INSTITUTE OF ARCHITECTURE AND CONSTRUCTION OF KAUNAS UNIVERSITY OF TECHNOLOGY

BUILDING PHYSICS LABORATORY

LIETUVOS NACIONALINIS AKREDITACIJOS BIURAS

BANDYMAI ISO/IEC 17025 Nr. LA.01.031

TEST REPORT No. 215-2 SF/23 U

Date: 20 of November 2023

Determination of thermal resistance of reflective insulation product according LST EN ISO 22097:2023 and LST EN ISO 8990:1999

(test title)

Test method: **LST EN ISO 22097:2023** Thermal insulation for buildings-Reflective insulation products-Determination of thermal performance (ISO 22097:2023);
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: **Product:** reflective multilayer insulation product Type 3
Name of product: BOLTHERM 121P/121PIGN
Thickness of product installed in the „Hot box" – 5 mm
Declared thickness of product – 5 mm *
* Declaration number: ETA 22/0178

(name, description and identification details of a specimen)

Customer: Parque Industrial, Rua M, Lote 15, 6200-027, Covilha, Portugal

(name and address)

Manufacturer: Parque Industrial, Rua M, Lote 15, 6200-027, Covilha, Portugal

(name and address)

Test results:

Name of the indicator and unit	Test method reference no.	Test result
Thermal resistance *R* with 2 air gaps, $(m^2 \cdot K)/W$	LST EN ISO 8990:1999 LST EN ISO 22097:2023	**1.11**
R-core thermal resistance of product **BOLTHERM 121P/121PIGN**, $(m^2 \cdot K)/W$	LST EN ISO 22097:2023	**0.15 ***
Position of specimen: vertical (direction of heat flow – horizontal) * R-core value of direct measurement in "Hot box"		

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

(name of the test laboratory)

Specimen delivery date: 2023-10-12 **Date of testing:** 2023-11-05 **Production data:** 2023-10-27

Sampling: The test specimen sampled by customer.

Additional information: Application – 2023-09-01;
Description of the sample – 2023-09-01

(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.

Annex 1. Test results:

Data element	unit	Value
Air velocity on warm side, downwards, v_i	m/s	0.11
Air velocity on cold side, upwards, v_e	m/s	4.54
Total power input to metering box, Φ_{in}	W	50.074
Heat flow density through a specimen, q_{sp}	W/m^2	16.8920
Corrected heat flow density through a specimen, q_c	W/m2	17.2685
Warm side air temperature, θ_{ci}	°C	23.33
Cold side air temperature, θ_{ce}	°C	-1.77
Surface temperature of the warm side, τ_{si}	°C	19.618
Surface temperature of the cold side, τ_{se}	°C	0.443
Temperature difference between surfaces, $\Delta\tau_s$	°C	19.175
Thermal resistance of insulation system, R	m^2·K/W	1.110
Thermal resistance of product, R_{core}	m^2·K/W	0.148
Uncertainty of the measurement, ΔR	m^2·K/W	± 0.0360

Tested by: A. Burlingis Date: 2023-11-05

Annex 2. Parameters of Guarded Hot Box measurement.

Table 1. Insulation system's specimen measured at 20°C/0°C temperature regime

Guarded Hot Box measurement. Parameters of insulation system's specimen:			
Specimen's area A, m²	1.831	Actual mean thickness of specimen, mm	≈ **65**
Position of a specimen	vertical	Length of specimen perimeter L, m	5.44
	Linear thermal transmittance of perimeter zone Ψ_L, W/(m·K)		-0.006615

Measurement data:							
Insulation system with product:							Result:
Sample No.	Temperature regime, °C	Hot side surface temperature τ_h, °C	Cold side surface temperature τ_c, °C	Temperature difference $\Delta\tau = (\tau_h - t\tau_c)$, °C	Measured heat flow density **q**, W/m²	Corrected heat flow density **q_c**, W/m²	**R-value** of insulation system, m²·K/W
215-2/23	20 / 0	19,6178	0,4433	19,1745	16,8920	**17,2685**	**1,110**±0,0360

Annex 3. Specimen product and air gaps thermal properties

Table 2. Results of insulation product R-core value of direct measurement

Product	Thickness, *d mm*	Hot side temperature τ_h, °C	Cold side temperature τ_c, °C	Temperature difference $\Delta\tau$, °C	Heat flow density q_c, W/m²	Product's core $R_{c,m,pr}$ *value*, m²·K/W
215-2/23	≈5	11,5275	8,9700	2,5575	17,2685	**0,148**±0,0167

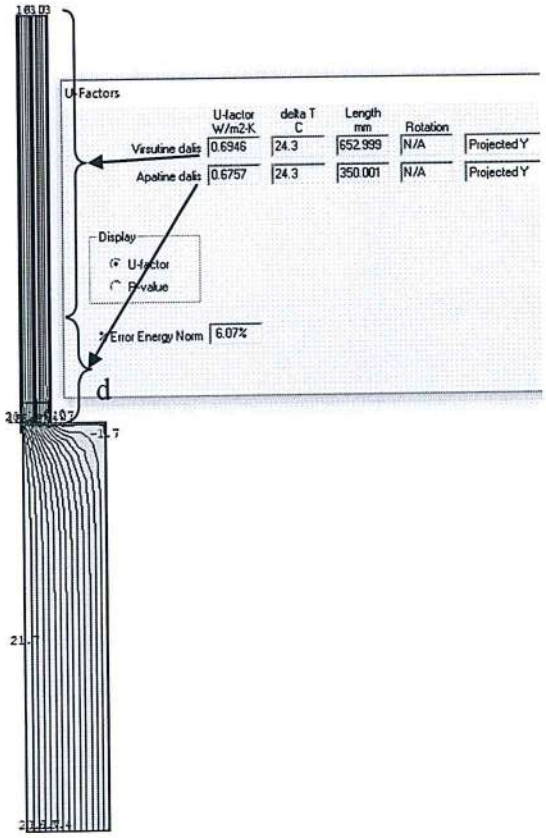
Table 3. Insulation specimen air gaps values of direct measurement according to LST EN ISO 22097:2023

Air gap number	Thickness *d*, mm	Measured temperature differences of surfaces, $\Delta\tau$, °C	Air gap *R* value, m²·K/W
Air gap #1	30	8.090	0.4669
Air gap #2	30	8.527	0.4921

R-core thermal resistance value calculation according to LST EN ISO 22097:2023:

$$R_{c,pr} = 1.110 - 0.4669 - 0.4921 = 0.148 \text{ (m}^2\text{·K)/W}$$

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



Perimeter zone's *U*-value: 0.6757 W/(m²·K); width "d"– 350 mm;

Central area *U*-value: 0.6946 W/(m²·K).

Perimeter's linear thermal transmittance: $\psi = (0.6757-0.6946)\cdot 0.350 =$ **-0.006615** 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, m²;

Q – measured mean heat flow through a specimen, W;

q – measured mean heat flow density through a specimen, W/m²;

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/m²;

L – perimeter length of a specimen, m;

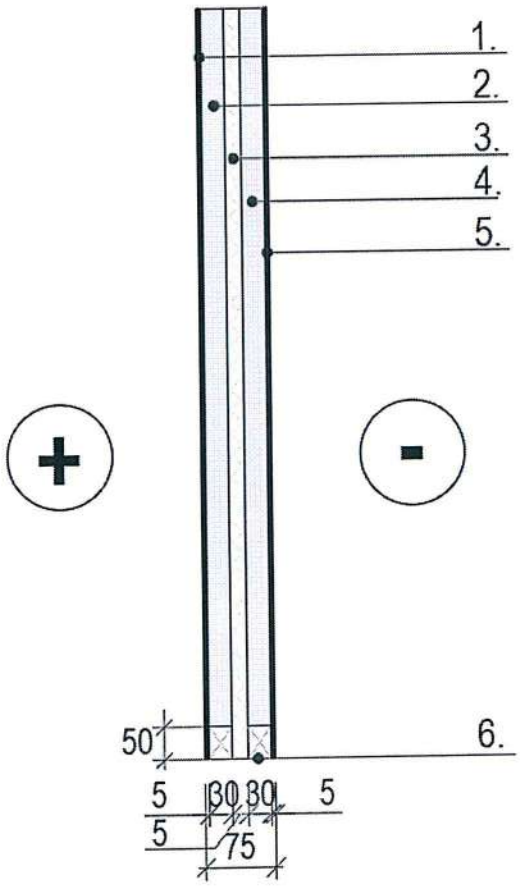
Δt – ambient temperature difference across a specimen, K;

ψ - perimeter's linear thermal transmittance of a specimen, W/(m·K).

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

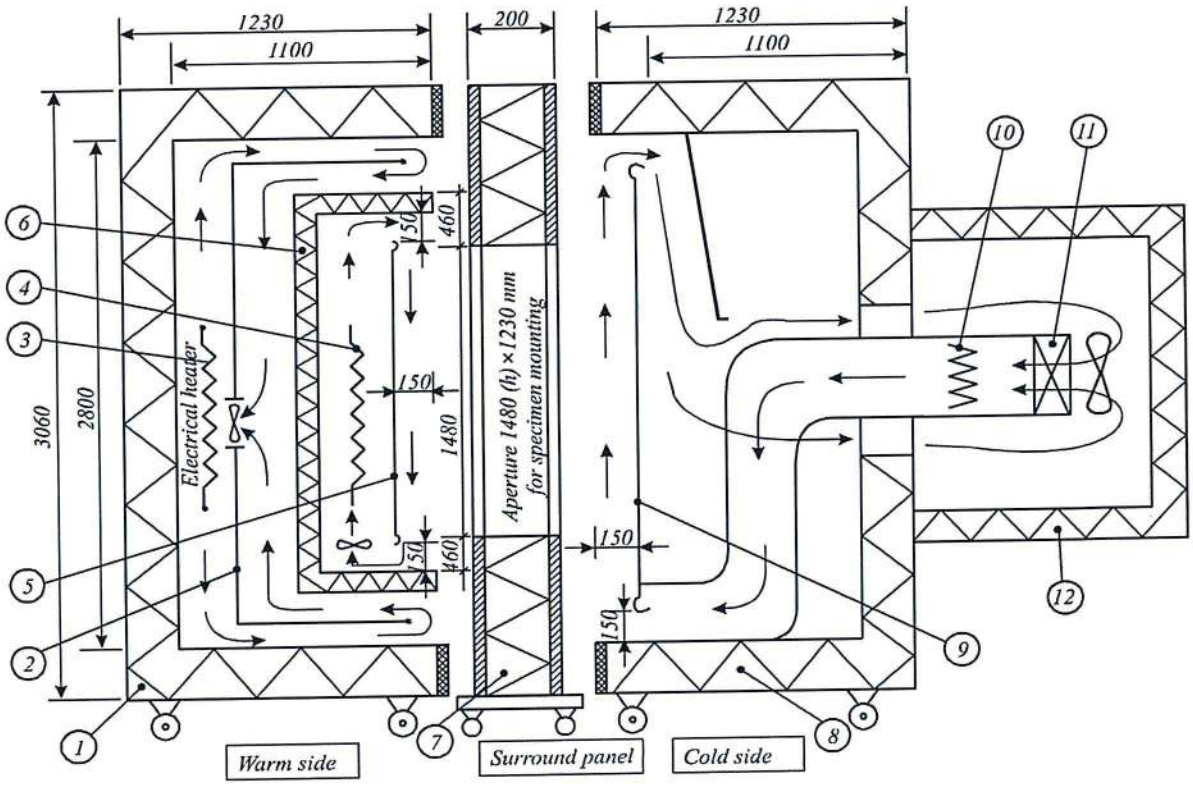
$\Delta\tau$ – temperature difference across a specimen, K.

Annex 5. Specimen design data



1.	PVC 5 mm
2.	Air gap 30 mm (#1)
3.	**BOLTHERM 121P/121PIGN**
4.	Air gap 30 mm (#2)
5.	PVC 5 mm
6.	XPS (polystyrene)

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 kW.