



Celotex Corporation  
Testing Services

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## THERMAL TESTING LABORATORY REPORT

June 17, 1998

**Client:** Tenneco Packaging - AVI  
1411 Pidco Drive  
Plymouth, IN 46563

**MTS Job No.:** 258481A

**Project:** Thermal Performance of an Astro-Foil Reflective Insulation Floor Assembly

### Introduction:

This report presents the results of thermal tests conducted on material submitted to our laboratory on April 6, 1998. Testing was completed on May 26, 1998.

### Sample Identification:

Two (2) 48 inch wide rolls of reflective insulation material were supplied by the client and identified as Astro-Foil foil/bubble/bubble/foil (FBBF) reflective insulation.

### Sample Preparation:

An 8 by 8 ft wall test assembly was fabricated using 5/16 inch thick Astro-Foil reflective insulation as per the client's request. A nominal 2 by 6 inch wood frame was constructed using 1.5 by 5.5 inch studs fastened together with wood screws. Four (4) framing members were placed 24 inches on center beginning 12 inches off the center line in the 8 by 8 foot test section opening. The reflective insulation was installed at the midpoint of the 5.5 inch stud dimension with staples and tightly draped between the framing members to form two (2) equal 2.75 inch air cavities between the reflective insulation and the 0.75 inch thick plywood sheathing to be placed on each side. A polystyrene baffle was installed to isolate the 6 by 6 foot metering area. All joints were sealed with caulk to prevent any air infiltration.

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Instrumentation:

The system was instrumented in accordance with ASTM C1224-93, "Standard Specification for Reflective Insulation for Building Applications".

Fifteen (15) type T, 30 gauge, thermocouples were used to measure the internal reflective air cavity, stud and plywood, surface temperatures for each side. Six (6) pairs of thermocouples were attached to the inside surface of the plywood with non-reflective aluminum tape and symmetrically positioned with the centerline of the inner most wood studs to determine temperature difference across the studs. Nine (9) pairs of thermocouples were attached to the inside surface of the plywood with non-reflective aluminum tape and symmetrically positioned with respect to the inner most reflective air cavity area to determine the temperature difference across the insulated cavity.

Test Method:

The thermal transmission properties were determined in accordance with the following American Society for Testing and Materials standard test methods at controlled laboratory conditions of 70°F and 50% relative humidity.

ASTM C 236-89 (Reapproved 1993), "Standard Test Method for Steady-State Thermal Performance of Building Assemblies by Means of a Guarded Hot Box"

ASTM C 518-91, "Standard Test Method for Steady-State Heat Flux Measurements by Means of the Heat Flow Meter Apparatus"

Vertical heat flow down was used to simulate the insulated floor cavity assembly. The testing was performed at a cavity mean temperature of  $75 \pm 4$  °F with a temperature difference across the insulated cavity of  $30 \pm 2$ °F.

The frame's wood studs were thermally characterized in an ASTM C518, heat flow meter apparatus. The insulation's thermal resistance was calculated using the guarded hot box measurements and the wood stud test information.

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Summary of Results:

The calculated thermal resistance of the framing members was determined to be 7.2 h ft<sup>2</sup>°F/Btu. ASTM C518 test results are located in the Appendix. All calculations are detailed in the Appendix.

The reflective insulation thermal performance results for horizontal heat flow are presented in Tables 1 and 2. All calculations are detailed in the Appendix of this report.

**Table 1: ASTM C 236, Guarded Hot Box Test Results**

Average Measured Data	Vertical-Down Test
Hot Surface Temperature (Cavity), °F	89.1
Cold Surface Temperature (Cavity), °F	59.8
Hot Surface Temperature (Frame), °F	88.7
Cold Surface Temperature (Frame), °F	60.1
Mean Temperature (Cavity), °F	74.5
Surface Temperature Difference (Cavity), °F	29.3
Average Power, Watts	24.64

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Summary of Results (Continued):**Table 2:** Reflective Insulation Thermal Performance Results

Heat Flow Direction	$Q_{TOTAL}$ Btu/h	$Q_{FRAME}$ Btu/h	$Q_{RI}$ Btu/h	$R_{RI}$ h ft <sup>2</sup> °F/Btu
Vertical-Down	84.12	5.96	78.16	12.9

- Notes: 1.  $Q_{TOTAL}$  denotes the total measured heat flow through the test assembly.  
 2.  $Q_{FRAME}$  denotes the calculated heat flow through the framing members.  
 3.  $Q_{RI}$  denotes the calculated heat flow through the reflective insulation cavity.  
 4.  $R_{RI}$  denotes the calculated thermal resistance of the reflective insulation and the accompanying air cavities as tested at the Celotex Corporation Technical Center

Tested by:

Russell Woltemar  
 Russell W. Woltemar  
 Research Technologist

Approved by:

Stanley D. Gatland II  
 Stanley D. Gatland II  
 Research Engineer

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# **A P P E N D I X**

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## Reflective Insulation Calculations Procedure

### Calculation Constants

$$\text{Metering Area} = 36 \text{ ft}^2$$

$$A_{\text{STUDS}} = (2)(1.5" \times 72") = 216 \text{ in}^2 = 1.50 \text{ ft}^2$$

$$A_{\text{RI}} = A_{\text{METERING}} - A_{\text{STUDS}} = 36 \text{ ft}^2 - 1.50 \text{ ft}^2$$

$$A_{\text{RI}} = 34.50 \text{ ft}^2$$

$$R_{\text{STUDS}} = \frac{7.2 \text{ h ft}^2 \cdot \text{°F}}{\text{Btu}} \quad (\text{Results from ASTM C518 test})$$

(5.5")

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Vertical Heat Flow Down Calculation

$$Q_{TOT} = 24.64 \text{ W} / (0.2931 \text{ W/Btu/h})$$

$$Q_{TOT} = 84.12 \text{ Btu/h}$$

$$Q_{STUDS} = \frac{(A\Delta T)}{(R)_{STUDS}} = \frac{(1.50 \text{ ft}^2)(88.7 - 60.1) \text{ }^\circ\text{F}}{7.2 \frac{\text{h ft}^2 \text{ F}}{\text{Btu}}}$$

$$Q_{STUDS} = 5.96 \text{ Btu/h}$$

$$Q_{RI} = Q_{TOT} - Q_{STUDS} = (84.12 - 5.96) \text{ Btu/h}$$

$$Q_{RI} = 78.16 \text{ Btu/h}$$

$$R_{RI} = \frac{(A\Delta T)}{(Q)_{RI}} = \frac{(34.50 \text{ ft}^2)(89.1 - 59.8) \text{ }^\circ\text{F}}{78.16 \text{ Btu/h}}$$

$$R_{RI} = 12.9 \frac{\text{h ft}^2 \text{ }^\circ\text{F}}{\text{Btu}}$$

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## CELOTEX TECHNICAL CENTER TESTING SERVICES

### STEADY STATE THERMAL TRANSMISSION PROPERTIES BY MEANS OF THE HEAT FLOW METER APPARATUS PER ASTM C-518

MTS Job No.: 258481  
Project No.: 258481  
Sample Description: Spruce-Pine-Fir  
Sample I.D.: 2 by 6 Wood Stud

Specimen Orientation: Horizontal  
Heat Flow Meter Location: Upper & Lower Plate surfaces  
Instrument Used: LaserComp Modified Holometrix R-Matic

Duration of Measurement = --- Minutes  
Average Heat Flux = 5.79 Btu/(h sq. ft.)  
Average Lower (Hot) Plate Temperature,  $T_h$  = 96.7 F  
Average Upper (Cold) Plate Temperature,  $T_c$  = 55.0 F  
Average Temperature Difference = 41.7 F  
Mean Specimen Temperature,  $T_m$  = 75.8 F  
Average Thermal Resistance, R = 7.2 (h sq. ft. F)/Btu  
Average Thermal Conductance, C = 0.139 Btu/(h sq. ft. F)

#### Calculations Based on Thickness Measured in Apparatus

Thickness = 5.498 inch  
Average Temperature Gradient = 7.582 F/inch  
Average Apparent Thermal Conductivity, k = 0.764 (Btu in.)/(h sq. ft. F)

Operator: R. Woltemar  
Date: 05-26-98

#### Comments:

Density = 28.39 lbs/cu. ft.  
5 Point Thickness Measurements: 0.000   0.000   0.000   0.000   0.000 inches  
Average thickness = 0.000 inches

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