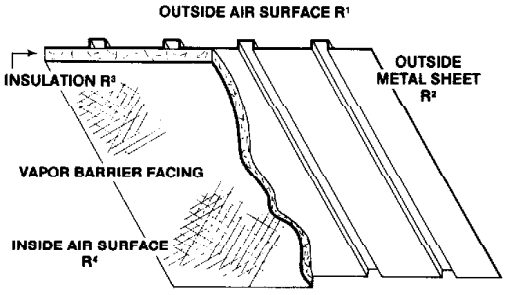
# Calculated U Values

The traditional method to obtain thermal transmittance (U) is by means of the reciprocal of the sum of the R Values.

$$U = \frac{1}{R^1 + R^2 + R^3 + R^4 + \ldots} \text{ or } \frac{1}{R^T}$$

An R Value is a measure of the **resistance** of a material to heat flow while the U Value is a measure of the **transmittance** of heat.

Heat transfer due to the compression of the insulation at the girts and purlins is not considered in the calculated method.




## INSULATION WITH FOIL-SCRIM-KRAFT FACING

| | | | THERMAL TRANSMITTANCE—U | | | |
|---|---|---|---|---|---|---|
| | | | WINTER 40°F MEAN TEMP. | | SUMMER 75°F MEAN TEMP. | |
| APPROX. THICKNESS | DESIG-NATION | RESISTANCE WINTER/SUMMER | ROOF | WALL | ROOF | WALL |
| 1½" | R5 | 5.45/5.00 | .144 | .137 | .102 | .144 |
| 2" | R6 | 6.99/6.41 | .118 | .113 | .089 | .120 |
| 3" | R10 | 10.91/10.00 | .081 | .078 | .068 | .084 |
| 4" | R13 | 14.20/13.00 | .064 | .062 | .056 | .067 |
| 5" | R16 | 17.48/16.00 | .053 | .052 | .048 | .056 |
| 6¼" | R19 | 20.76/19.00 | .045 | .044 | .042 | .048 |

R of outside air—summer = .25
R of outside air—winter = .17
R of inside air—roof—summer—non reflective = .92
R of inside air—walls—summer—non reflective = .68
R of inside air—roof—summer—reflective = 4.55
R of inside air—wall—summer—reflective = 1.70
R of inside air—roof—winter—non reflective = .61
R of inside air—walls—winter—non reflective = .68
R of inside air—roof—winter—reflective = 1.32
R of inside air—walls—winter—reflective = 1.70
R of metal panels is negligible

Notes: Resistance Values are taken from the standard formula, R = t/k where t = insulation thickness and k = thermal conductivity of one inch thick insulation.

All other values, except those products designated as fiberglass and faced fiberglass, are taken from the ASHRAE Handbook of Fundamentals 1977.

The additional heat transfer due to compression of the insulation at framing members is not calculated in these tables.

## Example of "U" Value Calculation

R 10, 3" thick insulation faced with White Vinyl. Summer calculation for the roof—

| | | |
|---|---|---|
| | $R^1$ Outside Air Surface | = .25 |
| + | $R^2$ Outside Metal Sheet | = Negl. |
| + | $R^3$ Insulation | = 10.00 |
| + | $R^4$ Inside Air Surface | = .92 |
| | $R^T$ | = 11.17 |

$$U = \frac{1}{R^T}$$

$$U = \frac{1}{11.17}$$

$$U = .090$$

## INSULATION WITH NON-REFLECTIVE FACING

| | | | THERMAL TRANSMITTANCE—U | | | |
|---|---|---|---|---|---|---|
| | | | WINTER 40°F MEAN TEMP. | | SUMMER 75°F MEAN TEMP. | |
| APPROX. THICKNESS | DESIG-NATION | RESISTANCE WINTER/SUMMER | ROOF | WALL | ROOF | WALL |
| 1½" | R5 | 5.45/5.00 | .161 | .159 | .162 | .169 |
| 2" | R6 | 6.99/6.41 | .129 | .128 | .132 | .136 |
| 3" | R10 | 10.91/10.00 | .086 | .085 | .090 | .091 |
| 4" | R13 | 14.20/13.00 | .067 | .066 | .071 | .072 |
| 5" | R16 | 17.48/16.00 | .055 | .055 | .058 | .059 |
| 6¼" | R19 | 20.76/19.00 | .046 | .046 | .050 | .050 |

## Resistance (R) Data for Various Other Building Materials

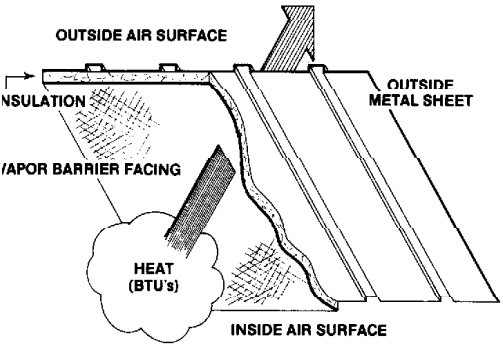
| MATERIAL | "R"/SECTION | "R"/INCH OF THICKNESS |
|---|---|---|
| Plastic Skylight, single wall | 0.09 | |
| Plastic Skylight, double wall | 0.65 | |
| Glass, single pane | 0.04 | |
| Glass, double pane | 0.87 | |
| Concrete block, 8" | 1.11 | |
| Cinder block, 8" | 1.72 | |
| Air Space—Vertical, 1" to 4" thick | 1.00 | |
| Air Space—Horizontal, 1" to 4" thick | 0.80 | |
| Asbestos—cement board | | 0.25 |
| Concrete | | 0.15 |
| Face brick | | 0.11 |
| Plasterboard | | 0.90 |
| Plywood | | 1.25 |
| Stone | | 0.08 |

A key advantage of metal building systems is the ease in which they are insulated. Fiberglass insulation with a facing applied to one side, which we term as Faced Flexible Fiberglass, is one of the most commonly used materials.

The most important reason for insulating a metal building is to retard the flow of heat. The performance achieved by the insulation selected will influence the environment inside the building and the capital investment in cooling and heating equipment.

A variety of terms and symbols are used to measure thermal performance. The most frequently used heat transfer term is U Value.

## Thermal Transmittance U Value (BTU/HR/SF/°F)




U value is the amount of heat expressed in Btu's passing through a complete building section including air films. Technically, it is heat transmission in Btu's per hour, per square foot, per degree Fahrenheit of temperature difference from air to air for a composite building section.

## Tested U Values and Calculated U Values

Of paramount importance is a recognition that U values can be determined in more than one way. As various insulation alternatives and construction methods are compared, the same type of U value determination should be used to allow an "apples to apples" comparison.

Guarded Hot Box

## Tested U Values

The most reliable values are those derived from tests of the actual construction simulating in-place conditions with insulation compressed at the framing members. This has been accomplished through the use of a testing device called the Guarded Hot Box and test method ASTM C-236.

### Thermal Transmittance U Values Tested

| FIBERGLASS INSULATION THICKNESS | DESIGNATION | U VALUE |
|---|---|---|
| 1½" | R 5 | .20 |
| 2" | R 6 | .17 |
| 3" | R 10 | .13 |
| 4" | R 13 | .12 |

Insulation compressed over purlins and girts spaced at 5 feet.
Fasteners applied on 12" centers.
Fiberglass Density .6 Lb./Cu. Ft.
Mean Wall Temperature 36.7°F
Data provided by the Metal Building Manufacturers Association (MBMA) and The Thermal Insulation Manufacturers Association (TIMA) 4/76.

✱ Using the above data and the subsequent formula developed by TIMA, these U values were extrapolated for insulation thicknesses not tested. These extrapolated U values were cross-checked using a special ASHRAE formula for panels containing metal elements, such as purlins and girts, and were found to be in close agreement.