NAIMA
North American Insulation
Manufacturers Association

Guide to Insulating Metal Buildings for Compliance to ASHRAE 90.1-2010

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INTRODUCTION:
ABOUT ASHRAE 90.1-2010 AND HOW TO USE THIS GUIDE

About ASHRAE 90.1

ANSI/ASHRAE/IESNA Standard 90.1-2010 titled "Energy Standard for Buildings Except Low-Rise Residential Buildings" is published by the American Society of Heating, Refrigerating and Air Conditioning Engineers Inc., and the Illuminating Society of Engineering. In most areas, 90.1 has been adopted as the commercial building energy code.

The Standard sets minimum requirements for the energy efficient design of new buildings in a manner that minimizes the use of energy without constraining the function or the comfort of the building. It is intended for buildings designed for human occupancy now or in the future.

The ASHRAE 2010 standard is considered more stringent than prior versions. ASHRAE's goal is to improve the energy efficiency of all buildings governed by the Standard by 30% with the 2010 version relative to the requirements of the ASHRAE 90.1-2004, and has a goal of improving the requirements by 50% by 2013. The ultimate objective is to provide compliance criteria for the construction of net zero energy buildings by 2030.

ASHRAE Standard 90.1-2010 Purpose and Scope

The purpose of the 2010 standard is to establish the minimum energy efficiency requirements of buildings, other than low rise residential buildings, for:

- Design, construction, and a plan for operation and maintenance, and
- Utilization of on-site, renewable energy resources

The Standard covers:

- New buildings and their systems
- New portions of buildings and their systems
- New systems and equipment in existing buildings
- New equipment or building systems specifically identified in the standard that are part of industrial or manufacturing processes

The Standard also provides criteria for determining compliance with these requirements.

When ASHRAE Standard 90.1 Does Not Apply

The provisions of the Standard **do not apply** to:

- Single-family houses, multi-family structures of three stories or fewer above grade, or manufactured houses
- Buildings that use neither electricity nor fossil fuel

How to Use This Guide

The purpose of this document is to provide guidance on compliance to the envelope requirements of Standard 90.1-2010 for metal building roof and wall assemblies. This document does not address other requirements of the Standard, such as HVAC systems and equipment, service water heating, lighting, or other equipment.

Chapter 1 – ASHRAE 90.1-2010 Envelope Requirements for Metal Buildings summarizes the envelope requirements of the Standard. Mandatory provisions, various compliance paths, and product requirements applicable to metal building envelopes are summarized. These requirements are extracted from Section 5 of ASHRAE Standard 90.1-2010.

Chapter 2 – ASHRAE Pre-Calculated U-Factors for insulated Metal Building Roofs and Walls summarizes the ASHRAE Prescriptive Insulation Assemblies and their associated U-factors. This information is extracted from 90.1-2010 Appendix A.

Chapter 3 – Guideline on Installing Fiber Glass Metal Building Insulation to Comply with ASHRAE 90.1-2010 provides additional recommendations and tips for installing fiber glass metal building insulation.

Appendix A summarizes the requirements of Chapter 5 of the 2012 International Energy Conservation Code (IECC) for metal walls and roofs.

ASHRAE 90.1 – Historical Timeline

Since its inception in 1975, Standard 90.1 has been widely adopted as the benchmark for energy efficiency in buildings. It has set the foundation for energy efficiency in buildings in the United States and is expected to maintain a leading role.

1975 – ASHRAE Standard 90-75 Energy

Conservation in New Building Design. The first consensus building energy standard. Developed by ASHRAE at the request of the National Council of States on Building Codes and Standards (NCSBCS). The scope covered both commercial and residential buildings and included requirements for HVAC, lighting, and envelope design.

1980 – ASHRAE Standard 90A-1980

Updated the Standard and included a lighting power budget method.

1989 – ASHRAE 90.1-1989

Major changes to standard including limiting scope to commercial buildings (Low-Rise Residential Buildings are covered in ASHRAE Standard 90.2) and introduction of an Energy Cost Budget Method. The 1989 Standard also incorporated more stringent mechanical equipment efficiency requirements and envelope thermal requirements.

1999 – ASHRAE Standard 90.1-1999

Major revision to the standard. Requirements were developed based on life-cycle costing criteria. Written in clearer, code-enforceable language.

2001 – ASHRAE Standard 90.1-2001

First revision of the Standard since being placed on a "continuous maintenance" basis. Standard began a three-year publishing schedule to match the publication of the IECC. The revisions mainly resolve issues carried over from the 1999 version.

2004 – ASHRAE Standard 90.1-2004

Incorporated 32 addendum since publication of the 2001 Standard, including a reducing the number of Climate Zones from 26 to 8, consistent with other national energy codes and standards.

2007 – ASHRAE Standard 90.1-2007

Incorporated 44 addenda characterized as incremental refinements or modifications that increase the stringency of the Standard.

Energy Standards vs. Energy Codes

ASHRAE Standard 90.1-2010 is a voluntary consensus standard. It is considered a voluntary standard because compliance with the standard is on a voluntary basis until and unless it is incorporated by reference as a requirement in a contract or in a building code.

ASHRAE, as the standards-writing organization, is accredited by the American National Standards Institute (ANSI) and follows ANSI's requirements for due process and standards development that includes:

- Consensus on a proposed standard by a group or "consensus body" that incorporates representatives from materially affected and interested parties
- Broad-based public review and comment on draft standards
- Consideration of and response to comments submitted by voting members for the relevant consensus body and by public review commenters
- Incorporation of approved changes into the draft standard and the right to appeal by any participant that believes that due process principles were not sufficiently respected during the development process

Although the ASHRAE Standard 90.1 is considered a voluntary standard, it was originally developed at the request of the National Conference of States on Building Codes and Standards (NCBCS) with the intention of being incorporated into building energy codes. Standard 90-75 was the first consensus Building Energy Standard and has been incorporated by reference in local buildings codes in one form or another since it was issued in 1975.

A building code is a set of requirements that specify the minimum acceptable level of safety or efficiency for a building. In the United States, building codes are adopted into law by state and/or local authorities, and are enforced by state and/or local building departments. Building codes carry the force of law. Because the development and maintenance of building codes is complicated and costly, most jurisdictions adopt "model" codes as the basis for their building codes. Historically, model codes were developed by various regional model code organizations (e.g. BOCA, ICBO, and SBCCI) and adopted in whole or in part by state and/or local jurisdictions. Since 2000, the International Code Council (ICC) has been the leading model code development organization.

The International Energy Conservation Code is a model energy code developed by the ICC. Since it was originally published in 2000, the IECC has incorporated the ASHRAE Standard 90.1 by reference to define the requirements for commercial buildings. The IECC states (in Chapter 5 - Commercial Energy Efficiency) that

> "…commercial buildings shall meet either the requirements of ASHRAE/IESNA Standard 90.1 Energy Standard for Buildings except for Low-Rise Residential Buildings or the requirements contained in this chapter"

Chapter 5 contains alternative requirements originally intended to be a simplified version of the ASHRAE Standard 90.1. A designer has the freedom to choose which compliance path to select. Although the intent is for the two paths to be equivalent, differences in publication timing and approach result in the requirements differing, sometimes significantly, between the paths.

The 2012 IECC is most recent version of the model code. Requirements for metal building roofs and walls are summarized in Appendix A of this document.

Chapter 1: ASHRAE 90.1-2010 Envelope Requirements for Metal Buildings

Envelope requirements are given in Section 5 of Standard 90.1-2010. Requirements are given for various opaque elements (roof, and walls) as a function of Climate Zone and Space-Conditioning Categories.

Climate Zones

ASHRAE began using a new climate zone map with ASHRAE 90.1-2004. The Department of Energy developed this map with the intention of making energy codes and standards easier to use and enforce, and to promote consistency between the IECC and ASHRAE. In addition to eliminating more than 40 pages of maps for residential construction and many pages of commercial envelope tables, both the commercial and residential sections of the standard now use a common set of climate zones. Users of both the IECC and ASHRAE 90.1 are able to determine the requirements anywhere in the United States without having to obtain climate data (e.g. heating degree days) from some other sources.

The first step in determining compliance is to identify the climate zone for the building location. This is done by referring to the climate zone map or to the climate zone tables. (For a full listing of climate zone tables, visit www.ashrae.org)

Space Conditioning Categories

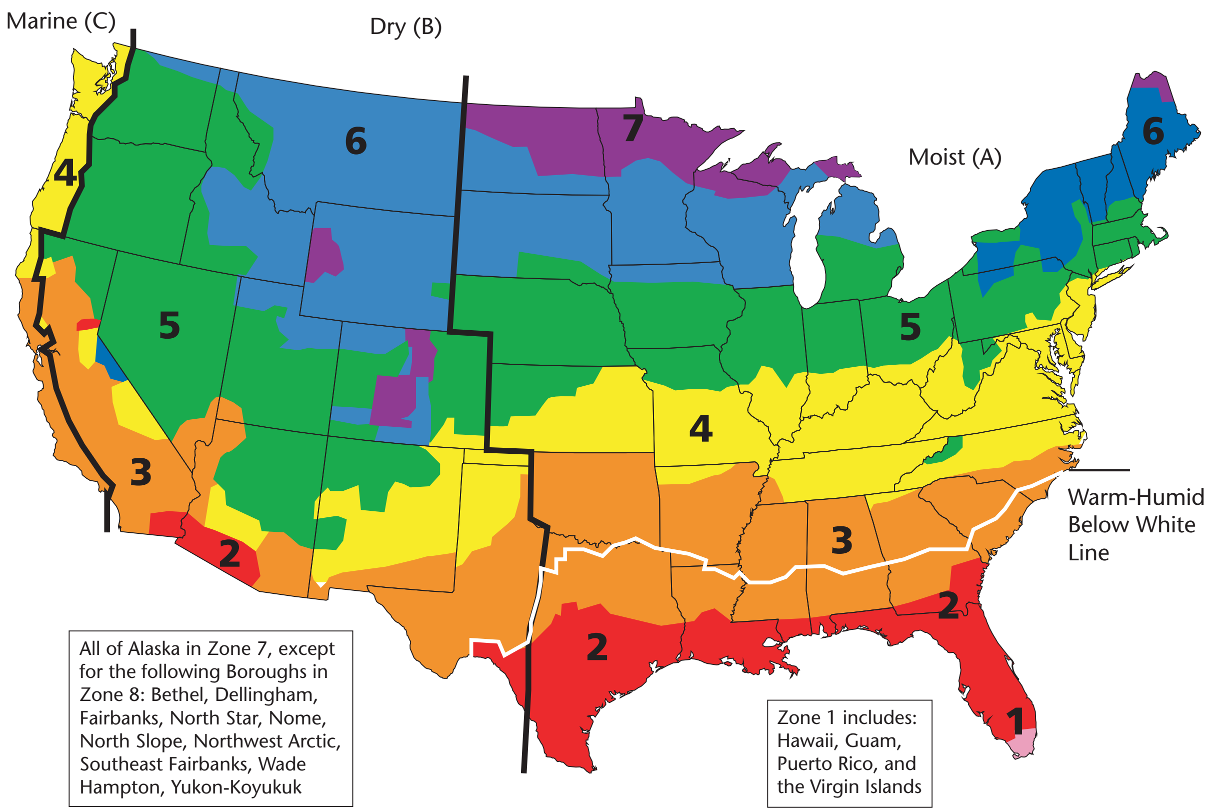
The next step in determining compliance is to identify the space conditioning category. Envelope requirements are specified for each of three space categories:

- Nonresidential conditioned space
- Residential conditioned space
- Semiheated space

Note that for metal building walls and roofs, there is no distinction between the requirements for residential and non-residential spaces. Since very few metal buildings are used for residential applications, this guide will focus on the non-residential conditioned and semiheated categories.

Fig. 1 ASHRAE 90.1 Climate Zone Map

Consult your local building code official for the envelope requirements in your area. (For a full listing of climate zone tables, visit www.ashrae.org)



Conditioned Space

Conditioned space is defined as a cooled space, heated space, or indirectly conditioned space.

A *cooled space* is an enclosed space within a building that is cooled by a cooling system whose sensible output exceeds 5 Btu/(h·ft^2).

A *heated space* is an enclosed space within a building that is heated by a heating system whose output capacity is greater than or equal to the following criteria:

TABLE 1. HEATED SPACE CRITERIA

Climate Zone	Minimum Heating Output, Btu/(h·ft^2)
1 and 2	5
3	10
4 and 5	15
6 and 7	20
8	25

An *indirectly conditioned space* is an enclosed space within a building that is not a heated or cooled space, but is heated or cooled indirectly by being connected to adjacent spaces.

Semiheated Space

A *semiheated space* is an enclosed space within a building that is not a conditioned space, but is heated by a heating system whose output is greater than 3.4 Btu/(h·ft^2) but not greater than the minimum output listed for each climate zone listed in Table 1.

Note that an enclosed space within a building that is not a *conditioned space* or a *semiheated space* is considered to be an *unconditioned space*. Many metal buildings fall within the semiheated category and some fall within the unconditioned category.

There are no envelope requirements for unconditioned spaces. The standard requires that approval from the building official be obtained to designate a space as semiheated or unconditioned in climate zones 3 through 8.

Example:

A 100,000 ft^2 distribution warehouse is planned for Columbus, Ohio. Columbus is in Climate Zone 5. The warehouse is considered *semiheated space* if the output of the heating system is between 340,000 Btu/h and 1,500,000 Btu/h and the sensible output of the cooling system is below 500,000 Btu/h.

Mandatory Provisions

Standard 90.1-2010 has certain mandatory provisions that apply to metal building insulation. These include:

- Labeling: Building envelope insulation must be clearly marked with its rated R-value.
- Installation: Insulation shall be installed in accordance with manufacturer's recommendations.
- Loose-fill insulation: Loose-fill insulation shall not be used in attic roof spaces where the slope of the ceiling is greater than three in twelve.
- Location of Roof Insulation: Insulation backloaded on suspended ceiling tiles (as is sometimes done for acoustical reasons) may not be counted as roof insulation.
- Extent of Insulation: Insulation shall extend over the full component area.

Mandatory provisions also apply to air sealing of the envelope to minimize air leakage. The entire building envelope assembly shall be designed and constructed with a continuous air barrier (except for semiheated spaces in Climate Zones 1-6 and single wythe concrete masonry buildings in Climate Zone 2B). The continuous air barrier:

- Must be clearly identified on construction documents
- Joints, interconnections, and penetrations must be detailed
- Must extend over all surfaces of the building envelope
- Must be designed to resist positive and negative pressure from wind, stack effect, and ventilation

Vestibules are required for entrances that separate conditioned space from the exterior.

In climate zones 4 through 8, loading dock weather seals are required to restrict infiltration when vehicles are parked in the doorway.

Compliance Paths

The envelope portion of ASHRAE Standard 90.1-2010 provides several compliance paths:

- The Prescriptive Building Envelope Option
- The Building Envelope Trade-Off Option
- The Energy Cost Budget Method

The Building Envelope Trade-off Option and the Energy Cost Budget Method provide alternatives to the prescriptive provisions of the Standard. They may be used to demonstrate compliance by trading-off the performance of envelope elements (for example fenestration performance vs. wall insulation levels using the Building Envelope Trade-off Option) or fenestration area vs. equipment efficiency using the Energy Cost Budget Method. These trade-off options are complicated and are beyond the scope of this guide. Note that the COMcheck program (available at www.energycodes.gov/comcheck) performs the building envelope trade-off method and is widely accepted in most areas. This guide will focus on the Prescriptive Envelope Option. Requirements for the Prescriptive Building Envelope Option are contained in Section 5.5 of the Standard.

Note that the Prescriptive Envelope Option can be used only if the vertical glazing area is less than or equal to 40% of the gross wall area and the skylight area is less than 5% of the gross roof area. If vertical glazing or skylight areas exceed these maximums, either the Building Envelope Trade-off Option or the Energy Cost Budget Method must be used to demonstrate compliance.

For opaque areas of the building envelope (roofs and walls), compliance may be demonstrated by one of two methods:

1. The minimum rated R-value of insulation method
2. The maximum U-factor of the assembly method

Minimum rated R-value approach:

The minimum rated R-value approach specifies the minimum R-value of insulation required for compliance for each envelope element. The approach is intended to be the simplest compliance approach in that, in theory, the code inspector would need only to verify that the rated R-value of insulation was installed. In practice, however, the rated R-value approach requires verification that a specific envelope design is utilized.

Maximum U-factor approach:

This approach specifies the maximum U-factor for each envelope element. ASHRAE provides tables of pre-calculated assembly U-factors for typical construction assemblies in Appendix A of the Standard. For assemblies not listed, applicant-determined U-factors are required. Applicant-determined procedures include testing and/or calculation procedures using approaches and assumptions specified in Appendix A of the Standard.

The prescriptive requirements for metal building walls and roofs are extracted from Standard 90.1-2010 and are summarized in Table 2: U-Factors for Compliance to ASHRAE Standard 90.1-2010 (Page 6).

Example: Selecting the Right Insulation System is Easy

As an example, assume a metal building worship facility is planned for Richmond, Virginia.

Step 1. Determine the climate zone

Using Figure 1 on page 3 or refer to the climate zone tables on www.ashrae.org
Richmond is located in Climate Zone 4.

Step 2. Determine the space conditioning category

A worship facility will fall into the category of non-residential conditioned space.

Step 3. Determine the maximum allowable U-factor

Using Table 2, for non-residential conditioned space in Climate Zone 4, maximum U-factors are:

Construction	Max U-factor
Metal Building Roofs	0.055
Metal Building Walls	0.084

Step 4. Determine insulation systems that meet the max U-factor requirements

Referring to Table 2, we see that a roof with a double layer fiber glass blanket installation of R-13 + R-13 is one way to meet the max U-factor requirement for roofs and that an R-19 fiber glass blanket is one way to meet the wall requirement. These methods may or may not be the least costly or most desirable way to meeting the requirements.

Additional methods of compliance can be identified by examining the roof and wall systems in Chapter 2. For example, for the roof requirement, a single layer of R-16 fiber glass with R-5.6 of continuous insulation (U = 0.051) also meets the roof requirement.

Similarly, a layer of R-10 fiber glass insulation with a layer of R-5.6 continuous insulation meets the wall requirement, and may fit better with the interior finish desired in a worship facility.

Table 2: U-Factors for Compliance to ASHRAE 90.1- 2010

These tables show the prescriptive requirements along with fiber glass metal building systems that meet the requirements when installed properly.

Roof Requirements - Overall U-Factors, Btu/(h·ft²·°F)*

Climate Zone	Conditioned Space		Semiheated Space	
	Assembly Max. U-Factor	Insulation Min. R-Value	Assembly Max U-Factor	Insulation Min R-Value
1	.065	R-19	.167	R-6
2	.055	R-13+R-13	.097	R-10
3	.055	R-13+R-13	.097	R-10
4	.055	R-13+R-13	.097	R-10
5	.055	R-13+R-13	.083	R-13
6	.049	R-13+R-19	.072	R-16
7	.049	R-13+R-19	.072	R-16
8	.035	R-11+R-19 LS	.065	R-19

LS = Liner System

* Future versions of 90.1 may contain revised U-Factors for these assemblies.
Consult with your local building authority for applicable U-Factors.

Wall Requirements - Overall U-Factors, Btu/(h·ft²·°F)

Climate Zone	Conditioned Space		Semiheated Space	
	Assembly Max. U-Factor	Insulation Min. R-Value	Assembly Max U-Factor	Insulation Min R-Value
1	.093	R-16	.113	R-13
2	.093	R-16	.113	R-13
3	.084	R-19	.113	R-13
4	.084	R-19	.113	R-13
5	.069	R-13+R-5.6 ci	.113	R-13
6	.069	R-13+R-5.6 ci	.113	R-13
7	.057	R-13+R-5.6 ci	.113	R-13
8	.057	R-13+R-5.6 ci	.113	R-13

ci = Continuous insulation

Cool Roof Requirements

For low slope (slope < 2:12) metal buildings located in Climate Zone 1, "cool roofs" are required.
High slope roofs are exempt from this requirement.

A "cool roof" is a roof surface that has both a high solar reflectance and a high thermal emittance. Cool roofs are an effective way to reduce solar gains through roofs. To meet the cool roof requirements in Zone 1, a metal building roof must meet one of the following criteria:

a. The roof surface has a three-year aged solar reflectance ≥ 0.55, and a three-year aged thermal emittance ≥ 0.75
b. The roof surface has a three-year aged Solar Reflectance Index ≥ 64
c. The roof construction has additional roof insulation (U-factor ≤ 0.028)

Chapter 2: ASHRAE Pre-Calculated U-Factors for Insulated Metal Building Roofs and Walls

The tables and corresponding illustrations in this chapter show typical metal building roof and wall assemblies and their associated U-factors.

These U-factors have been pre-calculated by ASHRAE and may be used to demonstrate compliance to the envelope requirements using the Maximum U-factor approach.

The tabulated values are taken from Standard 90.1-2010 Appendix A, Tables A2.3 (Metal Building Roofs) and Table A3.2 (Metal Building Walls).

The illustrations have been developed based on the descriptions contained in the Standard.

The typical assemblies include:

- Roof (Single Layer)
- Roof (Double Layer)
- Roof (Continuous Insulation)
- Roof (Liner System)
- Roof (Filled Cavity)
- Wall (Single Layer)

Standing Seam Roof Assemblies with Single Layer of Faced Insulation

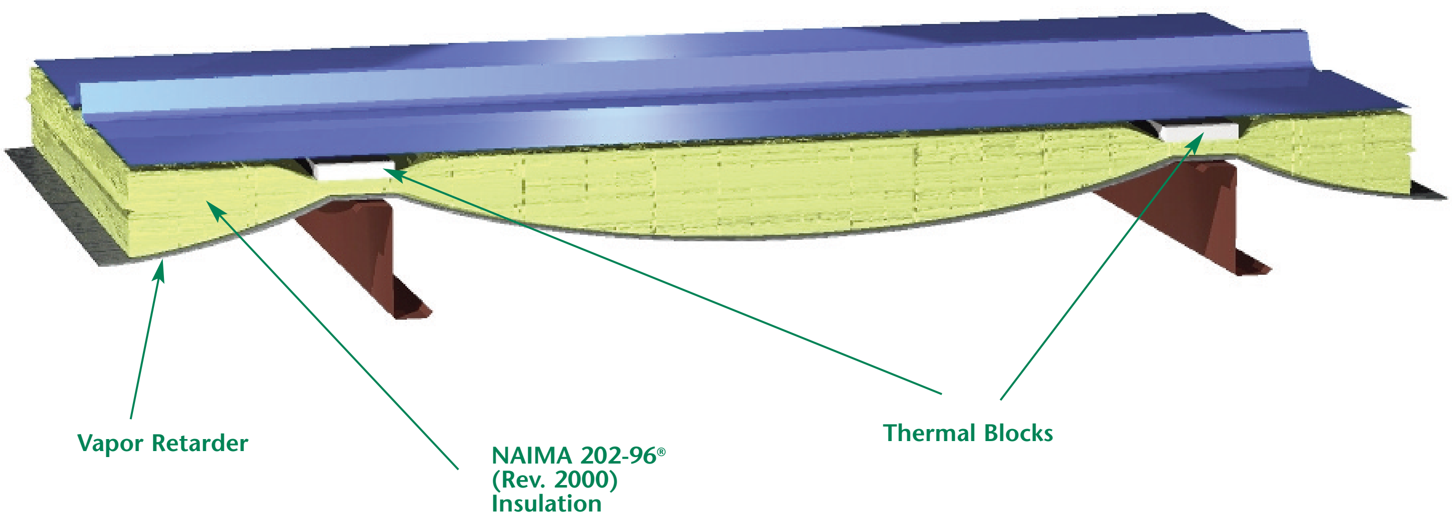
The rated R-value of insulation is installed perpendicular to and draped over purlins and then compressed when the metal roof panels are attached. A minimum R-3.5 thermal block between the purlins and the metal roof panels is required. Continuous insulation (uncompressed and uninterrupted by framing members) may be added either above or below the purlins to provide additional performance.

Table 3: Standing Seam Roof Assemblies with Single Layer of Faced Insulation - Overall U-Factors, Btu/(h·ft²·°F)

Rated R-value of Faced Insulation	Continuous Insulation		
	None	R-5.6	R-11.2
None	1.28	0.157	0.083
R-6	0.167	0.086	0.058
R-10	0.097	0.063	0.046
R-11	0.092	0.061	0.045
R-13	0.083	0.057	0.043
R-16	0.072	0.051	0.040
R-19	0.065	0.048	0.038

Note: A minimum R-3.5 thermal block between the purlins and the metal roof panels is required

Note: Diagrams not to scale.



Installation Tips

1. Install R-3.5 (minimum) thermal blocks to achieve the U-Factors shown in the table above. NAIMA recommends a 1" thick XPS or polyisocyanurate foam thermal block.
2. Use roof clips with the appropriate height to allow for the thickness of the thermal block. Verify with the metal building manufacturer that the clip is appropriate for the intended insulation.
3. Install NAIMA 202-96 laminated blanket insulation in a manner to allow expansion to the full thickness at the center point between the purlins.
4. Insulation should be installed around bracing, penetrations and other obstructions to minimize gaps and compression.

Standing Seam Roof Assemblies with Double Layers of Insulation

The first rated R-value of insulation is installed perpendicular to and draped over purlins. The second rated R-value of insulation is for unfaced insulation installed above the first layer and parallel to the purlins and then compressed when the metal roof panels are attached. A minimum R-3.5 thermal block between the purlins and the metal roof panels is required. Continuous insulation (uncompressed and uninterrupted by framing members) may be installed either above or below the purlins.

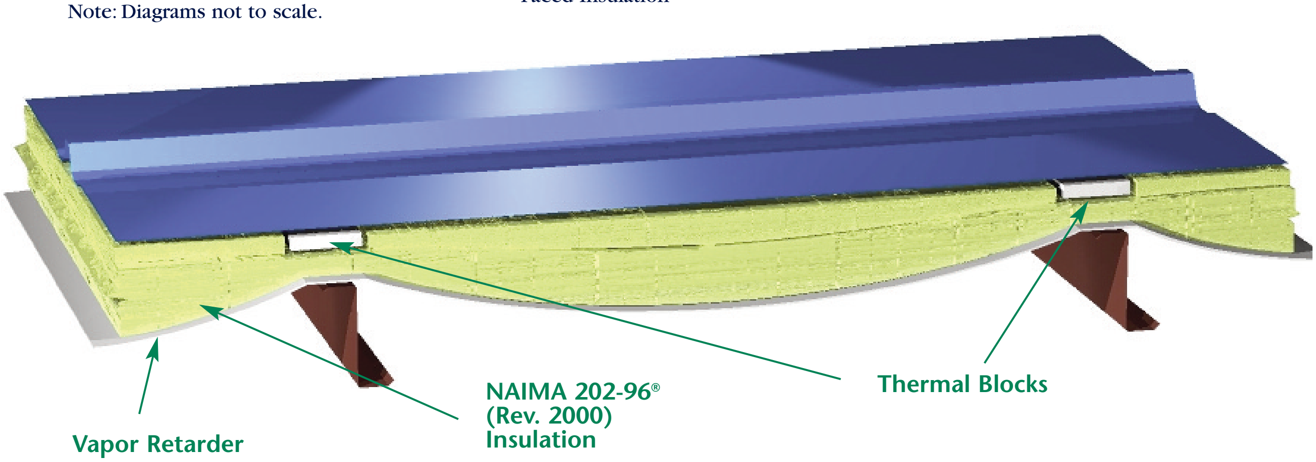
Table 4: Standing Seam Roof Assemblies with Double Layer of Faced Insulation - Overall U-Factors, Btu/(h·ft^2·°F)

Rated R-value of Faced Insulation	Continuous Insulation		
	None	R-5.6	R-11.2
*R-10 + R-10	0.063	0.047	0.037
*R-10 + R-11	0.061	0.045	0.036
*R-11 + R-11	0.060	0.045	0.036
*R-10 + R-13	0.058	0.044	0.035
*R-11 + R-13	0.057	0.043	0.035
*R-13 + R-13	0.055	0.042	0.034
*R-10 + R-19	0.052	0.040	0.033
*R-11 + R-19	0.051	0.040	0.032
*R-13 + R-19	0.049	0.038	0.032
*R-16 + R-19	0.047	0.037	0.031
*R-19 + R-19	0.046	0.037	0.030

Note: A minimum R-3.5 thermal block between the purlins and the metal roof panels is required

* Faced Insulation

Note: Diagrams not to scale.



Installation Tips

1. Install R-3.5 (minimum) thermal blocks to achieve the U-Factors shown in the table above. NAIMA recommends a 1" thick XPS or polyisocyanurate foam thermal block.
2. Use roof clips with the appropriate height to allow for the thickness of the thermal block. Verify with the metal building manufacturer that the clip is appropriate for the intended insulation.
3. Install NAIMA 202-96 laminated blanket insulation in a manner to allow expansion to the full thickness at the center point between the purlins.
4. Ensure the upper insulation blanket is of sufficient width to fill the space between the thermal blocks and minimize gaps between the insulation and the thermal blocks. For example, a 60" purlin spacing using 3" wide thermal blocks would utilize a 57" wide blanket for the upper layer.
5. Insulation should be installed around bracing, penetrations and other obstructions to minimize gaps and compression.

Standing Seam Roof Assemblies with Filled Cavities (Liner Systems)

A continuous membrane is installed below the purlins and uninterrupted by framing members. Uncompressed, unfaced insulation rests on top of the membrane between the purlins. The first rated R-value of insulation is for unfaced insulation draped over purlins and then compressed then the metal roof panels are attached. Assemblies in Table 5A require an R-3.5 thermal block.

Table 5A: Standing seam Roofs with Thermal Blocks
Overall U-factors, Btu/(h·ft²·°F)

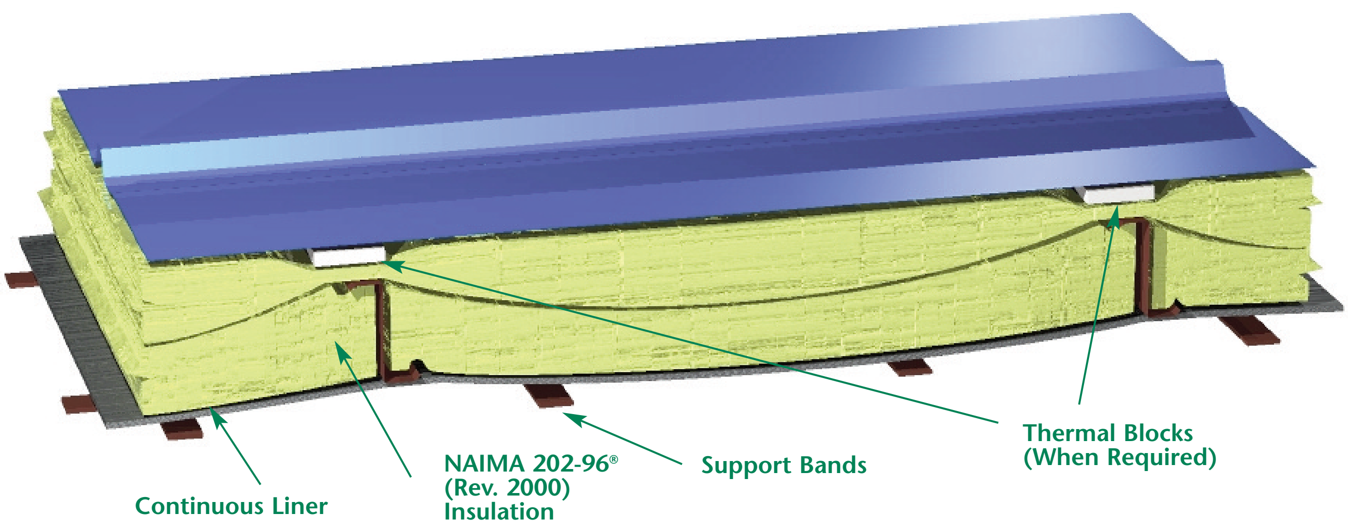
Rated R-value of Faced Insulation	U-factor
R-11+ R-19	0.035
R-11+ R-25	0.031
R-11+ R-30	0.029
R-11 + R-11 + R-25	0.026

Note: A minimum R-3.5 thermal block between the purlins and the metal roof panels is required

Table 5B: Standing seam Roofs without Thermal Blocks
Overall U-factors, Btu/(h·ft²·°F)

Rated R-value of Faced Insulation	U-factor
R-11+ R-19	0.040

Note: Diagrams not to scale.



Installation Tips

1. The higher R-value systems will require deeper purlins to accommodate the full recovered thickness of insulation.
2. Install R-3.5 (minimum) thermal blocks to achieve the U-Factors shown in Table 5A above. NAIMA recommends a 1" thick XPS or polyisocyanurate foam thermal block.
3. Use roof clips with the appropriate height to allow for the thickness of the thermal block. Verify with the metal building manufacturer that the clip is appropriate for the intended insulation.
4. Ensure the lower insulation blanket is of sufficient width to fill the space between the purlins and minimize gaps between the insulation and the purlins.
5. Install the banding tightly to minimize the sag of the insulation blankets.
6. Insulation should be installed around bracing, penetrations and other obstructions to minimize gaps and compression.

Standing Seam Roofs with Filled Cavities (Long Tab Banded)

The first rated R-value of the insulation is for faced insulation installed between the purlins. The second rated R-value of insulation represents unfaced insulation installed above the first layer, perpendicular to the purlins and compressed when the metal roof panels are attached. A supporting structure retains the bottom of the first layer at the prescribed depth required for the full thickness of insulation. A minimum R-3.5 thermal block between the purlins and the metal roof panels is required.

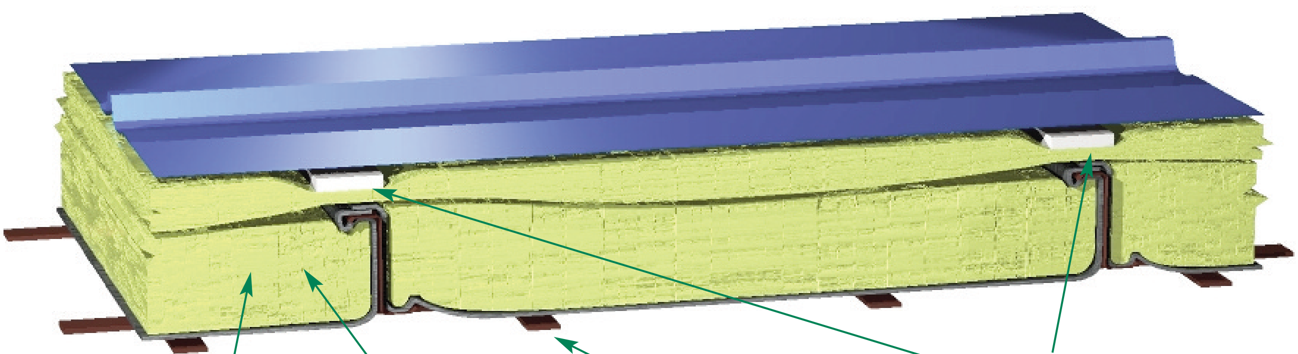
Table 6: Standing Seam Roofs with Filled Cavity Systems Overall U-factors, Btu/(h·ft^2·°F)

Rated R-value of Faced Insulation	U-factor
*R-19 + R-10	0.041

Note: A minimum R-3.5 thermal block between the purlins and the metal roof panels is required

* Faced Insulation

Note: Diagrams not to scale.



Installation Tips

1. Install R-3.5 (minimum) thermal blocks to achieve the U–Factors shown in the table above. NAIMA recommends a 1" thick XPS or polyisocyanurate foam thermal block.
2. Use roof clips with the appropriate height to allow for the thickness of the thermal block. Verify with the metal building manufacturer that the clip is appropriate for the intended insulation.
3. Ensure the lower insulation blanket is NAIMA 202-96 laminated blanket insulation and is installed in a manner to allow expansion to the full thickness.
4. Ensure the lower insulation blanket is of sufficient width to fill the space between the purlins and minimize gaps between the insulation and the purlins.
5. Install the banding tightly to minimize the sag of the insulation blankets.
6. Insulation should be installed around bracing, penetrations and other obstructions to minimize gaps and compression.

Thru-fastened Roofs

The rated R-value of insulation is installed over the purlins. The metal exterior roof sheets are fastened to the purlins holding the insulation in place. Normally, thermal blocks are not used in thru-fastened roofs.

Table 7A: Thru-fastened Roof Assemblies with Single Layer of Faced Insulation - Overall U-factors, Btu/(h·ft²·°F)

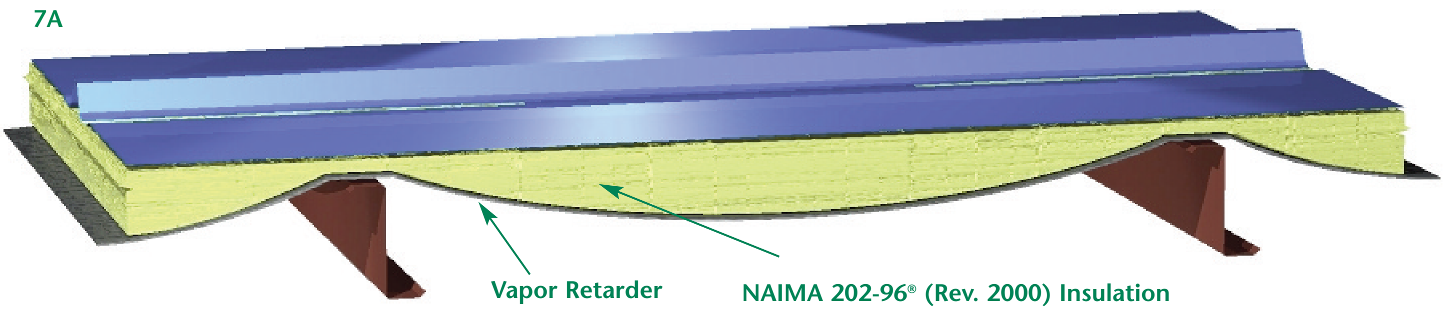
Rated R-value of Faced Insulation	U-factor
R-10	0.153
R-11	0.139
R-13	0.130
R-16	0.106
R-19	0.098

Table 7B: Thru-fastened Roof Liner System Overall U-factors, Btu/(h·ft²·°F)

Rated R-value of Faced Insulation	U-factor
R-11+ R-19	0.044

Note: Diagrams not to scale.

7A



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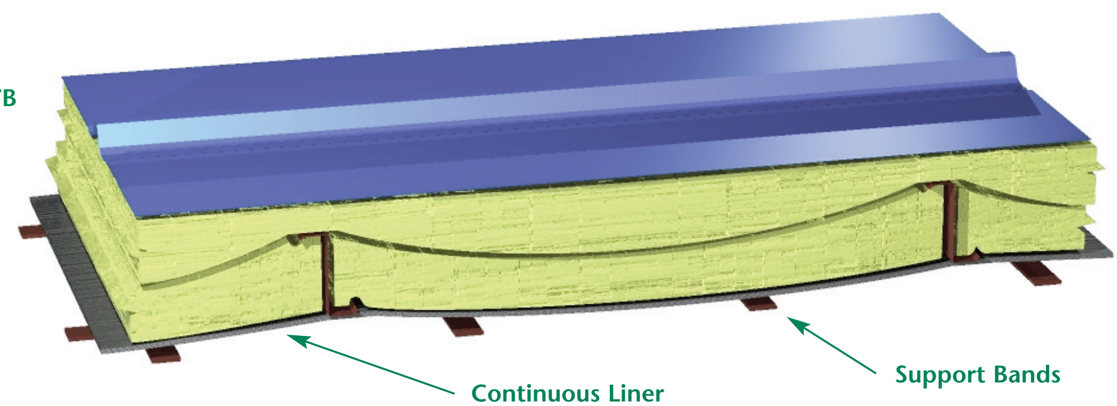


Installation Tips

In general, find out from the metal building manufacturer if the roof is rated for thermal blocks before installing thermal blocks.

7A: Install NAIMA 202-96 laminated blanket insulation in a manner to allow expansion to the full thickness at the center point between the purlins. Note: The U-Factors in the table above are based on full thickness at the centerline. If the insulation is installed in manner to restrict expansion, the U-Factor of the system will increase.

7B: Refer to Installation Tips on Page 10

Metal Building Walls

The rated R-value of faced insulation is draped outside the wall girts. The metal exterior wall sheets are fastened to the girts holding the insulation in place. Continuous insulation (uncompressed and uninterrupted by framing members) may be added to the girts to provide additional performance.

Table 8A: Metal Building Wall Assemblies with Single Layer of Faced Insulation - Overall U-Factors, Btu/(h·ft²·°F)

Rated R-value of Faced Insulation	Continuous Insulation		
	None	R-5.6	R-11.2
None	1.18	0.161	0.086
R-6	0.184	0.091	0.060
R-10	0.134	0.077	0.054
R-11	0.123	0.073	0.052
R-13	0.113	0.069	0.050
R-16	0.093	0.061	0.046
R-19	0.084	0.057	0.043

Note: Diagrams not to scale.

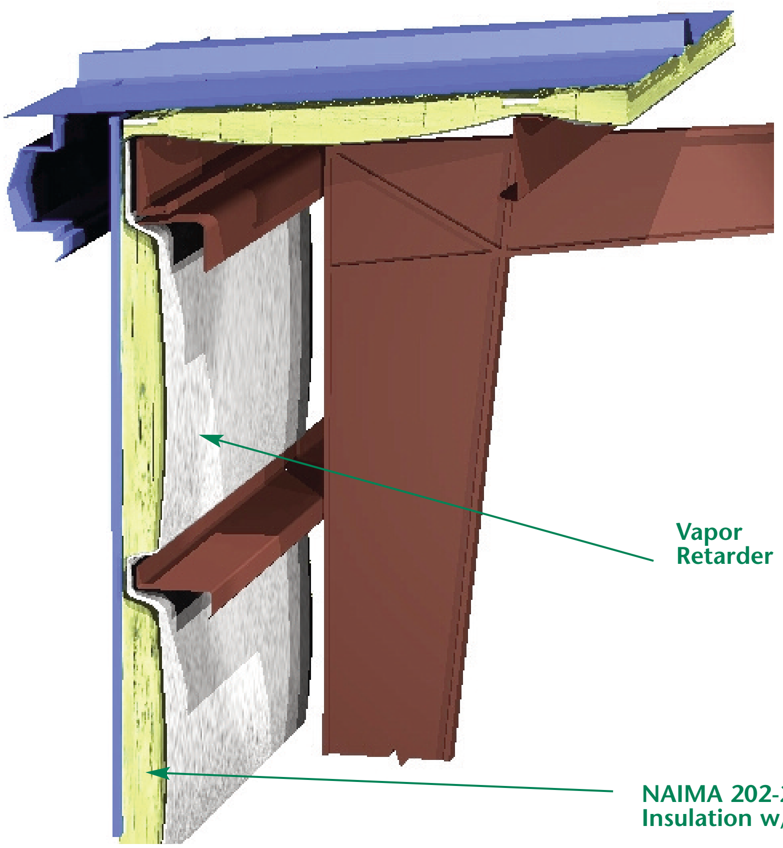


Table 8B: Metal Building Wall Assemblies with Double Layer of Faced Insulation Overall U-Factors, Btu/(h·ft²·°F)

Rated R-value of Faced Insulation	U-Factor
R-6 + R-13	0.070
R-10 + R-13	0.061
R-13 + R-13	0.057
R-19 + R-13	0.048

Installation Tips

Install NAIMA 202-96 laminated blanket insulation in a manner to allow expansion to the full thickness at the center point between the purlins. Note: The U-Factors in the table above are based on full thickness at the centerline. Compression of the insulation should be minimized.

Installing Fiber Glass Insulation in Metal Buildings

There are a variety of methods for installing insulation in metal building walls and roofs. Some are applicable for both new and retrofit construction, while others are suitable for new construction only. Some utilize manual techniques while others utilize mechanical systems to aid installation. Some of these mechanical systems are patented and their use may be restricted. Consult with the building manufacturer before specifying insulation installation procedures.

It is important to understand that the thermal performance of metal building walls and roofs will depend not only on the design and materials specified, but also on how these materials are installed. The ASHRAE pre-calculated U-factors were developed utilizing a number of assumptions thought to be representative of typical constructions, but variation in the installed thermal performance of these systems should be expected.

Installed Performance of Over-the-Purlin Systems

For over-the-purlin roof systems, the ASHRAE 90.1 committee has published a set of algorithms that can be used to estimate thermal performance.*

The thermal performance of the over-the-purlin roof design depends on a number of factors including:

1. Purlin spacing
2. Purlin flange width
3. Spacing between the top of the purlin and the roof sheet
4. R-value and thickness of the spacer block (if installed)
5. R-value of faced insulation material installed
6. Degree of compression of the faced insulation
7. R-value of continuous insulation (if installed).

Some of these factors are determined by the designer, while others are determined in the field by the installing contractor. Table 9 illustrates the range of U-factors calculated for various R-values of single layer faced insulation without thermal blocks and at various levels of compression. Compression is measured relative to the label thickness of blanket insulation at the centerline between the purlins.

* ASHRAE Symposium titled ASHRAE Standard 90.1 Metal Building U-Factors, ASHRAE Trans. 2010, Vol. 116, Part 1., Papers OR-10-017-020, Orlando, 2010.

Table 9: Standing Seam Roof Assemblies with Single Layer of Faced Insulation without Thermal Blocks – Overall U–Factors, Btu/(h·ft²·°F)

Rated R-value of Faced Insulation	Compression of Insulation at Center of Purlin Space			
	0%	10%	20%	30%
R-10	0.105	0.109	0.114	0.120
R-11	0.099	0.103	0.108	0.113
R-13	0.089	0.093	0.097	0.102
R-16	0.079	0.082	0.086	0.091
R-19	0.070	0.073	0.077	0.082

Assumes: 8"x 2 ½" purlins 60"o.c., 1.75" spacing between top of purlin and roof sheet, no thermal block.

These results are plotted in the figure below. Obviously, the amount of compression will impact the installed performance and excessive compression should be avoided to minimize U-factors.

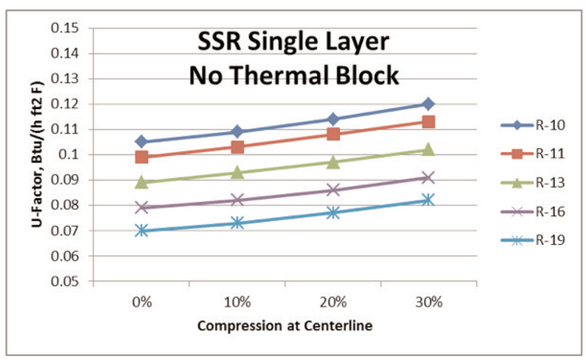


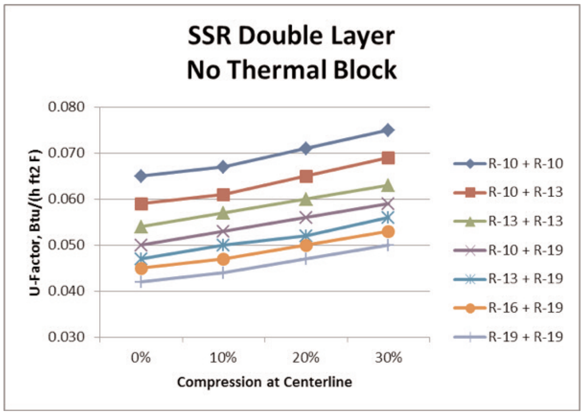
Table 10 gives precalculated U-factors for various combinations of R-values of double-layer installations at various levels of compression. As in Table 9, no thermal block is assumed for these calculations.

TABLE 10: STANDING SEAM ROOF ASSEMBLIES WITH DOUBLE LAYER OF INSULATION WITHOUT THERMAL BLOCKS – OVERALL U-FACTORS, BTU/(H·FT²·°F)

Rated R-value of Faced Insulation	Compression of Insulation at Center of Purlin Space			
	0%	10%	20%	30%
R-10 + R-10	0.065	0.067	0.071	0.075
R-10 + R-11	0.062	0.065	0.069	0.073
R-11 + R-11	0.061	0.063	0.067	0.071
R-10 + R-13	0.059	0.061	0.065	0.069
R-11 + R-13	0.057	0.060	0.063	0.067
R-13 + R-13	0.054	0.057	0.060	0.063
R-10 + R-19	0.050	0.053	0.056	0.059
R-11 + R-19	0.049	0.052	0.055	0.058
R-13 + R-19	0.047	0.050	0.052	0.056
R-16 + R-19	0.045	0.047	0.050	0.053
R-19 + R-19	0.042	0.044	0.047	0.050

Assumes: 8"x 2 ½" purlins 60"o.c., 1.75" spacing between top of purlin and roof sheet, no thermal block.

Again, these results are plotted in the figure below. Obviously, the amount of compression will impact the installed performance and excessive compression should be avoided to maximize thermal performance.



Installed Performance of Filled Cavity Systems

Liner and full-cavity insulation systems have the potential of improved thermal performance since compression of insulation is minimized. However, proper design and installation of these systems is important in achieving rated performance. Obviously, purlin depth and stand-off spacing must be adequate to allow full expansion of the insulation to rated thickness.

Additionally, insulation must completely fill the cavity. The insulating blankets must be full-width and tightly butted at joints to provide complete coverage.

Insulation Systems and Air Barriers

The ASHRAE 90.1-2010 Standard has provisions requiring a continuous air barrier to limit uncontrolled air leakage into the building. The air barrier must be specifically identified on the building plans and specifications and must be specifically designed to resist positive and negative pressures from wind, stack effect, and mechanical ventilation.

Vapor Retarders & Perm Ratings

The vapor retarder used on metal building insulation should be strong enough to withstand handling during installation as well as to function as an aesthetically pleasing interior building finish. Therefore, the facing must have good tensile strength, good rip-stop characteristics and puncture resistance. In addition it must be fire retardant, provide good light reflectivity, provide a durable, yet aesthetic appearance and have a low water vapor permeance. (Permeance is a measure of the flow of water vapor through a material). The lower the permeance, the better the vapor retarder. Table 11 is a list of typical vapor retarders.

TABLE 11: TYPICAL PERM RATING

Vapor Retarder Type	Typical Perm Rating
Vinyl	1.0
Polypropylene/Scrim/Kraft (PSK)	.02 - .09
Foil/Scrim/Kraft (FSK)	.02
Polypropylene/Scrim/Foil (PSF)	.02
Vinyl/Scrim/Metallized Polyester (VRP)	.02

Vapor Retarders & Workability Temperatures

It is important to remember that installing faced insulation is not recommended when the temperature falls below the minimum workability temperatures shown in Table 12.

TABLE 12: MINIMUM WORKABILITY TEMPERATURES

Vapor Retarder Type	Min. Workability Temp.
Vinyl	40°F
Polypropylene/Scrim/Kraft (PSK)	20°F
Foil/Scrim/Kraft (FSK)	10°F
Polypropylene/Scrim/Foil (PSF)	20°F
Vinyl/Scrim/Metalized Polyester (VRP)	20°F

Miscellaneous

Cover any rips or tears with matching facing tape to ensure a tight seal. Do not use patching tape to seal tabs.

Trim excessive insulation flush at eaves and rakes to keep water out of the insulation.

Since building and insulation systems differ, it is important that the contractor adhere to the particular erection instructions furnished by the metal building manufacturer and the laminator supplying the insulation.

Job Site Storage Recommendations

The insulation should be inspected upon arrival at the job site to ensure that it is exactly as ordered. If there is anything wrong with the insulation it should not be installed. Contact the supplier immediately.

Insulation should be stored in a dry, protected area.

All packages should be elevated above the ground or slab, preferably on a flat surface, to prevent contact with surface water accumulation. The facing should be protected from tears and punctures to maintain continuity of the vapor retarder.

Poly-bags should have hole in each end to aerate the insulation. It is also suggested that the contractor open the ends of the bags to allow better air circulation around the insulation.

Packages can be left uncovered during the day, weather permitting, but should be protected at night with polyethylene film, canvas or other covering.

NOTE: Whenever possible, the insulation should be used as soon as possible after it arrives at the job site. The sooner the insulation is installed, the less likely it is to get damaged in storage.

Fall Protection

Installing Insulation on Metal Building Roofs

There are a variety of methods available to provide fall protection for workers installing roof and wall insulation and cladding on metal buildings. Ultimately, it is the building erector's responsibility to select a system, train the workers, and use a system appropriate to the project under construction, and to comply with the appropriate safety regulations.

Installers engaged in insulating low slope roofs with unprotected sides and edges 15 feet or higher* or more should be protected from falling by: guardrail systems, safety net systems, personal fall arrest systems, or a combination of a warning line system and guardrail system, warning line system and safety net system, warning line system and personal fall arrest system, or warning line system and safety monitoring system.

Installing Insulation in Metal Building Sidewalls

Insulation installers working on, at, above or near wall openings where the outside bottom edge of the wall opening is six feet or more above lower levels, and the inside bottom edge of the wall opening is less than 39 inches above the walking/working surface, must be protected from falling by the use of either a guardrail system, a safety net system, or a personal fall arrest system.

*OSHA 29 CFR Part 1926 subpart R

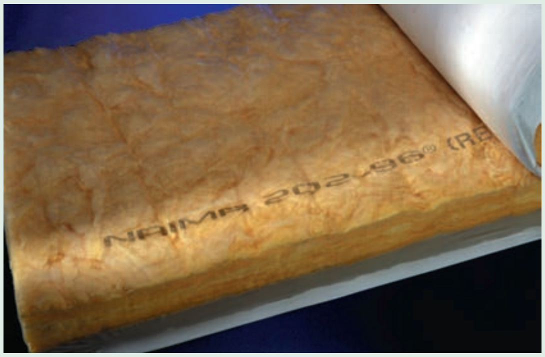
NAIMA 202-96® Fiber Glass Insulation Helps Builders Comply

Insulation is perhaps one of the most cost-effective ways to meet the energy code. Furthermore, it provides additional benefits such as energy savings, condensation control, noise control and enhanced light reflectivity that will remain with the building over the life of the structure.

Fiber glass insulation for metal building assemblies where a laminated facing is used is called NAIMA 202-96® (Rev. 2000) insulation. The standard designation means the insulation meets the requirements of the NAIMA 202-96® (Rev. 2000) Standard and is certified for thermal performance by the Home Innovation Research Labs (formerly the NAHB Research Center) for use in metal buildings. NAIMA metal building insulation products are tested quarterly and are certified to meet stringent thermal resistance requirements. The products intended for metal buildings will have the manufacturer's name, NAIMA 202-96® (Rev. 2000) and the R-value printed on the insulation surface for easy identification.

The NAIMA 202-96 insulations intended for laminations and are engineered so that the thickness recovery and R-value are still intact after the laminating process. The NIA Certified Faced Lamination Standard is now in place to protect the integrity of the insulation during the lamination process. Once the insulation is produced, a vapor retarder is applied to the fiber glass blanket by a laminator, and the insulation is re-rolled and compressed for shipment to the job site in custom lengths and widths to fit the building.

Look for this label:



This label is your assurance that the R-value of the faced insulation ordered is the R-value delivered to the job site. Residential grade or non-marked insulations are not engineered for the laminating process or sized for the metal building market.

Requirements for Metal Building Envelopes

The International Code Council has recently published the 2012 IECC. Requirements for commercial building envelopes have been increased significantly relative to earlier versions and are also generally more stringent than the ASHRAE Standard 90.1-2010 requirements. For references purposes, maximum U-factors are summarized here for metal building walls and roofs. The IECC distinguishes between Group R Occupancy (Residential) and All Other occupancies. No distinction is made for semi-heated spaces. Compliance for semiheated spaces can be achieved by using the ASHRAE compliance option discussed in this guide, which is allowed in Chapter 5 of the IECC.

ROOF REQUIREMENTS – MAXIMUM OVERALL U-FACTORS, BTU/(H·FT^2·°F)

Zone	All Other	Group R
1	0.044	0.035
2	0.035	0.035
3	0.035	0.035
4 (except Marine 4)	0.035	0.035
5 and Marine 4	0.035	0.035
6	0.031	0.031
7	0.029	0.029
8	0.029	0.029

WALL REQUIREMENTS – MAXIMUM OVERALL U-FACTORS, BTU/(H·FT^2·°F)

Zone	All Other	Group R
1	0.079	0.079
2	0.079	0.079
3	0.079	0.052
4 (except Marine 4)	0.052	0.052
5 and Marine 4	0.052	0.052
6	0.052	0.052
7	0.052	0.039
8	0.052	0.039

About NAIMA

NAIMA is the association for North American manufacturers of fiber glass, rock wool, and slag wool insulation products. Its role is to promote energy efficiency and environmental preservation through the use of fiber glass, rock wool, and slag wool insulation, and to encourage the safe production and use of these materials. NAIMA, continuing its members' commitment to safety has established a renewed Product Stewardship Program, which embodies the components of the earlier OSHA-NAIMA Health and Safety Partnership Program (HSPP). The HSPP was a comprehensive eight-year partnership with OSHA, which NAIMA completed in May 2007, and now NAIMA incorporates these safe work practices into NAIMA's Product Stewardship Program.

DISCLAIMER

Use of this information does not ensure or guarantee code compliance. Consult local code authorities before finalizing design.

Each metal building manufacturer has specific recommendations for the installation of fiber glass insulation. Consult your metal building manufacturer for specific details.

For more information, contact:

NAIMA
North American Insulation Manufacturers Association

44 Canal Center Plaza, Suite 310
Alexandria, VA 22314
Phone: 703-684-0084
Fax: 703-684-0427
www.naima.org

NAIMA Metal Building Committee Members

CertainTeed Corp.
P.O. Box 860
Valley Forge, PA 19482
800-233-8990
www.certainteed.com

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979 Batesville Road
Greenville, SC 29651
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