COMMERCIAL & RESIDENTIAL GARAGE DOOR DIVISION

DASMA TECHNICAL DATA SHEET

Door & Access Systems Manufacturers Association International

#163

1300 Sumner Avenue
Cleveland, Ohio 44115-2851
Phone: 216-241-7333 • Fax: 216-241-0105
E-mail: dasma@dasma.com

R-Value and U-Factor As Applied To A Residential or Commercial Garage Door

Introduction

This document is intended to provide a standard definition for manufacturers, and the customers they supply, to determine, communicate, and interpret the "thermal values" as applied to a commercial or residential garage door.

R-value is the thermal resistance to heat flow which is typically applicable to a particular material or composite thickness. R-value is rounded to the nearest tenth, and the units are (Hour x $Ft.^2$ x °F)/Btu

By contrast, U-factor is a measure of thermal transmittance of heat flow. U-factor units are Btu/(Hour x $Ft.^2$ x °F)

To determine thermal properties as applied to a garage door there are two methods for consideration.

1. Calculation. This involves the door section only and represents R-value through the mean thickness of the section.
2. Testing. This involves the entire garage door assembly, and is intended to determine the U-factor of an installed door assembly as opposed to the R-value of a material or composite aspect of the door.

R-value determined via a tested door section has been excluded from consideration.

Calculated Door Section

This method determines the insulating value of a door section without taking into account the complexities of door section joints, stile attachments, etc. It provides a means of determining the insulating effect through the "center" of a door section.

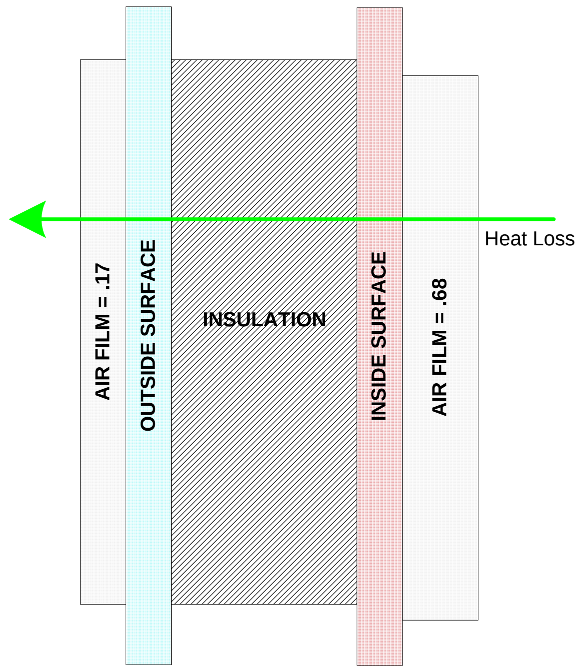
Refer to Figure 1. A typical insulated door has an exterior surface, interior surface, and an insulating core material. Also present is the insulating effect of air on a vertical surface, termed "air film". Each of these elements has a unique R-value that added together create the door section R-Value.

$$R_{section} = R_{air\ films} + R_{outside\ surface} + R_{insulation} + R_{inside\ surface}$$

For a door we assume that air will be stagnant on the inside of a closed door and that the exterior will have air moving against it at 15 MPH. Based on data published by ASHRAE[1], these air films will total an R-value of 0.85.

For the outside and inside surface values, we once again can refer to published sources such as ASHRAE[2] for values of various materials. For steel or other metal facings the R-values are considered negligible.

Figure 1.



Insulation values are based on a "k" (thermal conductivity) factor which is determined per inch of insulation thickness. The "k" factor for a particular material thickness is traced to testing in accordance with ASTM C177 / 518, and used considering an average material temperature of 40°F achieved based on testing using temperatures of 15º F and 65º F, for the actual thickness to be applied in use. Typical "k" factors for some common insulating cores are 0.235 to 0.265 for expanded polystyrene foam and 0.13 to 0.18 for polyurethane foam.

$$R_{insulation} = \text{Insulation Thickness} / k$$

As an example, for a steel skin sandwich door with a uniform polyurethane foam thickness of 1.75 inches, with an $R_{insulation}$ value of 7.0 per inch ("k" of 0.142 per inch), the door section R value would be 13.1.

$$R_{air\ films}\ [.85] + R_{outside\ surface}\ [0] + R_{insulation}\ [1.75 \times 7.0 = 12.25] + R_{inside\ surface}\ [0] = R_{section}\ [13.1]$$

Some insulated doors have insulation thicknesses which vary across the section of a door. In these cases, the door section R-Value is determined by examining the R-value at each insulation thickness and proportionally combining the values. As an example, for a section which has polyurethane foam at 7/8 inch thick for 18" of the height of a 20 inch section, and 1 3/8 inch thick for 2 inches and a foam R-value of 7.0 per inch, the door section R-value would be 7.32.

$$R_{18"portion} = .875 \times 7.0 \times 18/20 = 5.51 \qquad R_{2"portion} = 1.375 \times 7.0 \times 2/20 = 0.96$$

$$R_{air\ films}\ [.85] + R_{18"portion}\ [5.51] + R_{2"portion}\ [.96] = R_{section}\ [7.32]$$

Manufacturers will typically publish the R-value for a particular section design based on the most commonly sold section height of that design.

Tested Installed Door

In actual use a garage door consists of multiple sections that are coupled together to allow the operation of the door. These sections include features that greatly impact the thermal performance of a door, including the section joints, stiles, thermal breaks, air spaces, weather seals, etc. These design elements, whether all being present or just some, generally serve as locations for thermal conductance in a door.

This is depicted in Figure 2. These elements of door construction typically provide a "thermal shortcut" to the insulation in a door section and effectively reduce the R–value for the door section component of an entire garage door assembly as compared to a calculated door section R-value described earlier in this Technical Data Sheet. Therefore DASMA has developed test standard ANSI/DASMA 105 which provides a lab test measurement for the U-factor of a complete garage door assembly.

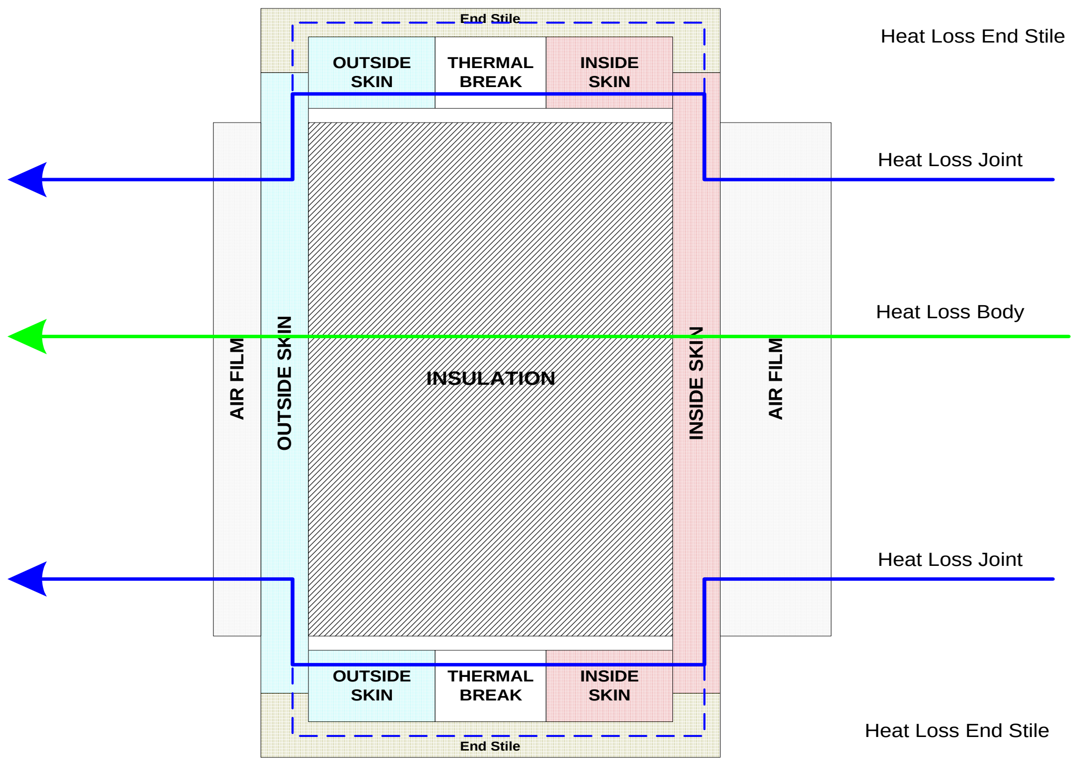
ANSI/DASMA 105 specifies door sizes for testing, where such doors are installed complete as provided by a manufacturer. The installation is in a special chamber constructed such that the inside face of the door is kept at a constant temperature and the outside face of the door is cooled. The energy required to maintain the constant temperature is measured and used to determine the amount of heat flow (U-factor) through the complete door system. This can be converted to a "Tested Installed Assembly" R-value by the following equation:

$$R_{TESTED\ INSTALLED\ ASSEMBLY} = 1 / U_{TESTED\ INSTALLED\ ASSEMBLY}$$

Note: Technical Data Sheets are information tools only and should not be used as substitutes for instructions from individual manufacturers. Always consult with individual manufacturers for specific recommendations for their products and check the applicable local regulations.

R-values for installed garage door assemblies should not be referenced unless based on results from ANSI/DASMA 105 testing or based on another nationally recognized standard, code requirement or method.

Figure 2.



Conclusion

In conclusion, the two most common ways garage door thermal performance can be reported are the “Calculated Door Section” and the “Tested Installed Door”. These two values are not comparable to each other. The “Tested Installed Door” produces a result representing a complete door, while the “Calculated Door Section” represents a portion of an individual door section. When publishing thermal performance, it should be made clear that R-value applies to a portion of the door section unless based on U-factor results from ANSI/DASMA 105 testing. Since the fenestration industry as a whole promotes U-factor, as opposed to R-value, and commonly promotes U-factor values as applying to entire installed assemblies, U-factor should be preferred when referencing the thermal performance of entire installed assemblies.

[1] 2005 ASHRAE® Handbook Of Fundamentals, page 25.2, Table 1. Still Air, Vertical Surface, Non-reflective shows R = 0.68. Moving Air, 15 MPH wind, Non-reflective shows R = 0.17. Therefore $R_{\text{total air film}} = 0.68 + 0.17 = 0.85$.

[2] 2005 ASHRAE® Handbook Of Fundamentals, page 39.3, Table 3.