NATIONAL PHYSICAL LABORATORY
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# Test Report

0002

## THERMAL TRANSMITTANCE OF A SECTION OF INSULATED ROOF

| | |
|---|---|
| FOR | Holdex ITC SA<br>Route de Clervaux 49<br>L-9991 WEISWAMPACH<br>Luxembourg<br><br>For the attention of Pierre Casier |
| IDENTIFICATION | CSM-4 Firm Price Agreement quotation number E06110187, dated 10 November 2006. NPL specimen number R062 was assigned to the section of insulated roof. |
| BASIS OF TEST | The NPL Rotatable Wall Guarded Hot Box whose calibration is traceable to National Standards and using the measurement procedures defined in the European Standard BS EN ISO 8990. |
| UNCERTAINTY | The overall measurement uncertainty is estimated to be within $\pm 7.2\%$ based on a standard uncertainty multiplied by a coverage factor $k = 2$, providing a level of confidence of approximately 95 %. |



**Date of issue:** 20 August 2007 **Signed:** R. Williams (Authorised Signatory)

**Checked by:** **Name:** Ray Williams for Managing Director

## 1 DESCRIPTION OF THE SPECIMEN

| | **NPL Identity Number** **R062**<br>**Service Number** **E06110187** |
|---|---|
| Manufacturer's name | Holdex ITC SA |
| Description of test element | Representative roof section insulated with "STARFLEX PRO"<br>A sectional drawing of the insulated roof section is shown in Figure 1.<br>Rafter thickness = 65 mm<br>Rafter depth = 154 mm<br>Vapour barrier type = Tile felt<br>Counter batten depth = 25 mm<br>Plaster board = 9.5 mm |
| Technical description of insulation | STARFLEX PRO Insulation comprises:<br>• pure aluminium sheet<br>• polypropylene closed cell foam 3.3 mm<br>• polypropylene non woven<br>• polypropylene closed cell foam 3.3 mm<br>• pure aluminium sheet<br>The total insulation thickness is approximately 8 mm |

A sketch of the roof element tested can be seen in Figure 1.

NB: - The rafter thickness used in most of the recent evaluations of the thermal performance of reflective insulation installed in a roof structure at NPL has been 38 mm. The rafters used in this test element were 65 mm. Furthermore to ensure a representative area of rafter is included in the test element the rafters at the sides of the test element are usually made to be half thickness. In this test element they were full thickness. Both of those variations from the normal will increase the cold bridging effect of the rafters and so produce a slightly higher U-value.

## 2 THE APPARATUS

Thermal transmittance measurements are made in the NPL Rotatable Wall Guarded Hot Box, described in NPL Report CBTLM 25. Where relevant, the equipment and measurement procedures are in accordance with the requirements of BS EN ISO 8990:1996. The main features of the equipment are summarised below:

- The interior dimensions of the hot box are 2.4 m x 2.4 m.
- All surfaces "seen" by the test element are matt black.
- There are twenty-five air temperature sensors, 75 mm from the holder panel face, positioned at the centres of squares of equal areas in front of the specimen in both the hot and cold boxes.
- The specimen was held at 45 degrees to the horizontal during this test.

## 3 MEASUREMENT PROCEDURES

The measurement procedure used was essentially an air-to-air method. Thermocouples were also mounted on the hot and cold surfaces of the specimen to facilitate calculation of the environmental temperatures, as specified in BS EN ISO 8990.

The 1.45 m x 1.23 m x 0.189 m roof panel (see figure 1) were mounted in a 300 mm thick expanded polystyrene (EPS) surround panel. The heat flow through this surround panel was calculated from its thermal conductivity and the surface temperature difference across it. The thermal conductivity of the EPS material was measured in the NPL guarded hot plate facility.

The small heat flow around the test element boundaries was calculated using the 2D FEA software tool THERM5 produced by the Lawrence Berkeley National Laboratory, USA.

Thermal transmittance values quoted are the mean of five sets of readings taken at two-hourly intervals. Equilibrium is assumed when the maximum difference between the five thermal transmittance values is less than approximately 2%.

## 4 RESULTS

The measurements on R062 were carried out on the 30 April 2007.

The standardised thermal transmittance value for R062 is given in Table 2, and a summary of the main experimental parameters is given in Table 3.

Table 2 Standardised Thermal Transmittance (U)

| NPL ID number<br>Customer identity | Test element description | Mean environmental temperature (°C) | Environmental temperature difference (°C) | Standardised[1] thermal transmittance ($W/m^2.K$) |
|---|---|---|---|---|
| R062<br>Roof section insulated with STARFLEX PRO insulation | See figure 1 | 12.37 | 19.17 | 0.633 |

Note [1] Standardized to include a standard, total surface resistance value of 0.17 ($m^2.K$)/W instead of the total surface resistance of 0.166 ($m^2.K$)/W that was produced during the measurement.

Table 3 Measurement data for R062

| | | |
|---|---|---|
| **Test element number R062** | | |
| Holdex ITC SA roof section insulated with STARFLEX PRO insulation | | |
| **Test element dimensions** | | |
| Height | 1.451 | m |
| Width | 1.232 | m |
| Thickness | 189 | mm |
| **Measured values** | | |
| Mean warm air temperature | 22.22 | °C |
| Mean warm baffle temperature | 21.78 | °C |
| Mean cold air temperature | 2.78 | °C |
| Mean cold baffle temperature | 2.84 | °C |
| Power to hot box | 30.967 | W |
| Air flow rate in the cold box | 4.8 | m/s |
| Air flow rate in the hot box | 0.37 | m/s |
| **Calculated values** | | |
| Boundary loss correction (calc with THERM5) | 0.47 | W |
| Heat flux density through specimen | 12.164 | W/m² |
| Warm side environmental temperature | 21.96 | °C |
| Cold side environmental temperature | 2.79 | °C |
| Environmental temperature difference | 19.17 | °C |
| Environmental temperature mean | 12.37 | °C |
| Measured thermal transmittance (U) | 0.635 | W/(m²·K) |
| Total measured surface resistance | 0.166 | (m²·K)/W |
| **Standardised thermal transmittance (U)** (to a standardised total surface resistance of 0.17 ($m^2$.K)/W) | **0.63** | **W/(m²·K)** |

**Figure 1 Test element design**

Note: The test element measured did not include tiles.