QUICK GUIDE
Foam Plastic Applications for Better Building

Foundation Insulation R-values for Energy Code Compliance Using Foam Plastic Insulating Sheathing (FPIS)

Foundation insulation is an important part of an overall building thermal envelope. Like above-grade assemblies, the proper and code-compliant use of FPIS on foundations provides energy savings, moisture control, and occupant comfort for below grade spaces and slab-on-grade floors. When detailed correctly, it also mitigates (minimizes) thermal bridging at the building's interface with the ground. Common foundation assemblies include basement walls, crawlspace walls, and slabs-on-grade. Various insulation installation details, configurations, and tips for these foundation applications are addressed and illustrated separately in the Quick Guide on Foundation Insulation Fundamentals, which should be used in coordination with this Guide.

This Guide focuses on the proper specification of FPIS foundation insulation R-values for energy code compliance based on the 2024 IECC (and IRC Chapter 11) as follows: [1]

For all commercial buildings and residential Group R buildings greater than three stories (IECC-C):

- Section C401.2.1 (Item 1) defines the prescriptive compliance path addressed in this Guide, which includes compliance with either of the following options to determine insulation requirements for any given building thermal envelope assembly.
  - Section C402.1.2 provides prescriptive U-, C-, and F-factor requirements for building thermal envelope assemblies to determine a code-compliant R-value solution.
  - Section C402.1.3 provides prescriptive component R-values that are a limited selection of pre-determined solutions complying with Section C402.1.2.
- ASHRAE 90.1 Appendix A provides tabulated U-, C-, and F-factors to assist in complying with Section C402.1.2 where used instead of Section C402.1.3.

For one- and two-family residential buildings of three stories or less (IECC-R | IRC Ch11):

- Section R401.2.1 | N1101.13.1 defines the prescriptive compliance path.
- Section R402.1 | N1102.1 (Item 1) further defines the prescriptive compliance path addressed in this Guide, which includes compliance with either of the following options to determine insulation requirements for any given building thermal envelope assembly.
  - Section R402.1.2 | N1102.1.2 provides prescriptive U- and F-factor requirements for building thermal envelope assemblies to determine a code-compliant R-value solution.
  - Section R402.1.3 | N1102.1.3 provides prescriptive component R-values that are a limited selection of pre-determined solutions complying with Section R402.1.2 | N1102.1.2.
- Appendix RF | Appendix NF provides tabulated U- and F-factor data for alternative building thermal envelope insulation component R-value options to assist in complying with Section R402.1.2 | N1102.1.2 where used instead of Section R402.1.3 | N1102.1.3.

KEY TERMS

Technical definitions for the following terms can be found in IECC-C Section C202, IECC-R Section R202, and IRC Chapter 11 Section N1101.6. The descriptions below are provided for additional understanding:

R-VALUE: A thermal resistance value applied to only the insulation component (material) on or within an assembly (it does not represent the actual "effective" thermal resistance of an overall building thermal envelope assembly).

U-FACTOR: An overall thermal transmittance value per unit area of a building assembly (only applied to above grade assemblies in the IECC-C provisions). It includes the effect of thermal insulation, building materials, and their arrangement in an assembly.

C-FACTOR: An overall thermal transmittance value per unit area applied to below-grade walls only in the IECC-C provisions. This differs from a U-factor only in its exclusion of surface air films.

F-FACTOR: The overall heat transmittance of a slab-on-grade foundation represented as a thermal transmittance value per unit length of the slab perimeter.

Note that thermal resistance and thermal transmittance are opposites. The greater the thermal resistance the less heat energy is conducted through an assembly or material. Conversely, the smaller the thermal transmittance, the less heat energy is conducted. Thus, when complying with R-values, it is a minimum value to meet or exceed. But, when complying with U-, C-, or F-factors, it is a maximum value not to be exceeded. The effective (actual total assembly) R-value of an above grade assembly can be determined by taking the inverse of the U-factor (i.e., Effective Assembly R-value = 1/U).

CAVITY INSULATION: Insulation material located between framing members (i.e., insulation is thermally bridged).

CONTINUOUS INSULATION: Insulation that is continuous across all structural members without thermal bridges other than fasteners and service openings (or structural columns for fully insulated slabs-on-grade).

[1] While beyond the scope of this Guide, the energy code also includes a prescriptive compliance approach that is known as the "component performance method" (or the "total UA" approach). It allows flexibility to adjust individual building thermal envelope assembly insulation requirements (up and down) provided the overall building thermal envelope heat transfer coefficient (UA) or thermal conductance (TC) remains at least equivalent in thermal performance. Typically, tools like REScheck and COMcheck are used for this purpose, but executable equations also are provided in Section C402.1.4 and in Section R402.1.5 | N1102.1.5.

FOUNDATION PRESCRIPTIVE INSULATION REQUIREMENTS

The following tables summarize the foundation insulation requirements in the 2024 IECC and IRC Chapter 11 in accordance with Climate Zones shown in Figure 1.

TABLE 1. 2024 IECC-C Tables C402.1.2 & C402.1.3 Combined

(All commercial buildings, including Group R residential > 3 stories)

Climate Zone	Building Use	Below-Grade Wall[a]	Slabs	
			Unheated	Heated[b]
0 and 1	All other	NR (C-1.140)	NR (F-0.73)	R-7.5 for 12" + R-5 full slab (F-0.69)
	Group R			
2	All other			
	Group R			
3	All other			R-10 for 24" + R-5 full slab (F-0.66)
	Group R		R-10 for 24" (F-0.54)	
4 Except Marine	All other	R-7.5ci (C-0.119)	R-15 for 24" (F-0.52)	R-15 for 24" + R-5 full slab (F-0.62)**
	Group R	R-10ci (C-0.092)		
5 and Marine 4	All other	R-7.5ci (C-0.119)		R-15 for 36" + R-5 full slab (F-0.62)**
	Group R	R-10ci (C-0.092)	R-20 for 24" (F-0.51)	
6	All other			
	Group R	R-15ci (C-0.063)	R-20 for 48" (F-0.434)	R-20 for 48" + R-5 full slab (F-0.602)
7	All other		R-20 for 24" (F-0.51)	
	Group R		R-20 for 48" (F-0.434)	
8	All other			
	Group R		R-25 for 48" (F-0.424)	

a. A below-grade wall includes foundation walls enclosing a conditioned below-grade space (e.g., a basement or conditioned/unvented crawlspace).

b. A heated slab is one with an in-slab heating system (e.g., hydronic or electric).

TABLE 2. 2024 IECC-R Tables R402.1.2 & R402.1.3 Combined (IRC Ch11 Tables N1102.1.2 and N1102.1.3)

(One- and Two-Family Dwellings ≤ 3 stories)

Climate Zone	Basement Wall	Slabs		Crawlspace Wall[b]
		Unheated	Heated[a]	
0, 1 and 2	0 (U-0.360)	0 (F-0.73)	R-5ci edge + R-5 full slab (F-0.74)	0 (U-0.477)
3	R5ci or R13 (U-0.091)	R10ci, 2' (F-0.54)	R-10ci, 2 ft + R-5 full slab (F-0.66)	R5ci or R13 (U-0.136)
4 except Marine	R10ci or R13 (U-0.059)	R10ci, 3' (F-0.51)	R10ci, 3ft + R-5 full slab (F-0.66)	R10ci or R13 (U-0.065)
5 and Marine 4	R15ci or R19 or R13+5ci (U-0.050)			R15ci or R19 or R13+5ci (U-0.055)
6		R10ci, 4' (F-0.48)	R10ci, 4ft + R-5 full slab (F-0.66)	
7 and 8				

a. A heated slab is one with an in-slab heating system (e.g., hydronic or electric).

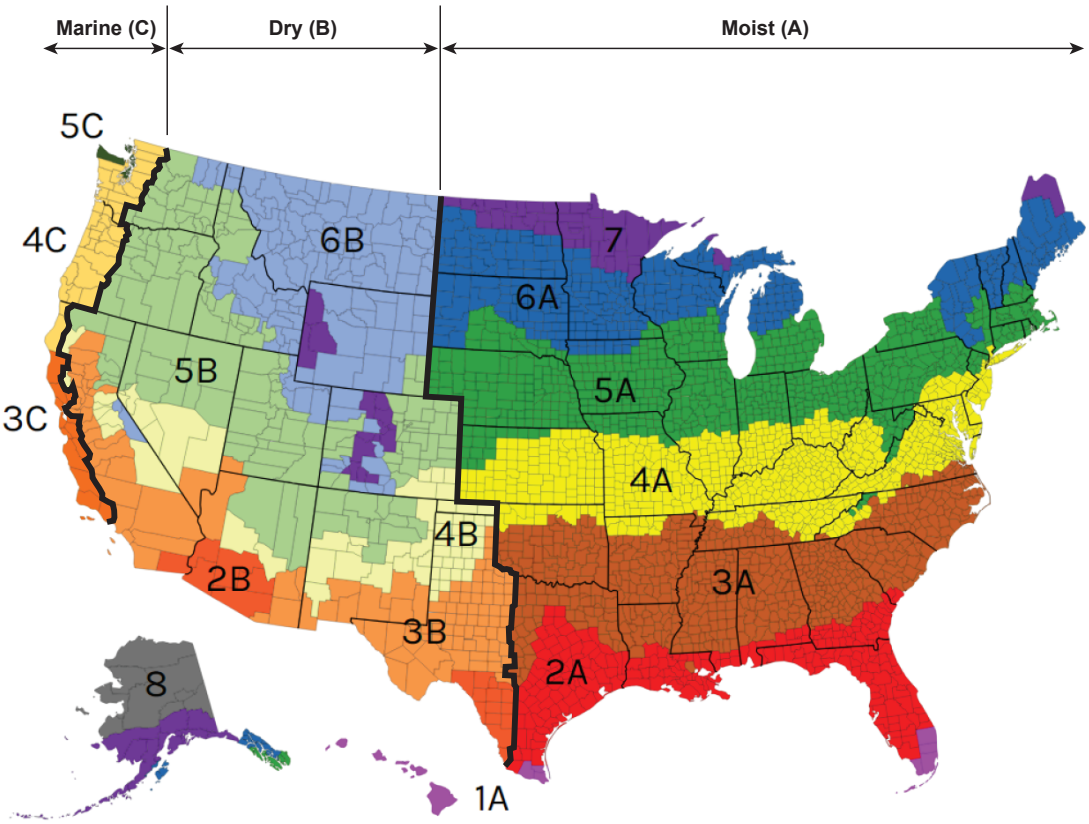
b. Applies to the perimeter walls of a conditioned (unvented) crawlspace.

NOTE: For slabs, the tabulated R-value solutions and associated F-factors relate to a vertical application of the slab edge or perimeter insulation. Insulation under the full slab is additionally required for heated slabs. For more information on slab insulation options and the relationship between slab F-factors and R-values, refer to the design examples and SUPPLEMENTAL DATA provided later in this Guide.

R-Value Designations & Definitions Matter!

As shown in Tables 1 and 2, R-values are shown in different ways for important reasons related to how the insulation is to be installed so it performs as intended. For example, “R-10ci” means insulation with an R-value of 10 that is applied continuously over the surface area (with only interruptions for fasteners or services). Note that the “ci” designations are missing for slabs in Table 1 for the IECC-C. “R13” and “R19” as shown in Table 2 are for cavity insulation between 2x4 and 2x6 framing, respectively. “R13+5ci” (or similar) is a combination of cavity and continuous insulation.

Figure 1.



U.S. Climate Zones per DOE

(Same as IECC Figures C301.1 and R301.1, and IRC Figure N1101.7)

OPTION 1:

Specifying Foundation Insulation Based on Prescribed R-Values

Using code-prescribed minimum R-values is the simplest way of showing compliance with the energy code. For your foundation, it involves the following three steps:

STEP 1: Determine your project's climate zone (see Figure 1).

STEP 2: Using Table 1 or 2 as applicable, select the appropriate minimum R-value based on the climate zone, foundation type, and building use.

STEP 3: Install the insulation (at equal or greater R-value than determined in Step 2) on the foundation in accordance with Section C402.2 or Section R402.2 | N1102.2, as applicable. Refer to the Quick Guide on Foundation Insulation Fundamentals, which illustrates various foundation insulation methods, for guidance.

OPTION 2:

Specifying Equivalent Insulation R-Values and Configurations Based on Prescribed U-, C-, and F-Factors

Using the code-prescribed maximum U-, C-, or F-factors is a useful way to determine alternative solutions equivalent to the limited selection of R-value solutions provided in the code (see Option 1). For your foundation, it requires the following four steps:

STEP 1: Determine your project's climate zone (see Figure 1).

STEP 2: Using Table 1 or 2 as applicable, select the appropriate maximum U-factor or C-factor (foundation walls) or F-factor (slab-on-grade) based on the climate zone, foundation type, and building use.

STEP 3: Using the appropriate U-factor, C-factor, or F-factor as determined in Step 2, select an appropriate R-value solution that has an equal or lower U-factor, C-factor, or F-factor using Appendix RF | NF for compliance with IECC-R and IRC Ch11 or ASHRAE 90.1 Appendix A for compliance with IECC-C. See **SUPPLEMENTAL DATA**.

STEP 4: Install the insulation on the foundation in accordance with the code and the Quick Guide on Foundation Insulation Fundamentals, being sure to comply with the minimum insulation R-value and its detailing (location and placement) on the foundation associated with the solution identified in Step 3.

The examples shown in Table 3 below compare how to apply the three-step process outlined in OPTION 1 with the different equivalent solutions for the foundation insulation R-value and its application to the foundation as outlined in OPTION 2.

TABLE 3. Comparing Prescriptive R-value Method (Option 1) & Prescriptive U-/C-/F-factor Method (Option 2)

EXAMPLE 1:

Office Building (IECC-C "all other") in Climate Zone 4 (except Marine) on an unheated slab-on-grade foundation

3-step R-value Solution (Option 1)	4-step U-/C-/F-factor Solution (Option 2)
STEP 1: Climate Zone 4 (except Marine) **STEP 2:** Minimum R-value = R-15 for 24" depth (Table 1) **STEP 3:** Section C402.2.4 requires the insulation to be placed on inside or outside of the independent foundation stem wall (or outside of a thickened edge monolithic slab) and extended downward 24" or to footing, whichever is less.	**STEP 1:** Climate Zone 4 (except Marine) **STEP 2:** Maximum F-factor = 0.52 (Table 1) **STEP 3:** From ASHRAE 90.1 Appendix A, Table A6.3.1-1 (see SUPPLEMENTAL DATA), select "fully-insulated" slab with R-5 rated R-value of insulation (F-factor = 0.46 < 0.52, OK). Note that this reduces the thicker R-15 slab edge insulation required per Option 1 and provides greater performance (lower F-factor). **STEP 4:** Section C402.2.4 requires that a "fully insulated slab" have the required insulation (R-5 in this example) extend over the full area of the slab (i.e., under the slab). While not clearly stated, this includes the slab edge where it is exposed or abuts a foundation wall.

NOTE: While not stated as a requirement in the code, the required minimum R-values for slab perimeters assume the slab surface is not elevated above ground by more than about 6" (greater distance above ground will increase slab edge heat loss). This design factor is addressed in the data appendices for the IECC-R and IRC Ch11 (see SUPPLEMENTAL DATA), but is not currently required for compliance with the IECC.

EXAMPLE 2:

Mid-Rise Apartment (IECC-C "Group R") in Climate Zone 5 on a conditioned basement or crawlspace foundation

3-step R-value Solution (Option 1)	4-step U-/C-/F-factor Solution (Option 2)
STEP 1: Climate Zone 5 **STEP 2:** Minimum R-value = R10ci (Table 1) **STEP 3:** Section C402.2.5 requires the insulation to be placed on the outside, inside, or integral to the foundation wall. It is not placed between framing members as cavity insulation because it is identified as "ci" (continuous insulation) in Table 1. Where an alternative cavity only or cavity plus continuous insulation combination is desired, use Option 2.	**STEP 1:** Climate Zone 5 **STEP 2:** Maximum C-factor = 0.092 (Table 1) **STEP 3:** From ASHRAE 90.1 Appendix A, Table A4.2.1 (see SUPPLEMENTAL DATA), select R14ci with 1" metal clips spaced 24" horizontally and 16" vertical (C-factor = 0.089 < 0.092, OK). The metal clips provide a means to attach interior framing or finishes as an alternative to using only fasteners through the FPIS ci on the foundation wall (and thermal bridging effect of the metal clips is included in the C-factor). **NOTE:** The alternative of using continuous metal Z-furring through the FPIS ci, renders it not compliant with the ci definition and the insulation's intended performance is significantly degraded as is the case with cavity insulation between metal framing (e.g., C-factor essentially doubled or effective R-value halved).

EXAMPLE 3:

Duplex home (IECC-R | IRC Ch11) in Climate Zone 4 (except Marine) on a heated slab-on-grade foundation

3-step R-value Solution (Option 1)	4-step U-/C-/F-factor Solution (Option 2)
STEP 1: Climate Zone 4 (except Marine) **STEP 2:** Minimum R-value = R10ci for 3 ft depth plus R5 full slab (Table 2) **STEP 3:** Section R402.2.10 requires that slab perimeter insulation be placed on the inside or outside of the independent foundation stem wall (or outside of a thickened edge monolithic slab) and extend downward 3 ft or to footing, whichever is less. The full slab insulation must extend over the full surface area of the slab (i.e., under the slab). **NOTE:** The full-slab R5 requirement is in addition to the R10ci perimeter edge insulation because of the heated slab (R5 full slab insulation has been a long-standing minimum requirement for heated slabs previously in the mechanical code). The R10ci insulation at the slab edge reduces the higher intensity heat loss that occurs at the slab perimeter. See also the NOTE in EXAMPLE 1 above.	**STEP 1:** Climate Zone 4 (except Marine) **STEP 2:** Maximum F-factor = 0.66 (Table 2)) **STEP 3:** From IECC-R Appendix RF, Table RF106.1 (see SUPPLEMENTAL DATA), select R7.5 entire slab area and edge (F-factor = 0.64 < 0.66 OK). **STEP 4:** Install insulation for full depth of slab edge and entire slab area as noted in Table RF106.1. Section R402.2.10 permits the top of the slab edge insulation to be cut at a 45 degree angle to minimize exposure at the slab edge where needed. **NOTE:** This solution reduces the thickness of the R10 slab edge insulation required for Option 1 and improves the overall slab thermal performance (i.e., lower F-Factor), which is especially important for a heated slab.

EXAMPLE 4:

Townhouse (IECC-R | IRC Ch11) in Climate Zone 3 on basement foundation

3-step R-value Solution (Option 1)	4-step U-/C-/F-factor Solution (Option 2)
STEP 1: Climate Zone 3 **STEP 2:** Minimum R-value = R5ci or R13 (Table 2); use R5ci for this example **STEP 3:** Section R402.2.9 requires that the basement wall insulation extend from the top of wall downward 10' or to the surface of the basement floor. **NOTE A:** In its silence, the code permits the insulation to be placed anywhere on the basement wall (interior, exterior, or integral) provided it is continuous if complying with a "ci" R-value. R-values without the "ci" designation are considered for cavity insulation in a separately wood-framed wall to the interior side of a basement foundation wall. **NOTE B:** While the code does not require it, if the basement floor slab is at or near exterior grade (e.g., less than 2' below grade), interior basement wall insulation should be as required for above-grade walls and the slab edge insulated per code for slab-on-grade foundations. This condition will occur on walk-out basements. **NOTE C:** Use of FPIS ci (R5ci in this example) provides a means to protect the enclosed below grade space and any interior finishes from moisture (see Foundation Insulation Fundamentals).	**STEP 1:** Climate Zone 3 **STEP 2:** Maximum U-factor = 0.136 (Table 2) **STEP 3:** From IECC-R Appendix RF, Table RF105.1 (see SUPPLEMENTAL DATA), select R7.5 ci (U-factor = 0.092 < 0.136, OK). **STEP 4:** Section R402.2.9 requires that the basement wall insulation extend from the top of wall downward 10' or to the surface of the basement floor. **NOTE:** This solution exceeds code minimum performance; R-5ci could have been selected from Table RF105.1 and also met the code requirement (same as Option 1). The additional foundation wall R-value will improve basement comfort and provide the intended performance for basement walls that may have portions extending more than about 1' above grade). Where the basement wall extends more than 50% above grade (the limit in the code's definition of a basement wall), it must be insulated, in accordance with an above grade wall. See also NOTES A, B, and C for Option 1. Also, the code's F-factors and R-values as shown in Table 1 are not coordinated to give equivalent performance. Corrections will be needed in future code editions, which is another reason for exceeding the minimum code requirements in this example.

EXAMPLE 5:

Single-family Home (IECC-R | IRC Ch11) in Climate Zone 5 on conditioned (unvented) crawlspace foundation

3-step R-value Solution (Option 1)	4-step U-/C-/F-factor Solution (Option 2)
STEP 1: Climate Zone 5 **STEP 2:** Minimum R-value = R15ci, R19, or R13+5ci (Table 2); Use R15ci **STEP 3:** Section R402.2.11 requires that the crawlspace foundation wall be insulated from the top plate down to the footing or to the crawlspace floor (interior finish grade) surface where 24" or greater below exterior grade.	**STEP 1:** Climate Zone 5 **STEP 2:** Maximum U-factor = 0.055 (Table 2) **STEP 3:** From IECC-R Appendix RF, Table RF105.1 (see SUPPLEMENTAL DATA), select R15ci (U-factor = 0.055 = maximum 0.055, OK). **STEP 4:** Section R402.2.11 requires that the crawlspace foundation wall be insulated from the top plate down to the footing or to the crawlspace floor (interior finish grade) surface where 24" or greater below exterior grade.

NOTE: All crawlspaces require a continuous ground vapor barrier in accordance with the building code. Also, conditioned (unvented) crawlspaces must comply with building code requirements for properly conditioning an unvented crawlspace. Such crawlspaces provide excellent moisture control in the crawlspace and the overall building, eliminate the need to insulate the entire floor area above, and provide for a more comfortable floor.

The SUPPLEMENTAL DATA that follows provides U-, C-, and F-factor data to identify compliant alternative insulation solutions as discussed in this Guide. However, not all of these solutions are equivalent to the prescriptive foundation insulation requirements featured in this Guide. Where an insulation configuration has a higher U-, C-, or F-factor than required by code, the lack of performance must be addressed by "trade-offs" or modeling of the whole building to demonstrate overall equivalency of the building thermal envelope.

ASHRAE 90.1-2022 Appendix A, Foundation Wall C-Factor Data

Table A4.2.1 Assembly C-Factors for Below-Grade Walls

Framing Type and Depth	Rated R-Value of Insulation	Specified C-Factors (Wall Only, without Soil and Air Films)
No framing	R-0	C-1.140
EXTERIOR INSULATION CONTINUOUS AND UNINTERRUPTED BY FRAMING		
No framing	R-5.0	C-0.170
No framing	R-7.5	C-0.119
No framing	R-10.0	C-0.092
No framing	R-12.5	C-0.075
No framing	R-15.0	C-0.063
No framing	R-17.5	C-0.054
No framing	R-20.0	C-0.048
No framing	R-25.0	C-0.039
No framing	R-30.0	C-0.032
No framing	R-35.0	C-0.028
No framing	R-40.0	C-0.025
No framing	R-45.0	C-0.022
No framing	R-50.0	C-0.020
CONTINUOUS METAL FRAMING AT 24 IN. ON CENTER HORIZONTALLY		
3.5 in.	R-11.0	C-0.182
3.5 in.	R-13.0	C-0.174
3.5 in.	R-15.0	C-0.168
5.5 in.	R-19.0	C-0.125
5.5 in.	R-21.0	C-0.120
1 IN. METAL CLIPS AT 24 IN. ON CENTER HORIZONTALLY AND 16 IN. VERTICALLY		
1.0 in.	R-3.8	C-0.233
1.0 in.	R-5.0	C-0.201
1.0 in.	R-5.6	C-0.189
1.5 in.	R-5.7	C-0.173
1.5 in.	R-7.5	C-0.147
1.5 in.	R-8.4	C-0.138
2.0 in.	R-7.6	C-0.138
2.0 in.	R-10.0	C-0.116
2.0 in.	R-11.2	C-0.108
2.5 in.	R-9.5	C-0.114
2.5 in.	R-12.5	C-0.096
2.5 in.	R-14.0	C-0.089
3.0 in.	R-11.4	C-0.098
3.0 in.	R-15.0	C-0.082
3.0 in.	R-16.8	C-0.076
3.5 in.	R-13.3	C-0.085
3.5 in.	R-17.5	C-0.071
3.5 in.	R-19.6	C-0.066
4.0 in.	R-15.2	C-0.076
4.0 in.	R-20.0	C-0.063
4.0 in.	R-22.4	C-0.058

SOURCE: ASHRAE 90.1-2022 Appendix A, **Table A4.2.1** (page 254)

ASHRAE 90.1-2022 Appendix A, Slab-on-grade F-factor Data

Table A6.3.1-1 Assembly F-Factors for Slab-on-Grade Floors

Insulation Description	Rated R-Value of Insulation												
	R-3.5	R-5	R-7.5	R-10	R-15	R-20	R-25	R-30	R-35	R-40	R-45	R-50	R-55
Uninsulated: 0.73	**UNHEATED SLABS**												
12 in. horizontal		0.72	0.71	0.71	0.71								
24 in. horizontal		0.70	0.70	0.70	0.69								
36 in. horizontal		0.68	0.67	0.66	0.66								
48 in. horizontal		0.67	0.65	0.64	0.63								
12 in. vertical		0.61	0.60	0.58	0.57	0.567	0.565	0.564					
24 in. vertical		0.58	0.56	0.54	0.52	0.510	0.505	0.502					
36 in. vertical		0.56	0.53	0.51	0.48	0.472	0.464	0.460					
48 in. vertical		0.54	0.51	0.48	0.45	0.434	0.424	0.419					
Fully insulated slab		0.46	0.41	0.36	0.30	0.261	0.233	0.213	0.198	0.186	0.176	0.168	0.161
Uninsulated: 1.35	**HEATED SLABS**												
12 in. horizontal		1.31	1.31	1.30	1.30								
24 in. horizontal		1.28	1.27	1.26	1.25								
36 in. horizontal		1.24	1.21	1.20	1.18								
48 in. horizontal		1.20	1.17	1.13	1.11								
12 in. vertical		1.06	1.02	1.00	0.98	0.968	0.964	0.961					
24 in. vertical		0.99	0.95	0.90	0.86	0.843	0.832	0.827					
36 in. vertical		0.95	0.89	0.84	0.79	0.762	0.747	0.740					
48 in. vertical		0.91	0.85	0.78	0.72	0.688	0.671	0.659					
Fully insulated slab		0.74	0.64	0.55	0.44	0.373	0.326	0.296	0.273	0.255	0.239	0.227	0.217
Underslab insulation only	1.06	1.01	0.95	0.90	0.82	0.76							

SOURCE: ASHRAE 90.1-2022 Appendix A, **Table A6.3.1-1** (page 258)

Table A6.3.1-2 Assembly F-Factors for Fully Insulated Heated Slab-on-Grade Floors

Insulation Description	Rated R-Value of Edge Insulation							
	R-3.5	R-5	R-7.5	R-10	R-15	R-20	R-25	R-30
HEATED SLABS								
R-3.5 under slab	0.81	0.78	0.74	0.71	0.69	0.671	0.670	0.669
R-5 under slab	0.77	0.74	0.69	0.66	0.62	0.602	0.602	0.601
R-7.5 under slab	0.71	0.67	0.64	0.60	0.58	0.566	0.564	0.563
R-10 under slab	0.66	0.62	0.58	0.55	0.51	0.496	0.494	0.493
R-15 under slab	0.57	0.54	0.50	0.47	0.45	0.433	0.432	0.431
R-20 under slab	0.51	0.48	0.44	0.41	0.39	0.371	0.370	0.369

SOURCE: ASHRAE 90.1-2022 Appendix A, **Table A6.3.1-2** (page 258)

from IECC-R Appendix RF (same as IRC Appendix NF)

TABLE RF105.1 U-FACTORS FOR BASEMENT AND CRAWL SPACE WALLS[a]

Insulation Configurations[b]	Wall U-factor[c] (Btu/h × ft2 × °F)	Wall Effective U-factor[d] by Percentage of Wall Height Projecting Above Grade (Btu/h × ft2 × °F) for Use Only with SECTION R402.1.5			
		50%	35%	20%	5%
BASEMENT WALLS					
Uninsulated and unfinished basement wall	0.360	0.324	0.288	0.252	0.216
Continuous insulation					
R-5ci	0.122	0.109	0.097	0.085	0.073
R-7.5ci	0.093	0.084	0.075	0.065	0.056
R-10ci	0.076	0.068	0.060	0.053	0.045
R-15ci	0.055	0.049	0.044	0.038	0.033
R-20ci	0.043	0.039	0.034	0.030	0.026
R-25ci	0.035	0.032	0.028	0.025	0.021
Cavity insulation					
R-11	0.076	0.068	0.060	0.053	0.045
R-13	0.067	0.060	0.054	0.047	0.040
R-15	0.060	0.054	0.048	0.042	0.036
R-19	0.050	0.045	0.040	0.035	0.030
R-21	0.045	0.041	0.036	0.032	0.027
Cavity + continuous insulation					
R-13 + R-5ci	0.050	0.045	0.040	0.035	0.030
R-13 + R-7.5ci	0.045	0.040	0.036	0.031	0.027
R-13 + R-10ci	0.040	0.036	0.032	0.028	0.024
R-19 + R-5ci	0.040	0.036	0.032	0.028	0.024
R-19 + R-7.5ci	0.036	0.033	0.029	0.025	0.022
R-19 + R-10ci	0.033	0.030	0.027	0.023	0.020
CRAWL SPACE WALLS					
Uninsulated crawl space wall	0.477	0.429	0.382	0.334	N/A
Continuous insulation					
R-5ci	0.141	0.127	0.113	0.099	N/A
R-7.5ci	0.104	0.094	0.083	0.073	—
R-10ci	0.083	0.074	0.066	0.058	—
R-15ci	0.058	0.053	0.047	0.041	—
R-20ci	0.045	0.041	0.036	0.032	—
R-25ci	0.037	0.033	0.030	0.026	—
Cavity insulation					
R-11	0.083	0.074	0.066	0.058	N/A
R-13	0.072	0.065	0.058	0.051	—
R-15	0.065	0.058	0.052	0.045	—
R-19	0.054	0.049	0.043	0.038	—
R-21	0.048	0.043	0.038	0.033	—
Cavity + continuous insulation					
R-13 + R-5ci	0.053	0.048	0.043	0.037	N/A
R-13 + R-7.5ci	0.047	0.042	0.038	0.033	—
R-13 + R-10ci	0.042	0.038	0.034	0.029	—
R-19 + R-5ci	0.043	0.038	0.034	0.030	—
R-19 + R-7.5ci	0.039	0.035	0.031	0.027	—
R-19 + R-10ci	0.035	0.032	0.028	0.025	—

N/A = Not Applicable.

For SI: 1 British thermal unit per hour per square foot per °Fahrenheit = 5.6783 W/m2 × K.

a. The wall U-factor excludes exterior the air-film R-value and, for insulated assemblies, includes the following: R-0.68 for interior air film, R-0.45 for 1/2-inch gypsum panel finish (insulated basement walls only), and R-2.1 for 12-inch block basement wall or R-1.4 for 8-inch block crawl space wall, both with empty cells. Where cavity insulation is included between 2 × 4 or 2 × 6 framing on the interior side of a foundation wall, wood stud material with thermal resistivity of R-1.25/in is assumed to be spaced at not less than 16 inches on center with an assumed framing factor not greater than 0.15.

b. All insulation configurations extend from the top of the foundation wall to the floor of the basement or crawl space. Extrapolation to partial height insulation shall not be permitted; U-factors for such insulation configurations shall be determined by accepted engineering practice for modeling of thermal bridging and ground-coupled assemblies.

c. Applicable to Sections R402.1.2, R405 and R406.

d. Effective U-factors are adjusted to account for ground-coupling effects to provide equivalency to U-factors used for above-grade building thermal envelope assemblies. The effective U-factors are provided for use with Section R402.1.5 for evaluation of trade-offs with above-grade assemblies and other components of the building thermal envelope. The effective U-factor shall apply to the foundation wall area from the interior floor or ground surface to the top of the wall. Interpolation between R-values and percentage of wall height projecting above grade within a given insulation configuration type is permitted.

SUPPLEMENTAL DATA

from IECC-R Appendix RF (same as IRC Appendix NF)

TABLE RF106.1 F-FACTORS FOR SLABS-ON-GRADES[a,b,c,d,e,f]

Unheated Slabs-on-Grade: Insulation Configurations	F-FACTOR (Btu/h × ft × °F)
Uninsulated slab	0.73
Horizontal insulation under slab at slab perimeter—slab edge not insulated (i.e., thermal bridge)	
≥ R-5 for 2 ft	0.70
R-5 for 4 ft	0.67
≥ R-10 for 4 ft	0.64
Vertical insulation on exterior face[g]—slab edge insulated[h]	
R-2.5 for 2 ft	0.66
R-5 for 2 ft	0.58
R-7.5 for 2 ft	0.56
R-10 for 2 ft	0.54
R-15 for 2 ft	0.52
R-5 for 3 ft	0.56
R-7.5 for 3 ft	0.54
R-10 for 3 ft	0.51
R-15 for 3 ft	0.49
R-5 for 4 ft	0.54
R-7.5 for 4 ft	0.51
R-10 for 4 ft	0.48
R-15 for 4 ft	0.45
Fully insulated slab—full slab area and slab edge continuously insulated	
R-5 entire slab area and R-3.5 edge	0.48
R-5 entire slab area and edge	0.46
R-7.5 entire slab area and R-3.5 edge	0.45
R-7.5 entire slab area and edge	0.41
R-10 entire slab area and R-5 edge	0.40
R-10 entire slab area and edge	0.36
R-15 entire slab area and R-5 edge	0.35
R-15 entire slab area and edge	0.30
R-10 slab edge and under slab perimeter inward 4 ft; R-5 remaining slab area	0.42
R-15 slab edge and under slab perimeter inward 4 ft; R-5 remaining slab area	0.40
R-15 slab edge and under slab perimeter inward 4 ft; R-10 remaining slab area	0.34

Heated Slabs-on-Grade: Insulation Configurations	F-FACTOR (Btu/h × ft × °F)
Uninsulated	1.35
Fully insulated slab—full slab area and slab edge continuously insulated	
R-5 entire slab area and R-3.5 edge	0.77
R-5 entire slab area and edge	0.74
R-7.5 entire slab area and R-3.5 edge	0.71
R-7.5 entire slab area and edge	0.64
R-10 entire slab area and R-5 edge	0.62
R-10 entire slab area and edge	0.55
R-15 entire slab area and R-5 edge	0.54
R-15 entire slab area and edge	0.44
R-20 entire slab area and R-7.5 edge	0.44
R-20 entire slab area and edge	0.37
R-5 entire slab area and R-10 slab edge extending downward for minimum 3 ft	0.66
R-10 slab edge and under slab perimeter inward 4 ft; R-5 remaining slab area	0.66
R-15 slab edge and under slab perimeter inward 4 ft; R-5 remaining slab area	0.62
R-15 slab edge and under slab perimeter inward 4 ft; R-10 remaining slab area	0.51

For SI: 1 British thermal unit per hour per square foot per °Fahrenheit = 5.6783 W/m2× K.

a. For alternative slab-on-grade insulation configurations, F-factors shall be determined in accordance with accepted engineering practice for modeling three-dimensional ground-coupled building assemblies using project-specific building and site conditions to estimate annual energy use attributed to foundation heat transfer and converting the result to an equivalent air-to-air F-factor basis.

b. Interpolation between R-values for a given insulation configuration type is permitted.

c. Tabulated F-factors are based on a typical soil thermal conductivity of 0.75 Btu/h × ft × °F and shall be multiplied by one of the following adjustment factors as applicable to site soil conditions: (1) rock or any soil on sites with poor drainage or high water table, 1.2; (2) sandy soils, 1.1; (3) loam or clay soils on well-drained sites in dry climate zones, 0.85; and (4) for all other soil or site conditions, 1.00. Where soil conditions are unknown, use of 1.00 is permitted.

d. Tabulated F-factors are based on a slab area to perimeter length ratio of 9:1 and shall be multiplied by one of the following adjustment factors as applicable to a slab's area to perimeter length ratio: 5:1, 0.7; 6:1, 0.8; 7:1, 0.9; 8:1, 0.95; 9:1, 1.0; 10:1, 1.05; 15:1, 1.2; 20:1, 1.35; 30:1, 1.5; and for ≥ 40:1, 1.7.

e. Tabulated F-factors are based on a slab perimeter edge projection above exterior finish grade of 6 inches. For portions of slab perimeter projecting 12 inches or more above grade, multiply the tabulated F-factors by one of the following adjustment factors as applicable: less than 12 inches, 1.0; 12 inches, 1.05; 18 inches, 1.1; 24 inches, 1.15; and 30 inches, 1.2.

f. For basement floor slabs, crawl space slabs or gravel floors, the tabulated F-factors shall be multiplied by one of the following adjustment factors based on the depth of the floor surface below exterior finish grade: less than 1 foot, 1.0; 1 foot, 0.95; 3 feet, 0.9; and 6 feet or more, 0.8.

g. Vertical insulation on the exterior shall extend for the indicated depth below finish grade and above grade to the top of the slab or stem wall. Where insulation is placed on the interior side of a foundation stem wall, it shall extend from the top of the slab to the indicated depth below the exterior finish grade and the applicable tabulated F-factor shall be multiplied by 1.05.

h. The R-value of the vertical insulation located on the interior side of a stem wall shall be permitted to be reduced to R-2.5 at the slab edge, not exceeding 6 inches thick, provided that the applicable F-factor is multiplied by 1.15 where R-5 vertical insulation is specified, 1.2 where R-10 vertical insulation is specified, or 1.25 where R-15 vertical insulation is specified.