MPS No. 1001

Subject: **Understanding Thermal Design Terms**

Date: **January 2008 (Revised January 2019)**

R-value (Thermal Resistance)

R-value, or thermal resistance, is a measure of a material's or a construction's ability to retard heat flow. A higher R-value provides better thermal insulation performance. R-values of materials in series can be added to determine a construction's total thermal resistance.

Although not normally written, the units of R-values are $\frac{hr \cdot ft^2 \cdot {}^oF}{Btu}$ or $\frac{m^2 \cdot {}^oC}{W}$

U-value (Thermal Transmittance)

U-value is a measure of a material's or a construction's ability to allow heat to pass through itself. A lower U-value provides better thermal insulation performance. It is the reciprocal of a construction's R-value.

U-values include air film resistances. The units of U-value are $\frac{Btu}{hr \cdot ft^2 \cdot {}^oF}$ or $\frac{W}{m^2 \cdot {}^oC}$

C-value (Thermal Conductance)

C-value is a measure of a material's or a construction's ability to allow heat to pass through itself. It is the same as U-value but without air film resistances. A lower C-value provides better thermal insulation performance.

The units of C-values, just like U-values, are $\frac{Btu}{hr \cdot ft^2 \cdot {}^oF}$ or $\frac{W}{m^2 \cdot {}^oC}$

K-value (Thermal Conductivity)

K-value is a measure of a homogeneous material's ability to allow heat to pass through itself, independent of its thickness. A lower K-value provides better thermal insulation performance. If we multiply a material's C-value by its thickness, we have its K-value.

$$K = \frac{1}{R} \cdot t = \frac{t}{R}$$

The units of K-value are $\frac{Btu \cdot in}{hr \cdot ft^2 \cdot {}^oF}$ or $\frac{W}{m^2 \cdot {}^oC}$

Example

	Component R-value
Inside Air Film	0.7
1/2" Gypsum Wallboard	0.5
R-19 Fiberglass	19.0
1" ThermaFoam R-Control 250	4.8
Wood Siding	0.8
Outside Air Film	0.2
Wall R-value	26.0

Using the example:

$$U = \frac{1}{R} = \frac{1}{26.0} = 0.038$$

From the example, the wall's R-value without air films is 26.0 minus 0.9 (0.7 + 0.2) or 25.1.

$$C = \frac{1}{R} = \frac{1}{25.1} = 0.040$$