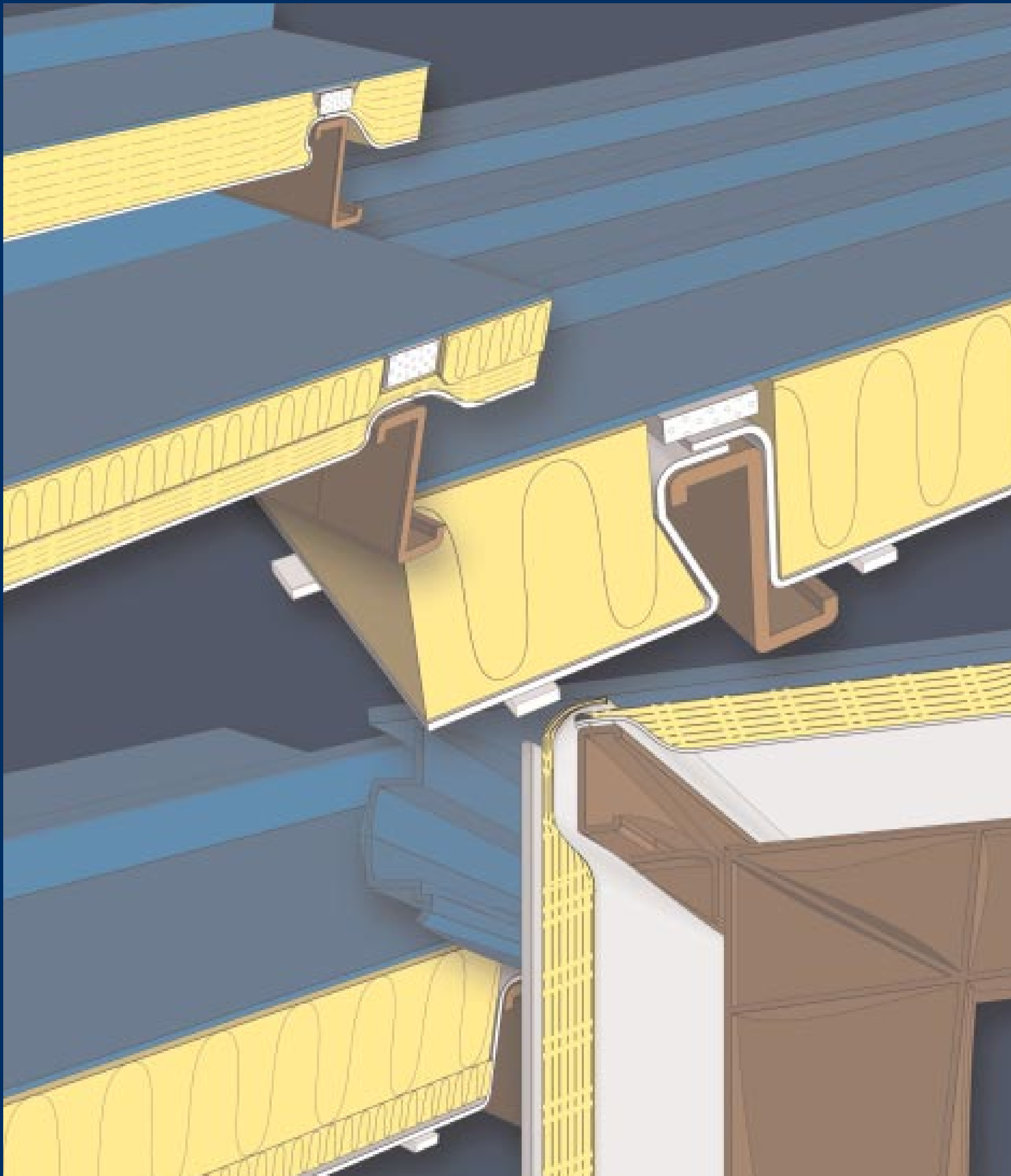
NAIMA
NORTH AMERICAN INSULATION MANUFACTURERS ASSOCIATION

ASHRAE 90.1 Compliance For Metal Buildings



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This guide contains typical metal building insulation system constructions and their associated U-values when different thicknesses of insulation are used (Pages 4–6). These insulation system constructions are listed by geographical region (Table 4, pages 8–9). For ASHRAE 90.1 compliance, the systems used in the construction of a metal building must be at or below the U-Values given in Table 4 for the appropriate geographic region.

To use the information in this guide, first find out which version of the Standard applies in your area: **ASHRAE 90.1-89 or ASHRAE 90.1-1999-2001**. (We will be referring to the 2001 version. However if the 1999 or 2000 version is in place, the same information applies.) The ASHRAE 90.1 Standard covers all commercial metal buildings that are heated and/or cooled. It does not apply to buildings that: a) do not use electricity, natural gas, propane or oil; and b) are used primarily for manufacturing or commercial processes (Check with the authority having jurisdiction in your area.) Then follow the relevant section below.

See page 7 for NAIMA's insulation recommendations for metal buildings not subject to ASHRAE 90.1 requirements.

If **ASHRAE 90.1-89** is the required energy code:

1 Determine the U-value requirements for the roof/ceiling and opaque walls from Table 4, pages 8–9, **ASHRAE 90.1-89 Section** based on the nearest city with similar climate conditions.

2 Turn to pages 4–6 and compare the systems and the required U-values. Look for the system which lists a U-value at or below the required U-value needed to meet the code.

An Example for Birmingham, Alabama

Table 4 lists the following U-value compliance requirements for Birmingham, Alabama:

- Roof/Ceilings: 0.069
- Opaque Walls: 0.147

For roof/ceilings, System 2, Single Layer, R-19 insulation will give a U-value of 0.65.

For sidewalls, System 1, R-10 insulation will give a U-value of .134 for 12" fastener spacing and a U-value of .139 for 6" fastener spacing.

City/State	ASHRAE 90.1-2001				ASHRAE 90.1-89		
	Non-Residential		Semi-Heated				
	Roofs & Ceilings	Opaque Walls	Roofs & Ceilings	Opaque Walls	Opaque Walls	Roofs & Ceilings	Walls Adjacent to Unconditioned Space
ALABAMA							
Birmingham FAA AP	0.065	0.113	0.097	0.184	0.147	0.069	0.230
Mobile WSO AP	0.065	0.113	0.167	0.184	0.226	0.076	0.376
Montgomery WSO AP	0.065	0.113	0.167	0.184	0.175	0.070	0.279

If **ASHRAE 90.1-1999-2001** is the required energy code:

1 Determine what type of metal building is being constructed. Buildings that are heated or cooled for human occupancy use the ***Non-Residential*** criteria column. Buildings that have a heating system that is rated at 3.4 Btu/h·ft^2 or less use the ***Semi-Heated*** criteria. Semi-heated buildings are generally ones that have a small heating system designed to prevent freezing of the building's contents.

2 Determine the U-value requirements for the roof/ceiling and opaque walls from Table 4, pages 8–9 **ASHRAE 90.1-2001 Section** based on the nearest city with similar climate conditions.

3 Turn to pages 4–6 and compare the systems and the required U-values. Look for the system which lists a U-value at or below the required U-value needed to meet the code.

An Example for Atlanta, Georgia – Non-Residential Building

Table 4 lists the following U-value compliance requirements for Atlanta, Georgia:

- Roof/Ceilings: 0.065
- Opaque Walls: 0.113

For roof/ceilings, System 2, Single Layer, R-19 insulation will give a U-value of 0.65.

For sidewalls, System 1, R-13 insulation will give a U-value of .113 for 12" fastener spacing and a U-value of .118 for 6" fastener spacing.

City/State	ASHRAE 90.1-2001				ASHRAE 90.1-89		
	Non-Residential		Semi-Heated				
	Roofs & Ceilings	Opaque Walls	Roofs & Ceilings	Opaque Walls	Opaque Walls	Roofs & Ceilings	Walls Adjacent to Unconditioned Space
GEORGIA							
Atlanta WSO AP	0.065	0.113	0.097	0.184	0.141	0.072	0.219
Augusta WSO AP	0.065	0.113	0.167	0.184	0.159	0.070	0.251
Macon WSO AP	0.065	0.113	0.167	0.184	0.171	0.070	0.272
Savannah WSO AP	0.065	0.113	0.167	0.184	0.193	0.075	0.313

BACKGROUND INFORMATION

ASHRAE 90. 1 (1989 and 2001), titled "Energy Efficient Design of New Buildings Except Low-Rise Residential Buildings," published by the American Society of Heating, Refrigerating and Air Conditioning Engineers Inc., is the latest of the Standard 90 series. This standard sets forth design requirements for the efficient use of energy in new buildings intended for human occupancy except single and multi-family residential buildings of three or fewer stories above grade.

The Standard applies to metal buildings that include the following:

- provisions for a space heating system
- provisions for a space cooling system
- provisions for a service water heating system

In other words, almost all metal buildings are subject to meeting the requirements of ASHRAE 90.1.

WHEN ASHRAE STANDARD 90.1 DOES NOT APPLY

ASHRAE Standard 90.1 does not apply in the following building situations:

- areas of the building intended primarily for manufacturing, commercial or industrial processing
- buildings where the combined peak design of energy usage is less than 3.5 Btu/hr•sf
- buildings of fewer than 100 square feet of gross floor area

The defining factor is whether or not the buildings are to be heated or cooled for human occupancy or used for products or processes that are temperature sensitive. For example, if the metal building used for a factory and a temperature needs to be maintained for employee comfort, the ASHRAE 90.1 applies. If the

building is intended for warehousing products not sensitive to extreme heat or cold and human comfort is not a factor, then the Standard does not apply. In most areas, 90.1 has been adopted as the commercial building energy code. Check with the authority having jurisdiction in your area to verify the applicable commercial building energy code requirements.

ADDITIONAL REASONS TO COMPLY WITH ASHRAE 90.1

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 buildings. It is intended for buildings designed for human occupancy whether it be now or in the future.

A building intended for a manufacturing or industrial processing plant today may be remodeled into a structure requiring office space or even warehouse space for temperature sensitive products tomorrow. Generally, the cost to retrofit a building to meet ASHRAE 90.1 requirements can be more costly than building in the recommended energy efficiency measures a the time of construction.

NAIMA 202-96® (Rev. 2000) Insulation Helps Builders Meet ASHRAE 90.1

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.

Builders and designers are using NAIMA 202-96® (Rev. 2000) fiber glass metal building insulation because it requires no new investment in technology, resources or time. It is a technology that makes code compliance easier.

To assure builders they are getting the right R-value delivered to the job site, NAIMA 202-96® (Rev. 2000) insulation is purposely designed by the manufacturer to assure that thickness recovery and R-value are still intact after the laminating process. NAIMA metal building insulation products are tested quarterly by NAHB Research Center and are certified to meet stringent thermal resistance requirements. These fiber glass insulation products intended for metal buildings will have the manufacturer's name, NAIMA 202-96® (Rev. 2000) and the R-value printed on the surface for easy identification on the project site.

Today's Designers Are More Energy Conscious

Many metal building designers and building owners are designing energy efficiency into their structures at the onset. An energy efficient building provides greater flexibility in its use and generally will be more marketable for resale.

ASHRAE 90.1 OFFERS THREE COMPLIANCE PATHS

The Standard offers multiple paths by which compliance can be determined. This allows the designer to follow Prescriptive Criteria, System Performance Criteria, or a Building Energy Cost Budget Method to reach a compliant design. The Prescriptive Method requires the minimum design effort while the latter two methods allows for more innovative design flexibility.

ASHRAE Standard 90.1 is rapidly being adopted by model, state, and local energy code-making bodies. Requests have been made to the NAIMA Metal Building Insulation Committee to provide further information on the use of the Prescriptive Criteria with regard to metal building insulation systems. This provides easy-to-use information tailored specifically to the unique nature of metal building insulation systems. For more sophisticated designs where trade-offs are to be considered, one of the other design paths is recommended.

CITY DIRECTORIES OF ASHRAE 90.1 U-VALUE REQUIREMENTS

Overall U-values for various building envelope requirements were tabulated in Table 4 for 183 cities using the climate data listed in Appendix C of ASHRAE 90.1-1989 and Appendix D of ASHRAE 90.1-2001.

For additional cities not listed in Table 4, refer to the appropriate version of ASHRAE 90.1 to determine the envelope U-value requirements.

TYPICAL ASSEMBLIES AND THEIR ASSOCIATED U-VALUES

The following illustrations show typical metal building systems constructions and their associated U-values when different thicknesses of insulation are used. Deviations from this information should only be made when specific test data from valid hot box assembly tests can be provided.

About the Calculations

Previous versions of this brochure entitled ASHRAE 90.1 Compliance for Metal Buildings provided insulation system illustrations and a U-value chart based on the Zone Method of Calculation described in the ASHRAE Handbook of Fundamentals. While the Zone Method is still referenced in the Handbook, its simplified two-dimensional analysis does not accurately portray the complexities of a metal building insulation system.

The calculations and the U-values portrayed on the following pages more accurately reflect the multi-dimensional systems seen in the field. They are calculated using the entire metal building system including purlins, clips, fasteners, and the insulation. Each system shown was modeled using the ANSYS Finite Element Analysis (FEA) software program. The FEA program breaks the systems down into small pieces that are called elements. The elements are related to each other through a large matrix of equations based on the physical properties of the various materials in the system. Solution of these equations yields a detailed picture of the temperature distribution and heat flow in the system.

To verify the accuracy of the modeling technique, the results for several insulation configurations were compared to available hot box testing results. Once the modeling technique was verified, it was applied to a large number of insulation configurations.

System Assumptions for FEA Calculations

1. The U-values displayed apply to both bar joist and purlin applications.
2. U-values include air film coefficients.
3. In the systems where thermal spacer blocks are recommended, the FEA models used 3″ wide spacer blocks made from 1″ extruded polystyrene foam.
4. All calculations were made based on 75°F mean temperature using NAIMA 202-96® (Rev. 2000) fiber glass metal building insulation.
5. Vapor retarders were always installed toward the conditioned space.
6. In multi-layer systems such as System 2B and System 3, NAIMA 202-96 (Rev.2000) was used for both layers. The model made the calculations based on placement of the faced, first layer towards the conditioned space and a second, unfaced layer installed towards the roof sheet. This thicker, or in most cases, top layer will therefore have a greater R-value than the thinner faced insulation.

System 1 - Screw Down Roofs & Side Walls

Screw Down Roof Or Wall System With Single Layer Insulation Installed Over Purlins/Girts

In this system, NAIMA 202-96® (Rev. 2000) fiber glass metal building insulation is installed over and perpendicular to the purlins/girts and the metal exterior roof or wall sheets are fastened to the purlins/girts holding the insulation in place.

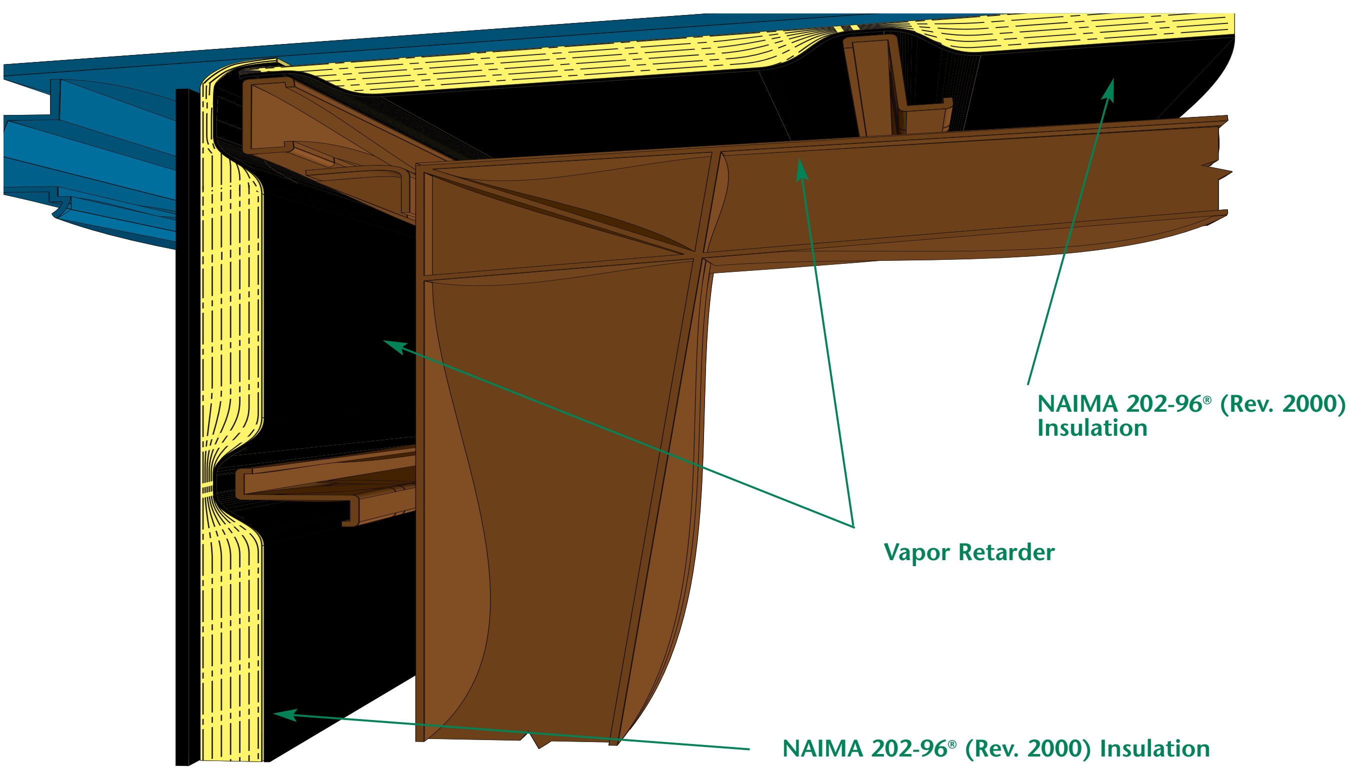
TABLE 1A: SCREW DOWN ROOFS (5' PURLIN SPACING)

NAIMA 202-96® (Rev. 2000) R-VALUE	U-VALUE SCREW DOWN ROOF 12″ Fastener Spacing	U-VALUE SCREW DOWN ROOF 6″ Fastener Spacing
10	.153	.160
11	.139	.147
13	.130	.137
19	.098	.106

TABLE 1B SIDE WALLS (7' GIRT SPACING)

NAIMA 202-96® (Rev. 2000) R-VALUE	U-VALUE SCREW DOWN WALL 12″ Fastener Spacing	U-VALUE SCREW DOWN WALL 6″ Fastener Spacing
10	.134	.139
11	.123	.129
13	.113	.118
19	.084	.090

Note: The lower the U-value the better the performance.



System 2 - Standing Seam Roof only

Standing Seam Roof With Single Or Double Layers Of Insulation Installed Over And Between Purlins With Thermal Spacer Blocks

Faced NAIMA 202-96® (Rev. 2000) metal building insulation is installed over and perpendicular to the purlins prior to applying the roof. A second layer of unfaced NAIMA 202-96® (Rev. 2000) insulation may be applied between the purlins and over the first layer of faced insulation (or over the purlins) to fill the space formed by the roof sheet stand offs.

To further retard heat transfer at the joists, thermal spacer blocks are placed over the purlins where insulation will be compressed. The insulation is installed with the vapor retarder toward the conditioned space, giving an aesthetic interior appearance that also enhances light reflectivity.

Table 2a: Standing Seam Roof - Single Layer

(5′ purlin spacing, 24″ o.c. clip spacing, 1″ x 3″ foam block on purlin)

NAIMA 202-96® (Rev. 2000) R-VALUE	U-VALUE
10	.097
11	.092
13	.083
19	.065

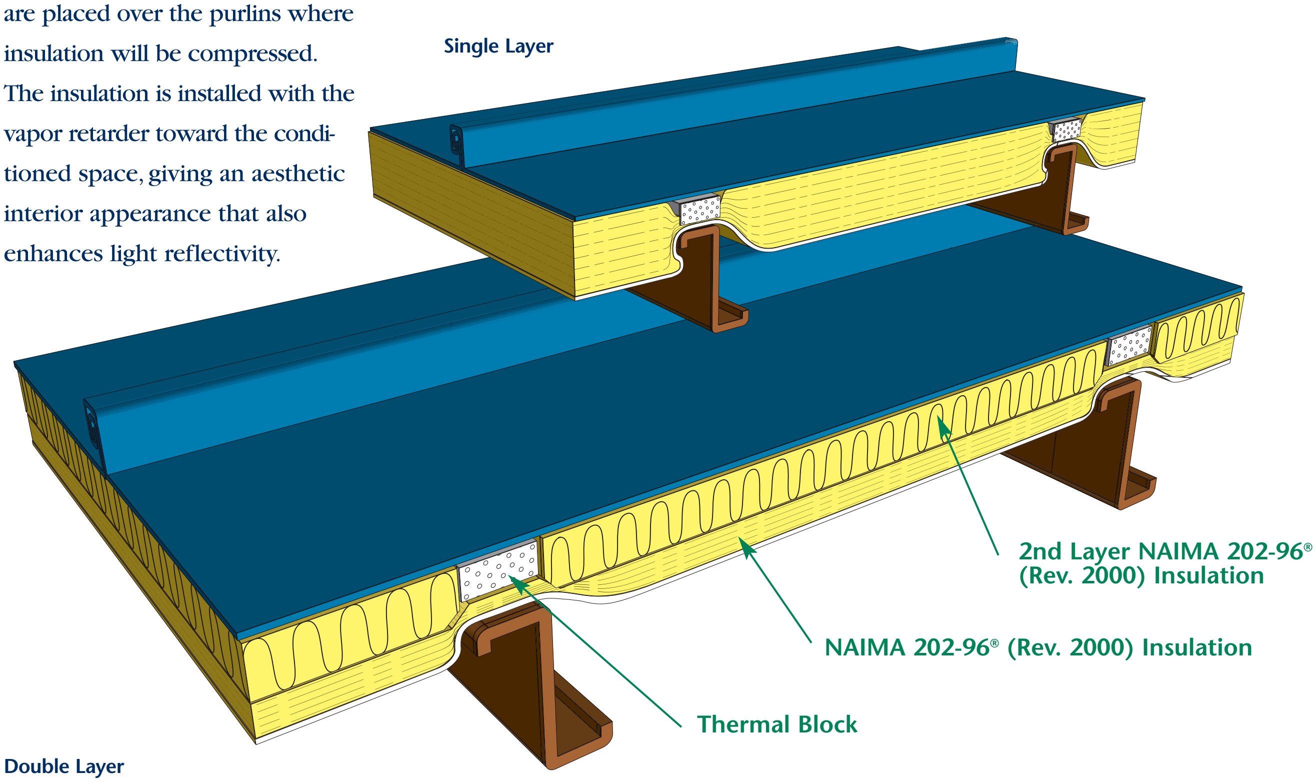
Note: The lower the U-value the better the performance.

Table 2b: Standing Seam Roof - Double Layer

(5′ purlin spacing, 24″ o.c. clip spacing, 1″ x 3″ foam block on purlin)

NAIMA 202-96® (Rev. 2000) R-VALUES (*)	U-VALUE
10/10	.063
10/11	.061
11/11	.060
10/13	.058
11/13	.057
13/13	.055
10/19	.052
11/19	.051
13/19	.049
19/19	.046

*The first number (first layer) represents the NAIMA 202-96® (Rev. 2000) insulation with a vapor retarder facing. The second number (second layer) represents NAIMA 202-96® (Rev. 2000) unfaced insulation. This thicker layer will therefore have a greater R-value than the thinner faced insulation.



System 3 - Standing Seam & Screw Down Roof

Standing Seam Roof With Two Layers Of Insulation Installed Between Purlins With Spacer Blocks

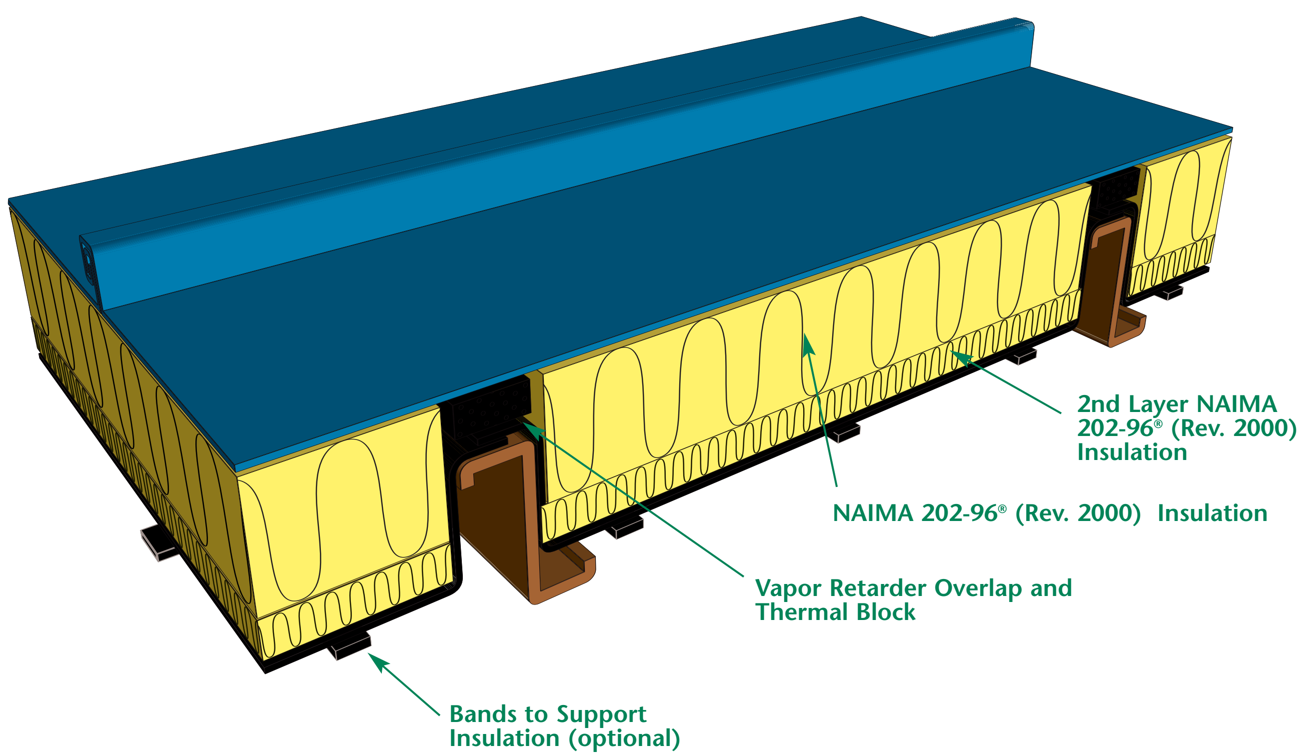
This insulation system uses a vapor retarder faced NAIMA 202-96® (Rev. 2000) insulation placed between the purlins with the facing tabs overlapping on the top face of the purlins. Unfaced NAIMA 202-96® (Rev. 2000) insulation is installed as a second layer, also between the pulins and completely fills the cavity. Thermal spacer blocks are placed on top of the purlins to create a thermal break at the structural members.

TABLE 3A: STANDING SEAM ROOF - DOUBLE LAYER

(5' purlin spacing, 24" o.c. clip spacing, 1" x 3" foam block on purlin)

NAIMA 202-96® (Rev. 2000) R-VALUE	U-VALUE
10/19	.057

Note: The lower the U-value the better the performance.



Guidelines For Insulating Metal Buildings Not Subject To ASHRAE 90.1 Requirements

Metal buildings intended for human occupancy and that include provisions for a space heating system, a space cooling system, or a service water heating system must comply with ASHRAE 90.1 or other local energy codes.

Even if your metal building is not required to comply with ASHRAE 90.1, it is still good practice to provide insulation to reduce energy costs, control condensation and for other aesthetic purposes.

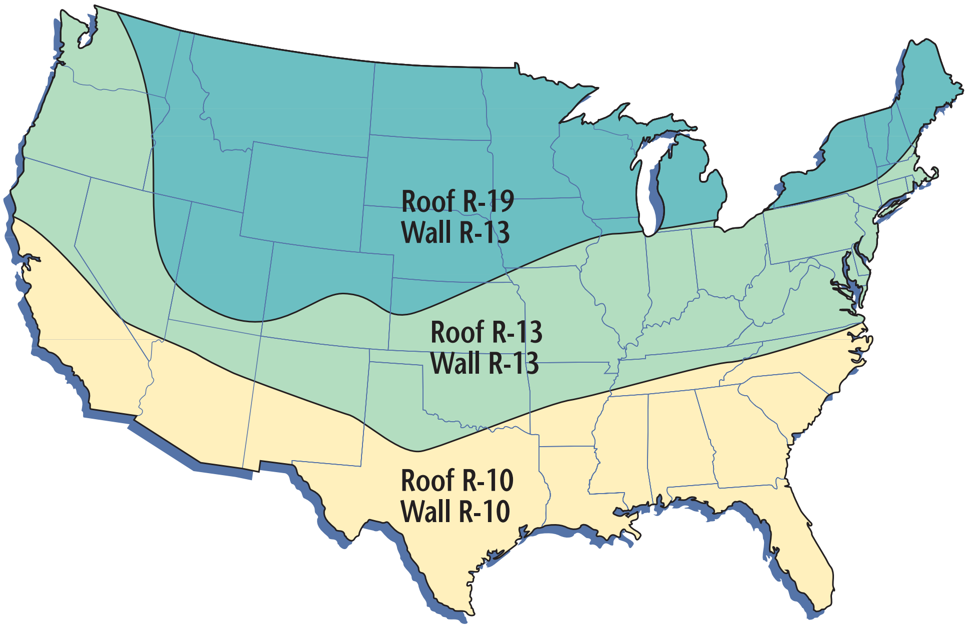
Faced insulation also provides better lighting inside buildings due to the increased light reflectance of the facing. This can reduce the lighting costs necessary to adequately light the building interior. Also, excessive noise levels beyond building boundaries can be reduced by utilizing insulation in both the walls and roofs of metal buildings.

In cooler climates some codes assume that heating will always be installed for freeze protection and therefore require a minimum level of insulation during the initial construction of the shell building. This is based on the rationale that to add this later may be more costly.

Finally, insulating a new metal building can help ensure that the building will be more marketable for other uses besides its current intended use.

With all of these things in mind, NAIMA has developed the following minimum guidelines for insulating metal buildings not subject to ASHRAE 90.1.

Roof and Wall Insulation Product R-Values



Insulate Today

- Condensation Control
- Light Reflectance
- Noise Control

Table 4: U-values for Compliance to ASHRAE Standard 90.1

	ASHRAE 90.1-2001				ASHRAE 90.1-89		
	Non-Residential		Semi-Heated				
City/State	Roofs & Ceilings	Opaque Walls	Roofs & Ceilings	Opaque Walls	Opaque Walls	Roofs & Ceilings	Walls Adjacent to Unconditioned Space
ALABAMA							
Birmingham FAA AP	0.065	0.113	0.097	0.184	0.147	0.069	0.230
Mobile WSO AP	0.065	0.113	0.167	0.184	0.226	0.076	0.376
Montgomery WSO AP	0.065	0.113	0.167	0.184	0.175	0.070	0.279
ALASKA							
Anchorage WSCMO AP	0.065	0.057	0.097	0.113	0.058	0.041	0.101
Fairbanks WSFO AP	0.049	0.057	0.072	0.113	0.047	0.032	0.088
Juneau AP	0.065	0.113	0.097	0.113	0.064	0.045	0.107
Kodiak WSO AP	0.065	0.113	0.097	0.113	0.066	0.047	0.110
Nome WSO AP	0.049	0.057	0.072	0.113	0.047	0.032	0.088
ARIZONA							
Phoenix WSFO AP	0.065	0.113	0.167	0.184	0.248	0.047	0.422
Prescott	0.065	0.113	0.097	0.134	0.108	0.064	0.167
Tucson WSO AP	0.065	0.113	0.167	0.184	0.224	0.059	0.372
Winslow WSO AP	0.065	0.113	0.097	0.134	0.106	0.059	0.164
Yuma WSO AP	0.065	0.113	0.167	0.184	0.373	0.045	0.706
ARKANSAS							
Ft Smith WSO AP	0.065	0.113	0.097	0.184	0.131	0.059	0.203
ARKANSAS							
Little Rock FAA AP	0.065	0.113	0.097	0.184	0.140	0.064	0.218
CALIFORNIA							
Bakersfield WSO AP	0.065	0.113	0.167	0.184	0.179	0.062	0.286
Fresno WSO AP	0.065	0.113	0.167	0.184	0.154	0.063	0.242
Long Beach WSO AP	0.072	0.113	0.167	0.184	0.236	0.105	0.397
Los Angeles WSO AP	0.072	0.113	0.167	0.184	0.235	0.116	0.395
Oakland/Intl	0.065	0.113	0.167	0.184	0.146	0.094	0.228
Sacramento FAA AP	0.065	0.113	0.097	0.184	0.152	0.073	0.238
San Diego WSO AP	0.072	0.113	0.167	0.184	0.236	0.117	0.454
San Francisco WSO AP	0.065	0.113	0.097	0.184	0.136	0.089	0.211
Santa Maria WSO AP	0.065	0.113	0.097	0.184	0.142	0.091	0.221
COLORADO							
Colorado Sprgs WSO AP	0.065	0.113	0.097	0.123	0.087	0.058	0.138
Denver WSFO AP	0.065	0.113	0.097	0.123	0.087	0.056	0.014
Grand Junction WSO AP	0.065	0.113	0.097	0.123	0.091	0.053	0.142
Pueblo WSO AP	0.065	0.113	0.097	0.123	0.096	0.057	0.149
CONNECTICUT							
Hartford-Brainard Fld	0.065	0.113	0.097	0.123	0.085	0.055	0.134
DELAWARE							
Wilmington WSO AP	0.065	0.113	0.097	0.134	0.098	0.061	0.153
FLORIDA							
Daytona Beach WSO AP	0.065	0.113	0.167	0.184	0.371	0.087	0.702
Jacksonville WSO AP	0.065	0.113	0.167	0.184	0.252	0.076	0.429
Miami WSCMO AP	0.065	0.113	1.280	1.180	1.000	0.075	1.000
Orlando WSO Mc Coy	0.065	0.113	1.280	1.180	0.491	0.076	1.000
Tallahassee WSO AP	0.065	0.113	0.167	0.184	0.213	0.075	0.350
Tampa WSCMO AP	0.065	0.113	1.280	1.180	0.464	0.079	0.942
West Palm Beach WSO AP	0.065	0.113	1.280	1.180	1.000	0.075	1.000
GEORGIA							
Atlanta WSO AP	0.065	0.113	0.097	0.184	0.141	0.072	0.219
Augusta WSO AP	0.065	0.113	0.167	0.184	0.159	0.070	0.251
Macon WSO AP	0.065	0.113	0.167	0.184	0.171	0.070	0.272
Savannah WSO AP	0.065	0.113	0.167	0.184	0.193	0.075	0.313
IDAHO							
Boise WSFO AP	0.065	0.113	0.097	0.123	0.091	0.057	0.142
IDAHO							
Lewiston WSO AP	0.065	0.113	0.097	0.134	0.049	0.059	0.147
Pocatello WSO AP	0.065	0.113	0.097	0.123	0.078	0.051	0.125
ILLINOIS							
Chicago O'Hare WSO AP	0.065	0.113	0.097	0.123	0.086	0.054	0.135
Moline WSO AP	0.065	0.113	0.097	0.123	0.085	0.054	0.135
Springfield WSO AP	0.065	0.113	0.097	0.123	0.094	0.057	0.147

	ASHRAE 90.1-2001				ASHRAE 90.1-89		
	Non-Residential		Semi-Heated				
City/State	Roofs & Ceilings	Opaque Walls	Roofs & Ceilings	Opaque Walls	Opaque Walls	Roofs & Ceilings	Walls Adjacent to Unconditioned Space
INDIANA							
Evansville WSO AP	0.065	0.113	0.097	0.134	0.105	0.061	0.163
Ft Wayne WSO AP	0.065	0.113	0.097	0.123	0.086	0.056	0.136
Indianapolis WSFO	0.065	0.113	0.097	0.123	0.092	0.058	0.144
South Bend WSO AP	0.065	0.113	0.097	0.123	0.085	0.056	0.134
IOWA							
Burlington	0.065	0.113	0.097	0.123	0.086	0.055	0.137
Des Moines WSFO AP	0.065	0.113	0.097	0.123	0.083	0.054	0.132
Mason City FAA AP	0.065	0.113	0.097	0.123	0.073	0.049	0.119
Sioux City WSO AP	0.065	0.113	0.097	0.123	0.080	0.051	0.128
KANSAS							
Dodge City WSO AP	0.065	0.113	0.097	0.134	0.098	0.055	0.152
Goodland WSO AP	0.065	0.113	0.097	0.123	0.086	0.053	0.137
Topeka WSFO AP	0.065	0.113	0.097	0.134	0.097	0.056	0.151
KENTUCKY							
Covington WSO AP	0.065	0.113	0.097	0.134	0.099	0.061	0.154
Lexington WSO AP	0.065	0.113	0.097	0.134	0.105	0.063	0.161
Louisville WSFO AP	0.065	0.113	0.097	0.134	0.107	0.061	0.165
LOUISIANA							
Baton Rouge WSO AP	0.065	0.113	0.167	0.184	0.227	0.073	0.378
Lake Charles WSO AP	0.065	0.113	0.167	0.184	0.240	0.075	0.404
New Orleans WSCMO AP	0.065	0.113	0.167	0.184	0.247	0.076	0.420
Shreveport WSO AP	0.065	0.113	0.167	0.184	0.175	0.066	0.278
MAINE							
Bangor FAA AP	0.065	0.113	0.097	0.123	0.071	0.050	0.117
Caribou WSO AP	0.065	0.057	0.097	0.113	0.063	0.044	0.107
MARYLAND							
Baltimore WSO AP	0.065	0.113	0.097	0.134	0.100	0.060	0.156
MASSACHUSETTS							
Boston WSO AP	0.065	0.113	0.097	0.123	0.090	0.059	0.141
MICHIGAN (MI)							
Alpena WSO AP	0.065	0.113	0.097	0.113	0.070	0.048	0.115
Detroit City Airport	0.065	0.113	0.097	0.123	0.087	0.056	0.138
Flint WSO AP	0.065	0.113	0.097	0.123	0.076	0.054	0.127
Grand Rapids WSO AP	0.065	0.113	0.097	0.123	0.080	0.054	0.128
Sault Ste Marie WSO	0.065	0.057	0.097	0.113	0.064	0.045	0.108
Traverse City FAA AP	0.065	0.113	0.097	0.123	0.073	0.050	0.120
MINNESOTA							
Duluth WSO AP	0.065	0.057	0.097	0.113	0.061	0.043	0.104
International Falls WSO AP	0.065	0.057	0.097	0.113	0.059	0.041	0.101
Minneapolis-St Paul WSO AP	0.065	0.113	0.097	0.123	0.071	0.047	0.116
Rochester WSO AP	0.065	0.113	0.097	0.123	0.071	0.049	0.116
MISSOURI							
Columbia WSO AP	0.065	0.113	0.097	0.134	0.100	0.059	0.155
St. Louis WSCMO AP	0.065	0.113	0.097	0.134	0.101	0.058	0.158
MONTANA							
Billings WSO AP	0.065	0.113	0.097	0.123	0.077	0.051	0.124
Cut Bank FAA AP	0.065	0.113	0.097	0.113	0.066	0.046	0.110
Glasgow WSO AP	0.065	0.113	0.097	0.123	0.066	0.044	0.111
Great Falls WSCMO AP	0.065	0.113	0.097	0.123	0.075	0.051	0.121
Helena WSO AP	0.065	0.113	0.097	0.123	0.072	0.049	0.118
Lewistown FAA AP	0.065	0.113	0.097	0.113	0.071	0.049	0.116
Miles City FAA AP	0.065	0.113	0.097	0.123	0.071	0.046	0.117
Missoula WSO AP	0.065	0.113	0.097	0.113	0.074	0.051	0.120
NEVADA							
Elko FAA AP	0.065	0.113	0.097	0.123	0.077	0.051	0.124
Ely WSO AP	0.065	0.113	0.097	0.113	0.073	0.051	0.119
Las Vegas WSO AP	0.065	0.113	0.167	0.184	0.168	0.049	0.266
Lovelock FAA AP	0.065	0.113	0.097	0.123	0.089	0.054	0.140
Reno WSFO AP	0.065	0.113	0.097	0.123	0.089	0.058	0.140
Tonopah AP	0.065	0.113	0.097	0.123	0.091	0.058	0.143
Winnemucca WSO AP	0.065	0.113	0.097	0.123	0.083	0.052	0.132

City/State	ASHRAE 90.1-2001				ASHRAE 90.1-89		
	Non-Residential		Semi-Heated				
	Roofs & Ceilings	Opaque Walls	Roofs & Ceilings	Opaque Walls	Opaque Walls	Roofs & Ceilings	Walls Adjacent to Unconditioned Space
NEW MEXICO							
Albuquerque WSFO AP	0.065	0.113	0.097	0.134	0.109	0.061	0.168
Roswell FAA AP	0.065	0.113	0.097	0.184	0.129	0.061	0.199
Tucumcari	0.065	0.113	0.097	0.134	0.118	0.060	0.183
NEW YORK							
Albany WSFO AP	0.065	0.113	0.097	0.123	0.080	0.054	0.128
Binghamton WSO AP	0.065	0.113	0.097	0.123	0.075	0.052	0.122
Buffalo WSCMO AP	0.065	0.113	0.097	0.123	0.081	0.055	0.129
Massena FAA AP	0.065	0.113	0.097	0.123	0.069	0.047	0.114
N Y Central Pk WSO City	0.065	0.113	0.097	0.134	0.099	0.064	0.155
N Y La Guardia WSO AP	0.065	0.113	0.097	0.134	0.099	0.064	0.155
Rochester WSO AP	0.065	0.113	0.097	0.123	0.078	0.052	0.126
Syracuse WSO AP	0.065	0.113	0.097	0.123	0.079	0.054	0.127
NORTH CAROLINA							
Asheville WSO AP	0.065	0.113	0.097	0.134	0.113	0.070	0.174
Charlotte WSO AP	0.065	0.113	0.097	0.184	0.131	0.069	0.203
Greensboro WSO AP	0.065	0.113	0.097	0.134	0.122	0.068	0.189
Raleigh-Durham WSFO AP	0.065	0.113	0.097	0.184	0.128	0.070	0.198
NORTH DAKOTA							
Bismarck WSFO AP	0.065	0.113	0.097	0.123	0.065	0.044	0.110
Fargo WSO AP	0.065	0.106	0.097	0.113	0.064	0.043	0.108
Minot FAA AP	0.065	0.106	0.097	0.113	0.065	0.044	0.108
OHIO							
Akron-Canton WSO AP	0.065	0.113	0.097	0.123	0.086	0.057	0.136
Columbus WSO AP	0.065	0.113	0.097	0.123	0.093	0.060	146.000
Dayton WSCMO AP	0.065	0.113	0.097	0.123	0.092	0.060	0.145
Toledo Express WSO AP	0.065	0.113	0.097	0.123	0.082	0.054	0.131
Youngstown WSO AP	0.065	0.113	0.097	0.123	0.082	0.055	0.131
OKLAHOMA							
Oklahoma City WSFO AP	0.065	0.113	0.097	0.134	0.120	0.059	0.186
Tulsa WSO AP	0.065	0.113	0.097	0.134	0.122	0.058	0.190
OREGON							
Astoria WSO AP	0.065	0.113	0.097	0.134	0.096	0.068	0.151
Medford WSO AP	0.065	0.113	0.097	0.134	0.101	0.063	0.157
Portland WSFO AP	0.065	0.113	0.097	0.134	0.106	0.071	0.164
Salem WSO AP	0.065	0.113	0.097	0.134	0.101	0.068	0.157
PENNSYLVANIA							
Allentown WSO AP	0.065	0.113	0.097	0.123	0.090	0.059	0.410
Erie WSO AP	0.065	0.113	0.097	0.123	0.083	0.057	0.132
Harrisburg FAA AP	0.065	0.113	0.097	0.134	0.960	0.060	0.150
Philadelphia WSCMO AP	0.065	0.113	0.097	0.134	0.101	0.061	0.157
Pittsburgh WSCMO2 AP	0.065	0.113	0.097	0.123	0.088	0.059	0.139
RHODE ISLAND							
Providence WSO AP	0.065	0.113	0.097	0.123	0.087	0.058	0.138
SOUTH CAROLINA							
Charleston WSO AP	0.065	0.113	0.167	0.184	0.179	0.076	0.286
Columbia WSFO AP	0.065	0.113	0.167	0.184	0.156	0.066	0.244
Greenville-Spartanburg	0.065	0.113	0.097	0.184	0.136	0.072	0.211
SOUTH DAKOTA							
Huron WSO AP	0.065	0.113	0.097	0.123	0.069	0.045	0.114
SOUTH DAKOTA							
Pierre FAA AP	0.065	0.113	0.097	0.123	0.076	0.047	0.122
Rapid City WSO AP	0.065	0.113	0.097	0.123	0.077	0.050	0.123
Sioux Falls WSFO AP	0.065	0.113	0.097	0.123	0.073	0.048	0.119
TENNESSEE							
Chattanooga WSO AP	0.065	0.113	0.097	0.184	0.126	0.066	0.195
Knoxville WSO AP	0.065	0.113	0.097	0.134	0.121	0.066	0.187
Memphis FAA-AP	0.065	0.113	0.097	0.184	0.135	0.063	0.210
Nashville WSO AP	0.065	0.113	0.097	0.134	0.125	0.066	0.194
TEXAS							
Abilene WSO AP	0.065	0.113	0.167	0.184	0.154	0.060	0.241
Amarillo WSO AP	0.065	0.113	0.097	0.134	0.110	0.060	0.171
Austin WSO AP	0.065	0.113	0.167	0.184	0.211	0.063	0.347
Brownsville WSO AP	0.065	0.113	1.280	1.180	0.429	0.069	0.849
Corpus Christi WSO AP	0.065	0.113	0.167	0.184	0.340	0.067	0.628
Del Rio/Laughlin AFB	0.065	0.113	0.167	0.184	0.247	0.064	0.419
El Paso WSO AP	0.065	0.113	0.097	0.184	0.158	0.061	0.249
Ft Worth/Meacham	0.065	0.113	0.167	0.184	0.170	0.061	0.270
Houston FAA AP	0.065	0.113	0.167	0.184	0.253	0.070	0.433
Laredo	0.065	0.113	0.167	0.184	0.354	0.053	0.660
Lubbock WSFO AP	0.065	0.113	0.097	0.184	0.125	0.060	0.193
Lufkin FAA AP	0.065	0.113	0.167	0.184	0.202	0.066	0.330
Midland/Odessa WSO AP	0.065	0.113	0.097	0.184	0.160	0.064	0.251
Port Arthur WSO AP	0.065	0.113	0.167	0.184	0.244	0.073	0.414
San Angelo WSO AP	0.065	0.113	0.167	0.184	0.184	0.061	0.295
San Antonio WSFO	0.065	0.113	0.167	0.184	0.226	0.064	0.376
Sherman	0.065	0.113	0.097	0.184	0.154	0.061	0.241
Waco WSO AP	0.065	0.113	0.167	0.184	0.180	0.059	0.289
Wichita Falls WSO AP	0.065	0.113	0.097	0.184	0.141	0.057	0.220
UTAH							
Cedar City FAA AP	0.065	0.113	0.097	0.123	0.089	0.057	0.140
UTAH							
Salt Lake City NWSFO	0.065	0.113	0.097	0.123	0.088	0.052	0.138
VERMONT							
Burlington WSO AP	0.065	0.113	0.097	0.123	0.072	0.050	0.117
VIRGINIA							
Norfolk WSO AP	0.065	0.113	0.097	0.184	0.125	0.066	0.194
Richmond WSO AP	0.065	0.113	0.097	0.134	0.119	0.066	0.184
Roanoke WSO AP	0.065	0.113	0.097	0.134	0.113	0.066	0.175
WASHINGTON							
Olympia WSO AP	0.065	0.113	0.097	0.123	0.092	0.064	0.145
Seattle-Tacoma WSCMO AP	0.065	0.113	0.097	0.134	0.096	0.067	0.150
Spokane WSO AP	0.065	0.113	0.097	0.123	0.081	0.055	0.129
Yakima WSO AP	0.065	0.113	0.097	0.123	0.089	0.058	0.140
WEST VIRGINIA							
Charleston WSFO AP	0.065	0.113	0.097	0.134	0.106	0.064	0.164
WISCONSIN							
Eau Claire FAA AP	0.065	0.113	0.097	0.123	0.069	0.047	0.114
Green Bay WSO AP	0.065	0.113	0.097	0.123	0.071	0.049	0.116
La Crosse FAA AP	0.065	0.113	0.097	0.123	0.076	0.050	0.123
Madison WSO AP	0.065	0.113	0.097	0.123	0.075	0.051	0.121
Milwaukee WSO AP	0.065	0.113	0.097	0.123	0.077	0.053	0.125
WYOMING							
Casper WSO AP	0.065	0.113	0.097	0.123	0.074	0.049	0.120
Cheyenne WSFO AP	0.065	0.113	0.097	0.123	0.077	0.053	0.124
Rock Springs FAA AP	0.065	0.113	0.097	0.113	0.069	0.048	0.114
Sheridan WSO AP	0.065	0.113	0.097	0.123	0.075	0.051	0.122

The U-values for these cities were determined from the Standard as follows:

- Roof/ceiling – Equation 8-7, page 30.
- Opaque walls – Figure 8B-4, page 81.
- Walls adjacent to unconditioned spaces – Figure 8-8, page 32.

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.

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.

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