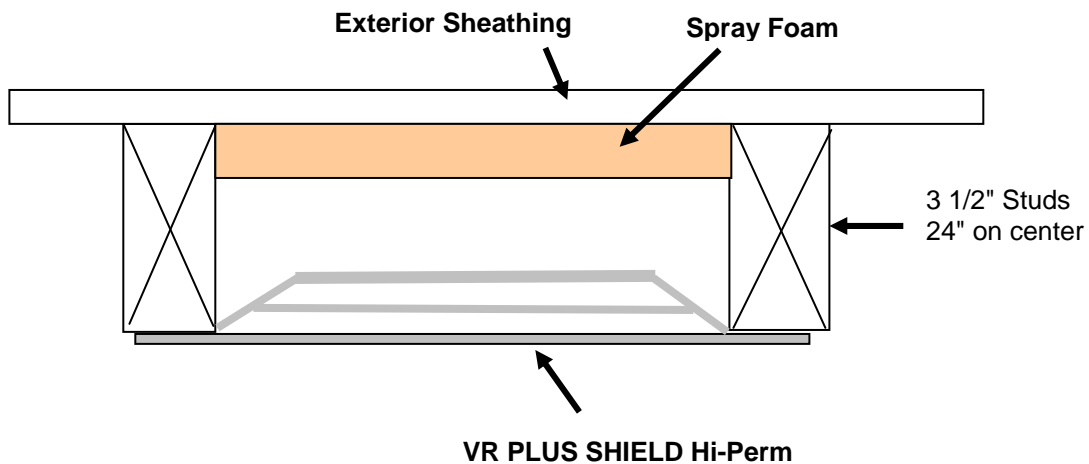




## **Calculated R-Values for Nominal 2x4 Wall Cavities Insulated with VR Plus Shield and Spray-Applied Cellular Plastic Foam**

The thermal resistances (R-values) for combinations of Fi-Foil VR-Plus Shield Reflective Insulation and spray-applied cellular foam plastic insulation have been calculated using a procedure published in ASTM STP 1116.<sup>1</sup> The reflective air spaces in the system have been corrected for two-dimension effects.<sup>2</sup> The configurations that have been evaluated are for nominal 2x4 wood framing 24-in. on center. VR-Plus Shield has two 3/8-inch internal reflective air spaces and one external reflective air space formed by the low-emittance outside surface of the reflective insulation material and the exposed surface of the foam. The foam is installed on the exterior side of the cavity. The reflective insulation is installed on the interior side of the cavity. The result is a layer of foam and a reflective insulation system with three reflective air spaces. The following diagram is a top view that shows foam on the exterior side of the wall cavity and VR-Plus Shield on the interior side of the cavity.



**Figure 1. Top View of Wall Cavity with Foam and Reflective Insulation Assembly**

<sup>1</sup> ASTM STP 1116, American Society for Testing and Materials (1991) pp. 24-43.

<sup>2</sup> J. of Thermal Insulation 14 281-294 (1991).

The calculated R-values are for mean temperature 75°F and a temperature difference across the cavity of 30 °F. The choice of temperatures is consistent with the labeling convention for residential insulations (75 °F) and the testing convention for reflective insulation systems (30 °F difference). The total space available for insulation in this case is 3.5 inches. As a result the space available for the reflective insulation is 3.5 minus the thickness of the foam layer. The air space between the reflective insulation and foam as a result depends on the thickness of the foam. Thermal resistivities (R-per-inch of thickness) of 6, 5, and 3.5 have been included in this evaluation. Each of the three foam types have been evaluated at thicknesses 2, 1.5, and 1 inch of thickness.

The following table contains the calculated R-values. The entries for “Total R” are for the insulation materials and reflective air spaces in the 3.5-inch cavity. All cavity R-values are reported in customary U.S. units at mean temperature 75 °F.

**Table 1. R-Values for Combinations of Foam and VR-Plus Shield**

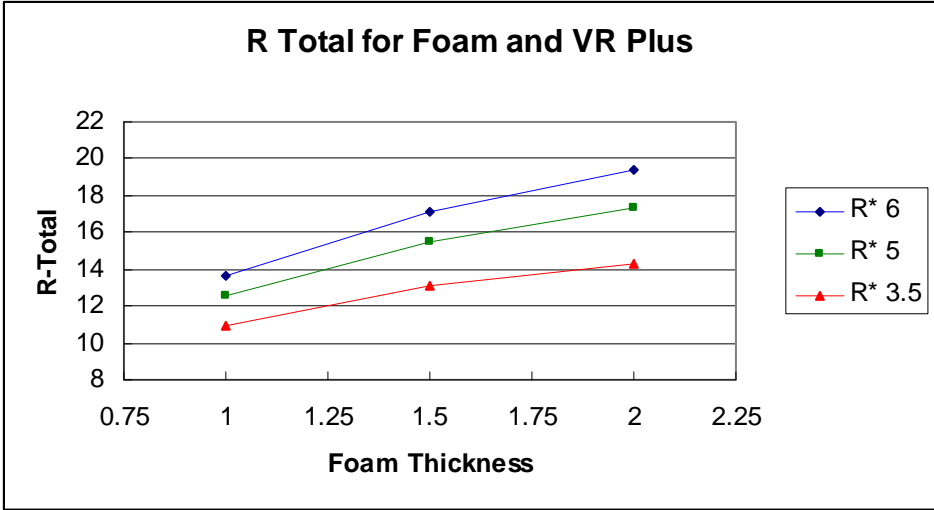
<u>System</u>	<u>Foam R</u>	<u>Reflective System R</u>	<u>Total R</u>
Foam R*=6.0	12	7.42	19.4
	9	8.09	17.1
	6	7.64	13.6
Foam R*=5.0	10	7.39	17.4
	7.5	8.02	15.5
	5.0	7.57	12.6
Foam R*=3.5	7.0	7.33	14.3
	5.25	7.87	13.1
	3.5	7.44	10.9

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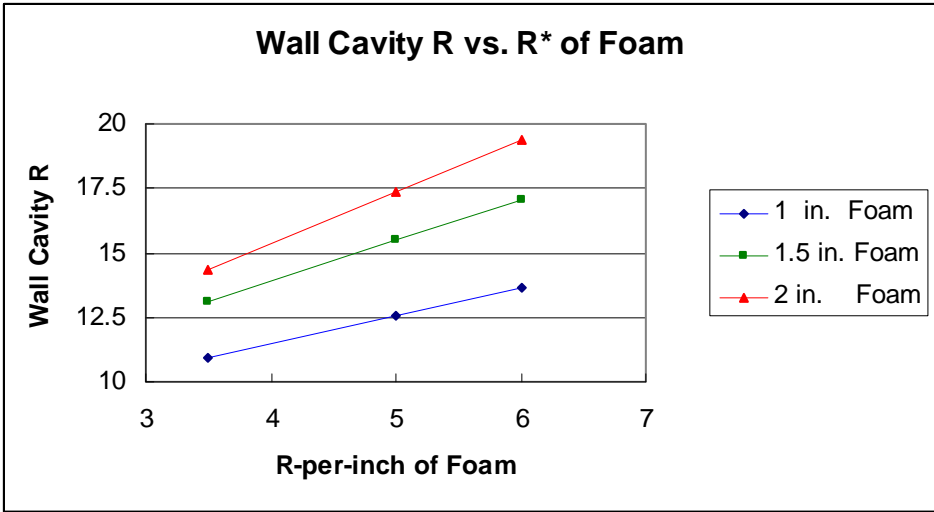
R\* - thermal resistivity per inch of thickness:  $\text{ft}^2 \cdot \text{h} \cdot ^\circ\text{F} / \text{Btu} \cdot \text{in}$

R - thermal resistance:  $\text{ft}^2 \cdot \text{h} \cdot ^\circ\text{F} / \text{Btu}$

The values in Table 1 have been used to construct two figures showing trends in the cavity thermal resistance that can be obtained with different R\* values and foam thicknesses. Figure 2 shows the variation in the total cavity R that can be attributed to changing the foam thickness at constant R\*. Figure 3 shows the variation in total cavity R that can be attributed to changes in the thermal resistivity of the foam at constant thickness. These data can be used to quickly estimate the performance for any type of foam and foam thickness in the range of values represented in the calculations. Interpolating equations and tables of interpolated values for R are attached.



**Figure 2. Wall Cavity R as a Function of Foam Thickness**



**Figure 3. Wall Cavity R as a Function of R\* for Foam**

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 January 2, 2008

## Interpolating Equations and Interpolated R-Values

The following array provides for interpolation in thickness results at fixed R\*.

R*	Equation for R at Thickness T		
6	$R=3.423+12.441*T-2.222*T^2$		
5	$R=3.431+11.293*T-2.158*T^2$		
3.5	$R=3.694+9.180*T-1.932*T^2$		

T	R*=6	R*=5	R*=3.5
1	13.64	12.57	10.94
1.1	14.42	13.24	11.45
1.2	15.15	13.88	11.93
1.3	15.84	14.46	12.36
1.4	16.49	15.01	12.76
1.5	17.09	15.52	13.12
1.6	17.64	15.98	13.44
1.7	18.15	16.39	13.72
1.8	18.62	16.77	13.96
1.9	19.04	17.10	14.16
2	19.42	17.39	14.33

The following array provides for interpolation in R\* at fixed thickness.

T	Equation for R at R*		
1	$R=7.106+1.1053R*-0.0027R*^2$		
1.5	$R=7.321+1.6961R*-0.0115R*^2$		
2	$R=7.137+2.0643R*-0.0029R*^2$		

R*	T=1	T=1.5	T=2
3.50	10.94	13.12	14.33
3.75	11.21	13.52	14.84
4.00	11.48	13.92	15.35
4.25	11.75	14.32	15.86
4.50	12.03	14.72	16.37
4.75	12.30	15.12	16.88
5.00	12.57	15.51	17.39
5.25	12.83	15.91	17.89
5.50	13.10	16.30	18.40
5.75	13.37	16.69	18.91
6.00	13.64	17.08	19.42
6.25	13.91	17.47	19.93
6.50	14.18	17.86	20.43