen surface layer* | *Test method reference No.* | *Declared emissivity, ε* |
|---|---|---|---|
| TRISO HYBRID$^S$ | HQ2000+LAQUE | EN 16012 | 0,06 * |
| | HQ2000+LAQUE | | 0,06 * |

** Emissivity results by Forschungsinstitut für Wärmeschutz e.V. München Tests Reports No. D3-06/11*

***R-core thermal resistance value calculation according to LST EN 16012:2012+A1:2015:***

$R_{core}$ (LST EN 16012:2012+A1:2015) = 4,180– 0,6308 - 0,6423 = 2,9071 ($m^2$·K)/W

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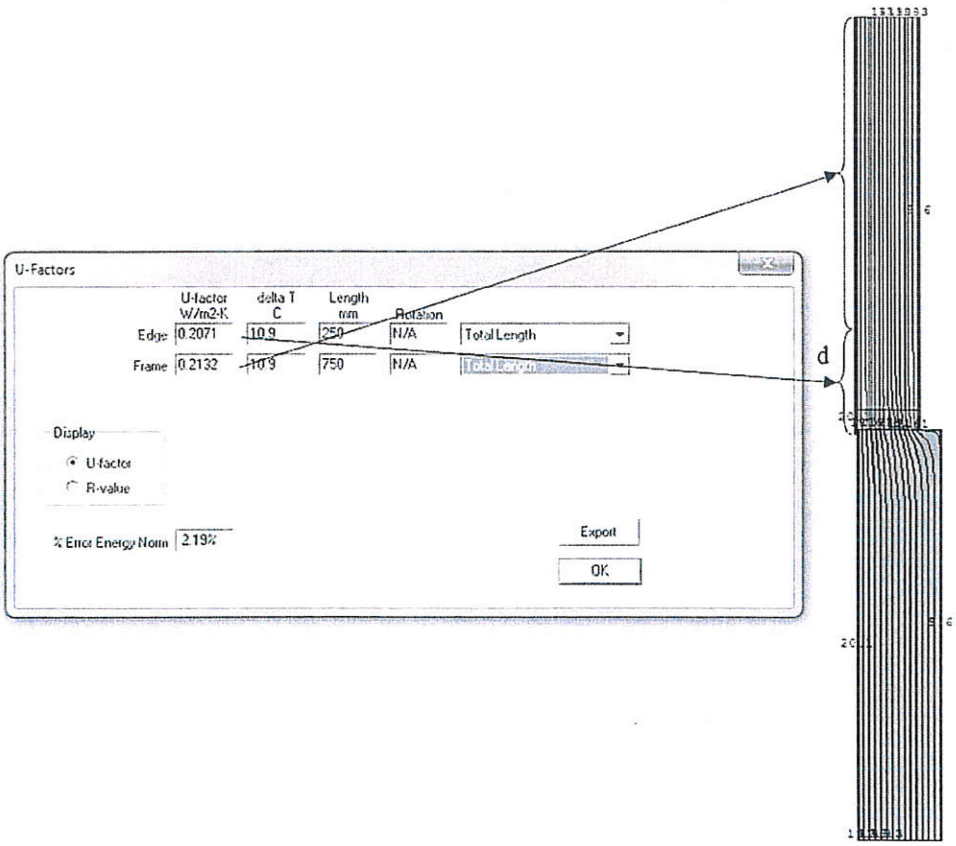
**Annex 4.** ***Perimeter zone's linear thermal transmittance value of the specimen***




Effective thermal conductivity of product $\lambda_{eff}$ – 0,03321 W/(m$^2$·K)
Perimeter zone's $U$-value: 0,2071 W/(m$^2$·K); width "d"– 250 mm;
Central area $U$-value: 0,2132 W/(m$^2$·K).
Perimeter's linear thermal transmittance: $\psi$= (0,2071-0,2132)·0,25 = **-0,001525** W/(m·K).

The correction of measured heat flow density value due to perimeter zone is calculated according to equation:

$$q_c = \frac{Q_c}{A} = \frac{Q - \psi \cdot L \cdot \Delta t}{A} = \frac{q \cdot A - \psi \cdot L \cdot \Delta t}{A} = q - \psi \cdot \left(\frac{L \cdot \Delta t}{A}\right);$$

here:
$A$ – area of a specimen, m$^2$;
$Q$ – measured mean heat flow through a specimen, W;
$q$ – measured mean heat flow density through a specimen, W/m$^2$;
$Q_C$ – corrected mean heat flow through a central area of specimen, W;
$q_C$ – corrected mean heat flow density through a central area of specimen, W/m$^2$;
$L$ – perimeter length of a specimen, m;
$\Delta t$ – ambient temperature difference across a specimen, K;
$\psi$ - perimeter's linear thermal transmittance of a specimen, W/(m·K).

Corrected R-value: $R_c = \frac{\Delta \tau}{q_c}$;

$\Delta\tau$ – temperature difference across a specimen, K.

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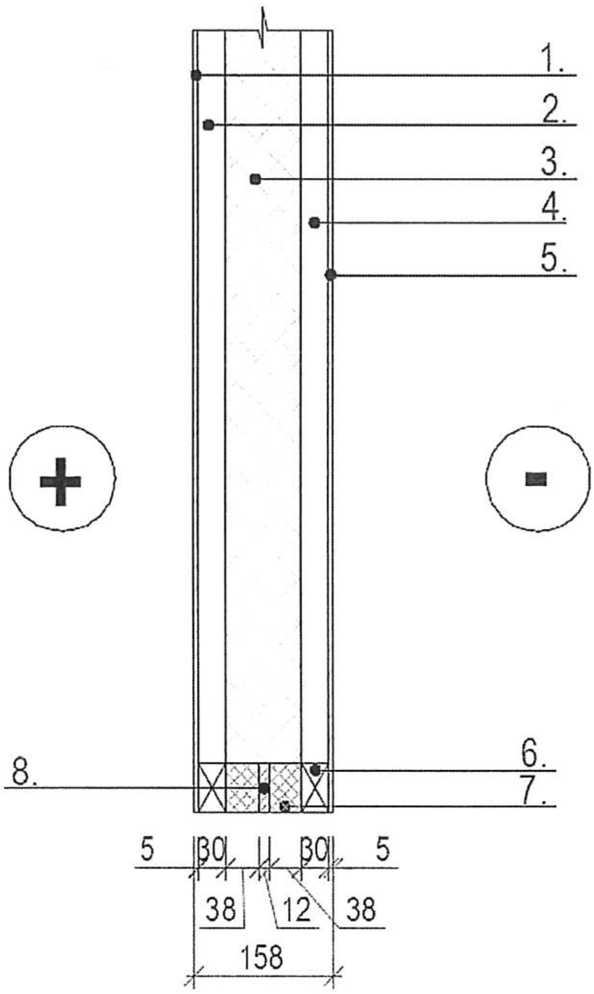
**Annex 5.** ***Specimen design data***




| | |
|---|---|
| 1. | OSB 5 mm |
| 2. | Air gap 30 mm (#1) |
| 3. | TRISO HYBRID$^S$ 88 mm |
| 4. | Air gap 30 mm (#2) |
| 5. | OSB 5 mm |
| 6. | XPS (extruded polystyrene) |
| 7. | XPS (extruded polystyrene) |
| 8. | plywood |

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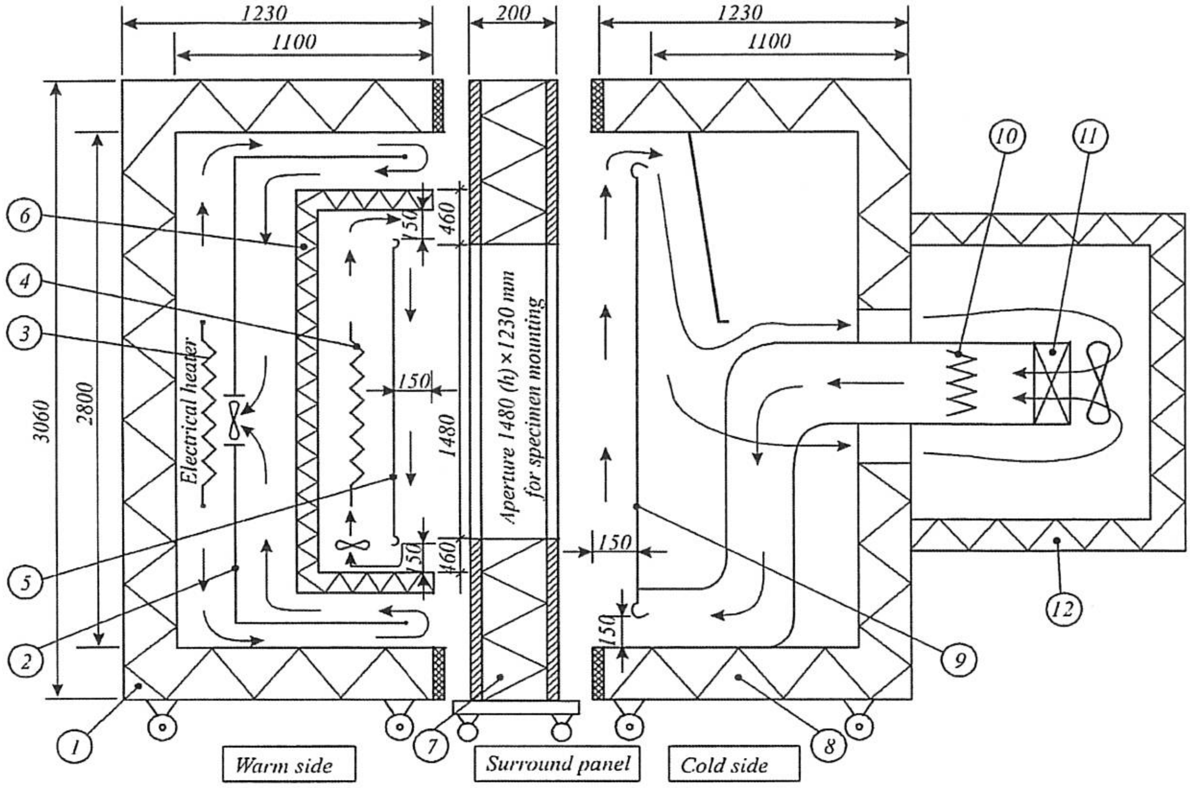
***Annex 6. Scheme of climate chamber „Hot box“***




1. Warm side guard box:
   - internal dimensions 2800 × 2800 × 1100 mm;
   - wall thickness 130 mm, total thermal resistance about 3 $m^2 \cdot K/W$.
2. Guard air flows deflecting screen.
3. Electrical heater, power 660 W, controlled according to a set point temperature in metering box (6).
4. Electrical heater of metering box, power control from 13W to 660 W.
5. Warm side baffler (of metering box) with surface and air temperature sensors.
6. Metering box – internal dimensions 2400 × 2400 × 360 mm.
7. Surround panel: 200 mm thick, core material EPS polystyrene (faced with 3 mm thick cellular PVC plastic sheet on either side), thermal resistance about 6 $m^2 \cdot K/W$, 1484 x 1234 mm aperture for specimen mounting.
8. Cold side box:
   - internal dimensions 2800 × 2800 × 1100 mm;
   - wall thickness 130 mm, total thermal resistance about 3 $m^2 \cdot K/W$.
9. Cold side baffler with surface and air temperature sensors.
10. Cold side box controlled
11. Cold side controlled cooling air unit, max. cooling power up to 3 kW.
12. Cold side air cooling box with 5 speed motor fan. electrical heater, max. power 2 k

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