

Thermal Performance of Insulated Metal Panels per ASHRAE 90.1-2007

A minimum R-value determined by testing is the most common way to specify thermal performance of any insulating material, including Insulated Metal Panels, or IMPs. However, a minimum R-value alone does not guarantee a certain level of performance due to the fact that many things affect the tested R-value of insulation, including:

- Insulation temperature or mean temperature of hot and cold side of test apparatus
- Insulation orientation and heat flow direction of test (Roofs only)
- Allowance for air film effects
- Presence of joints, fasteners, and thermal bridges in the insulation that were not represented in the tested specimen
- Test method

Therefore if this information is not specified in conjunction with the desired R-Value, the designer will likely not receive what he or she expects. This can lead to code compliance issues as well as poor performance of the finished building.

Code Compliance

In North America, the most accepted energy efficiency standard for commercial construction is the American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) Standard 90.1. In this standard, two methods of compliance are acceptable to determine the minimum thermal performance of opaque areas on the building envelope. Section 5.5.3 is the pertinent passage and it reads:

5.5.3 Opaque Areas. For all opaque surfaces except doors, compliance shall be demonstrated by one of the following two methods:

1. Minimum rated R-value of insulation for the thermal resistance of the added insulation in framing cavities and continuous insulation only. Specifications listed in Normative Appendix A for each class of construction shall be used to determine compliance.
2. Maximum U-factor, C-factor, or F-factor for the entire assembly. The values for typical construction assemblies listed in Normative Appendix A shall be used to determine compliance.

The definitions pertinent to this passage italicized above are:

Continuous insulation (c.i.): insulation that is continuous across all structural members without thermal bridges other than fasteners and service openings. It is installed on the interior or exterior or is integral to any opaque surface of the building envelope.

Rated R-value of insulation: the thermal resistance of the insulation alone as specified by the manufacturer in units of $h \cdot W \cdot ^\circ F / \text{Btu}$ at a mean temperature of 75°F. Rated R-value refers to the thermal resistance of the added insulation in framing cavities or insulated sheathing only and does not include the thermal resistance of other building materials or air films.

U-factor (thermal transmittance): heat transmission in unit time through unit area of a material or construction and the boundary air films, induced by unit temperature difference between the environments on each side. Units of U are $\text{Btu}/h \cdot W \cdot ^\circ F$.

These definitions in conjunction with Section A9 of Normative Appendix A dictate that if Method 1 is used, then the R-value must be determined by either ASTM C518 or ASTM C1363 with a mean temperature of 75 degrees Fahrenheit and cannot include air film effects. If Method 2 is used, the U-factor of the assembly is to be determined by testing per ASTM C1363 using a representative sample including panel edges, joints and thermal bridges such as fasteners. Alternatively, calculation of U-Value is allowed for certain roof and wall assemblies as specified in A9.2. Per A9.4.1 of ASHRAE 90.1, air film effects of R-0.17 for exterior surfaces and R-0.61 for interior horizontal surfaces (heat flow up) may be included in the U-factor.

IMPs meet the definition of continuous insulation provided the clip holding the panel to the framing is interpreted to be a type of fastener. Unfortunately, 'fastener' is not defined in ASHRAE 90.1. Because of this ambiguity, it is not clear which method from Section 5.5.3 is to be used for IMPs. Therefore R-values and U-factors determined in accordance with ASHRAE are presented below and it is the designer's discretion which to use.

It should also be noted that although mathematically $R = 1/U$, that rule does not hold true for the table below since air films are included in the U-factors but not the R-values and the test method used to determine the thermal conductivity may be different between Method 1 and 2.

R-Values and U-factors for Insulated Metal Panels per ASHRAE 90.1-2007

Panel Type	Thickness (in)	ASHRAE 90.1, Section 5.5.3 Method 1		ASHRAE 90.1, Section 5.5.3 Method 2	
		Maximum R-Value per ASTM C1363 or C518 @ 75 °F (°F-hr-ft ² /BTU)	R-Value per ASTM C518 @ 25 °F ¹ (°F-hr-ft ² /BTU)	Wall U-Value per ASTM C1363 ² (BTU/ft ² -hr-°F)	Roof U-Value per ASTM C1363 ³ (BTU/ft ² -hr-°F)
RWP	1 ½	10.85	12.38	0.1034	0.0989
	2	14.46	16.50	0.0776	0.0751
	2 ½	18.08	20.63	0.0619	0.0603
	3	21.69	24.75	0.0514	0.0503
	4	28.92	33.00	0.0351	0.0346
	5	36.24	41.25	0.0273	0.0270
	6	46.12	49.50	0.0215	0.0213
All Concealed Fastener Wall and Roof Panels Except HWP	1 ½	10.85	12.38	0.1214	0.1152
	2	14.46	16.50	0.0890	0.0856
	2 ½	18.08	20.63	0.0686	0.0666
	3	21.69	24.75	0.0562	0.0549
	4	28.92	33.00	0.0399	0.0392
	5	36.15	41.25	0.0302	0.0298
	6	43.38	49.50	0.0239	0.0237
HWP	1 ½	10.85	12.38	See note 4	
	2	14.46	16.50		
	2 ½	18.08	20.63		
	3	21.69	24.75		
	4	28.92	33.00		
	5	36.15	41.25		
	6	43.38	49.50		

Notes:

1. Although ASHRAE 90.1 requires 75°F mean temperature, in special cases such as freezers or buildings subject to extreme cold, 25°F may be more appropriate.
2. Including R-0.17 for interior and R-0.17 for exterior air films
3. Including R-0.61 for interior and R-0.17 for exterior air films, heat flow up.
4. Because of the wide variety of assemblies that can be used with HWP, U-factors for this application have to be determined on a case-by-case basis in accordance with Section A9 of ASHRAE 90.1