Innovative Energy
10653 W. 181st Avenue
Lowell, IN 46356
Attn. Mr. Robert Wadsworth

May 3, 1998

Dear Mr. Wadsworth:

The overall thermal resistances of specific building assemblies containing reflective air spaces have been calculated using the Fortran program REFLECT.FOR (Proc. of the 1990 Fire Safety and Thermal Insulation Conference, Pinellas Park, FL, pgs. 213-231) to calculate the thermal resistance contributed to the assembles by internal reflective air spaces. Since the thermal resistance of a reflective air space depends on the temperature difference across the air space, calculations were completed for temperature differences of 10°F and 30°F. Thermal resistance data for the components in the assembly other than the air spaces were taken from the ASHRAE Handbook (1993 ASHRAE Handbook of Fundamentals). All quantities in this communication have units in the BTU-in. system.

Outside air film	0.17
Inside air film	1.70 for horizontal heat flow
	4.55 for downward heat flow
Wood framing	1.06 per inch (average yellow pine)
3/4-in.-thick subfloor	0.94
5/8-in.-thick particle board	0.82
1/4-in.-thick ASTRO-FOIL	0.90
Emittance of Al foil	0.03
Emittance of wood	0.90

The assemblies that were considered consist of framing on 16-in. centers with 3/4-inch-thick plywood sheathing on both sides. ASTRO-FOIL is installed to provide two equal thickness air spaces within the specified cavity. The framing dimensions have been adjusted to account for the thickness of the ASTRO-FOIL. For example, two 1/2-inch-thick air spaces require 1.25 inches of framing.

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Table I. Contains calculated R-values for cavities containing two reflective air spaces formed by nominal 1/4-inch-thick ASTRO-FOIL. The average temperature is 75°F in each Case The temperature difference across the cavity was taken to be either 10°F or 30°F The exterior air-to-air temperature differences will be a few degrees greater than 10°F or 30°F, respectively

Table 1 Calculated Cavity R-Values

Number of air spaces	Width of each space (in)	Calculated R Δ T=10°F	Calculated R Δ T=30°F
		Heat-Flow Down	
2	0 50	6.0	6.0
2	1.75	15.0	14.7
2	2 50	18 9	18 1
2	5 00	26 2	23.4
		Heat-Flow Horizontal	
2	0 50	6 0	5.8
2	1.75	8 6	7.6
2	2.50	10.1	7 4
2	5 00	9 9	7.6

The calculated R-values listed in Table 1. were combined with the component R-values taken from the ASHRAE Handbook of Fundamentals to obtain "overall" R-values for assemblies with heat flow down or horizontal and reflective air-space temperatures of 10°F or 30°F U-values corresponding to the calculated R-values are shown in parentheses in Table 2.

Table 2. Calculated Assembly R-Values

Number of air spaces	Width of each air space (in.)	Air-to-Air R (U) with Δ T=10°F	Air-to-Air R (U) with Δ T=30°F
Heat-Flow Down			
2	0.50	11.9 (0.084)	11.9 (0.084)
2	1.75	19.7 (0.051)	19.4 (0.052)
2	2.50	23.1 (0.043)	22.5 (0.044)
2	5.00	30.3 (0.033)	29.1 (0.036)
Heat Flow Horizontal			
2	0.50	8.95 (0.112)	8.80 (0.114)
2	1.75	11.67 (0.086)	10.65 (0.092)
2	2.50	13.22 (0.076)	10.93 (0.091)
2	5.00	13.71 (0.073)	11.57 (0.086)

A system calculation for downward heat flow across a floor consisting of 5/8-inch-thick particle board, 3/4-inch-thick subflooring, nominal 2x10 inch floor joists on 16-in. centers, and 1/4-inch-thick ASTRO-FOIL attached to the bottom edge of the floor joists has been completed

REFLEC FOR was used to calculated the thermal resistance of the 9.5-inch-thick reflective air spaces formed by ASTRO-FOIL. The temperature difference across the reflective air space was taken to be 30°F.

	R-values (downward heat flow)	
	Across Framing	Across Cavity
Inside air film	0.68	0.68
5/8-in. particle board	0.82	0.82
3/4-in. subfloor	0.94	0.94
2 x 10 joists	10.07	---
9.5-in. air space	---	10.70
ASTRO-FOIL material	0.90	0.90
Bottom air film	4.55	4.55
Total	17.96	18.59

The totals from the above listing are combined to give an overall R-value of 18.5 (U-value of 0.054) for downward heat flow.

A series of R-value calculations for single reflective air spaces bounded on one side by 1/4-inch thick ASTRO-FOIL that is open to the interior air space have been completed. The results reported in Table 3 include the calculated value for the reflective air space and a total R-value that includes the material R-value for 1/4-inch-thick ASTRO-FOIL and the air-film resistance.

Table 3. R-Values for Single Reflective Air Spaces with 1/4-inch ASTRO-FOIL on one Boundary that is Open to the Interior Space

Width of Air Space (inches)	Heat Flow Direction	R (air space)	R (total)
1.0	down	4.47	9.92
1.0	horizontal	2.85	5.45
3.0	down	9.79	14.24
3.0	horizontal	2.65	5.25
12.0	down	10.50	15.95
12.0	horizontal	3.51	6.11

These calculations do not replace the need for direct measurements of the assemblies using guarded or calibrated hot boxes. The R-values for the reflective air spaces are based on assemblies of large parallel surfaces without multidimensional heat flows.

Sincerely,

David W. Yarbrough PhD, PE