RESNET® HERS®

Addendum 83f

CMU Insulation Grading and R-values

Date Approved:	October 29, 2025
Voluntary Compliance Date:	TBD
Mandatory Compliance Date:	TBD (Note: Addendum 83i is currently in effect)
Transition Period:	NA
Proponent:	SDC 300
Organization:	RESNET

Purpose:

Final Addendum 83f replaces interim Addendum 83i at the date indicated above. It revises ANSI/RESNET/ICC 301-2022 for the RESNET HERS® to provide inspection protocols and R-values for concrete masonry unit (CMU) assemblies insulated by foam insulation filled cores. Standard 301-2022 currently does not address these assemblies so they cannot be inspected for compliance with Installation Grade I. Addenda 83i and 83f provide the necessary protocols. The interim addendum protocols are required for rating homes with Building Permit Dates or permit application dates on or after the December 20, 2024, and will remain in place until replaced by criteria of the final addendum as indicated above.

Amendment:

Modify the RESNET HERS Standards Chapter 3 as follows:

303.1 Technical Requirements

Exception 4: RESNET Home Energy Ratings shall be calculated using the modifications of Standards ANSI/RESNET/ICC 301 established by MINHERS addenda:

- Addendum 66, CO_2e Index

- Addendum 81, Supplemental Criteria for Adoption of ANSI/RESNET/ICC 301-2022
- Addendum 83f, Pre-Expanded, Injectable Foam-in-Place Insulation in CMU Walls

Modify ANSI/RESNET/ICC 301-2022 Normative References as follows:

ANSI/CRRC S100-2021~~4~~5, "Standard Test Methods for Determining Radiative Properties of Materials," Cool Roof Rating Council, Portland, OR. www.coolroofs.org

CRRC-~~1~~2 *Wall Product Rating Program Manual, Appendix ~~8~~2*, 2021~~4~~5. Cool Roof Rating Council, Portland, OR, ~~www.cool- roofs.org~~ www.coolroofs.org

Modify ANSI/RESNET/ICC 301-2022 Appendix A as shown below:

Normative Appendix A

Inspection Procedures for Insulation Grading and Assessment

A-1. Insulation

In order to meet the requirements of a Grade I or Grade II insulation rating, the insulation material shall be installed in accordance with the minimum installation requirements of this Appendix and the requirements specified by ASTM standards C518, C727, C1015, C1743, C1320, C1321 and ASTM C1848 as described below in the insulation grading section.

Installations not complying with the minimum installation requirements of this Appendix, the relevant ASTM standard for the type insulation, or the Grade I or Grade II coverage requirements shall be considered Grade III installations. Grade III installations shall be recorded and shall be modeled as specified by Section 4.2.2.2.2 of this Standard.

A-1.1 Minimum General Installation Requirements:

1. Insulation shall be installed to manufacturer's recommendations.
2. No air spaces shall be allowed between different insulation types or systems.

Exception: When claiming the R-Value of an enclosed

reflective airspace in accordance with the ASHRAE *Handbook of Fundamentals*, Chapter 26, Table 3 or the ASHRAE 90.1-2016 Section A9-4 (or addendum ac to the 2013 edition) or ASTM C1224.

3. Insulation shall be installed to the required density and thickness necessary to achieve the labeled R-Value.
4. Insulation shall fill around obstructions including, but not limited to, framing, blocking, wiring, pipes, etc. without substantial gaps or voids.

A-1.2 Minimum Specific Application Requirements:

1. Insulation installed in framed floor assemblies shall be in substantial and permanent contact with the subfloor.

   Exception: The floor framing cavity insulation shall be permitted to be in contact with the topside of **sheathing** or continuous insulation installed on the bottom side of floor framing where combined with insulation that meets or exceeds the minimum wood frame wall R-Value in Table 402.1.2 of the International Energy Conservation Code (IECC) and that extends from the bottom to the top of all perimeter floor framing members.

   The cavity insulation between floor joists, beams or other horizontal floor supports that
   create cavities under the subfloor shall be permitted to be in direct contact with any additional continuous insulation attached to the underside of the horizontal supports. The combination of both cavity and continuous insulation shall meet or exceed the minimum required floor R value in Table 402.1.2 of the IECC. Instances of reflective insulation system installed beneath hydronic floors are not required to meet this standard.

2. For rim or band joist applications, insulation shall be in substantial and permanent contact with rim or band joist framing and tightly fitted to intersecting solid floor joists, wood i- joists or extend continuously through open web floor trusses. Interior sheathing or air barrier is not required provided there is an air barrier on the exterior side or the insulation material is installed as an air barrier material.

3. Air permeable insulation installed in ventilated attics and

vented sloped roofs shall have an effective air barrier (wind block, air chute, or eave baffle) securely fastened and installed at the eave or soffit edge vent of every cavity. The effective air barrier shall extend up and beyond the surface of the insulation or to the ridge vent.

A-1.3 Minimum Specific Material Requirements:

A-1.3.1 Insulated Sheathing:

1. If used as an air barrier, edges and joints shall be taped or otherwise air sealed in
   accordance with the manufacturer's recommendations.
2. Edges not supported directly on sheathing or framing shall be tightly fitted to one another without substantial gaps.
3. Sheathing shall be carefully fitted and taped or otherwise air sealed around obstructions in accordance with the manufacturer's recommendations.
4. When two or more layers of insulation are installed the joints shall be staggered. Only the joints of one of the layers shall be required to be taped or otherwise air- sealed where that layer is designated to be an air-barrier.
5. Where used as an Approved water-resistive barrier (WRB), sheathing joints, Fenestration, and service penetrations shall be taped or otherwise air sealed in accordance with the manufacturer's installation instructions.

A-1.3.2 Fibrous Batt Insulation:

1. Insulation shall fill the cavity being insulated side to side, top to bottom.
2. Insulation shall be enclosed on all six sides with durable materials.

Exceptions:

a. Insulation installed in attics above ceilings shall not require an air barrier on the exterior side.
b. Insulation installed under floors directly above an unvented crawl space shall not require an air barrier on the exterior side.
c. Insulation installed in rim or band joists located in conditioned space shall not require an air barrier on the interior side.
d. Insulation installed on conditioned basement and crawlspace walls where an air barrier material meeting code requirements for exposed applications and tested in accordance with ASTM E2178 is installed on the interior side.
e. Faced batts shall be stapled to the face of the studs or side

stapled to the studs with no buckling of the stapling tabs or the tabs shall be permitted to be left unstapled. Faced batt products without tabs and friction fit products shall not be required to be stapled when installed in walls. Compression of face stapled batts shall be graded in accordance with the criteria outlined in Sections A-2.1.1.1, A-2.1.2.1, or A-2.1.3.

f. When side stapled, compression is permitted only along edges to the depth of the stapling tab.
g. Insulation shall be closely fitted around obstructions including, but not limited to, framing, blocking, wiring, pipes, etc. to avoid substantial gaps, voids or compression."

A-1.3.3 Blown or Sprayed Fibrous Loose Fill Insulation:

1. Insulation containment fabric or system that is side stapled shall not be stapled more than ½ inch back from the face of the stud.
2. Insulation shall be rolled or trimmed flat to allow installation and contact with interior sheathing or finish material.
3. Insulation shall fill the cavity being insulated side to side and top to bottom.
4. Blown insulation shall meet the manufacturer's stated recommendations for density and coverage in order to meet the required R-Value and to minimize or prevent settling.
5. Insulation shall be enclosed on all six sides with durable materials.

   Exceptions:
   a. Air permeable insulation installed on the top side of the ceiling in unconditioned attics shall not require an air barrier on the exterior.
   b. Insulation installed under floors that are directly above an unvented crawl space shall not require an air barrier on the exterior side.
   c. Insulation installed in rim or band joists located in conditioned space shall not require an air barrier on the interior side.

6. Insulation shall be installed around obstructions including, but not limited to, framing, blocking, wiring, pipes, etc.as to avoid substantial gaps, voids or compression.

A-1.3.4 Open-Cell Spray Polyurethane Foam (SPF) Insulation:

Installers shall meet the manufacturer's recommended training requirements and shall complete the online health and safety training for SPF provided by the Center for Polyurethanes Industry.

1. Spray foam shall be well-bonded to the substrate, including framing and sheathing.
2. Insulation, installed at a minimum thickness to be air impermeable per ASTM E2178 (air permeance less than 0.04 cfm/ft^2) and in-contact with the substrate shall be permitted to serve as the air barrier.
3. When insulation extends beyond the wall cavity it shall be trimmed to allow installation and contact with interior sheathing or finish material.
4. Insulation shall fill the cavity to within at least ½ inch of the face of the studs.

   Exception: The cavity fill requirement is met when the required R-Value is achieved using a thickness that is less than the cavity depth.

A-1.3.5 Closed-Cell Spray Polyurethane Foam (SPF) Insulation:

Installers shall meet the manufacturer's recommended training requirements and shall complete the online health and safety training for SPF provided by the Center for Polyurethanes Industry.

1. Spray foam shall be well-bonded to the substrate, including framing and sheathing.
2. Closed-cell insulation, installed at a minimum thickness of 1.5 inches and in contact with the substrate, shall be permitted to serve as a component of the continuous air barrier.

   Exception: Thicknesses less than 1.5 inches considered air-impermeable with appropriate ASTM E2178 data (air permeance less than 0.04 cfm/ft^2) from manufacturer data sheet or code evaluation report prepared by an organization accredited for product certification per ISO-17065 or other source approved by an authority having jurisdiction.

A-1.3.6 Pre-Expanded, Injectable Foam-in-Place Insulation (FIPI):

A-1.3.6.1 Installers shall meet the manufacturer's recommended training requirements for properly installing pre-expanded injectable foam insulation.

1. Injection foam shall be site-installed via either the pressure injection (drill-n-fill) method or top-fill method.
2. FIPI shall only be installed in foundation or above grade wall assemblies that have cavity spaces that can receive the insulating material.

3. For pressure-injected installations, injection holes shall be drilled in every vertical core of concrete masonry walls.
4. For CMU block installation, inspection holes shall be installed at the top and bottom of each injected cavity.[1]
5. For framed wall application, inspection holes shall be installed 6 inches from the top and bottom plate of the wall of each injected cavity or as prescribed by the manufacturer installation instructions, whichever requires a greater number of total inspection holes.
6. Inspection holes shall be at a minimum ½ inch in diameter.

A-1.3.6.2 Obtain the average thickness of the FIPI installation using calibrated probes or a pin and disc depth gauge. Probing for average thickness shall occur through the application of inspection holes.

1. Thickness measurements shall be made randomly and averaged as set out in ASTM C1848. Alternately, thickness shall be measured regularly at a minimum of once every 300 square feet with measurements evenly distributed at the top, middle, and bottom of the assembly. and the measurements averaged to get the measured thickness for the insulated assembly.

2. For CMU walls, the insulated cavity thickness shall exclude the thickness of the outer CMU block surrounding the hollow cavity space that can be insulated.[2]
   a. Determine the total probe depth through the inspection hole then subtract the thickness of the core wall from the probe depth which is the insulation thickness.[2]

3. For framed walls, determine the total wall cavity insulation thickness by probing the wall cavity.

[1] (Informative Note) For example, for a wall section comprised of two-core CMU blocks and a window that is six cores wide, 24 holes would be drilled – six holes across the top of the wall, six above the window, six below the window, and six at the bottom of the wall.

[2] (Informative Note) National Concrete Masonry Association Tek 02-01B publication “TYPICAL SIZES AND SHAPES OF CONCRETE MASONRY UNITS”

A-2. Insulation Grading

A-2.1 Grading Criteria for Batt, Loose fill, Open and Closed Cell Polyurethane Spray Foam Insulation, ~~and~~ Insulated Sheathing and

Injectable Foam-in-Place Insulation:

A-2.1.1 Grade I (Minor Defects)
Shall meet ASTM-specified installation requirements in the applicable standards C1015, C1320 and ASTM C1848 and shall meet the following appropriate material installation grading requirements.

A-2.1.1.1 Batt or Loose fill Insulation
When installing batt, or loose-fill insulation, no more than 2% of the total insulated area shall be compressed below the thickness required to attain the labeled R-Value or contain gaps or voids in the insulation. These areas shall not be compressed more than 3/4 inch of the specified insulation thickness in any given location. Voids extending from the interior to exterior of the intended insulation areas shall not be permitted.

A-2.1.1.2 Open-Cell Polyurethane Spray Foam Insulation (cavity not filled and not trimmed)
When installing open-cell polyurethane spray foam, the average of all thickness measurements shall be greater than the specified thickness required to obtain the specified R-Value. No more than 2 percent of the insulated area shall contain voids or be more than ¾ inch below the specified thickness. The minimum installed thickness shall not be less than 1 inch below the specified thickness at any point. Voids extending from the interior to the exterior of the intended insulation areas shall not be permitted.

A-2.1.1.3 Open-Cell Polyurethane Spray Foam Insulation (cavity filled and trimmed)
When installing open-cell polyurethane spray foam, no more than 2 percent of the total insulated area (cavity) shall be below the thickness required to attain the specified thickness or contain gaps or voids in the insulation. The minimum installed thickness shall not be less than 1/2 inch below the specified thickness at any point.
Voids extending from the interior to exterior of the intended insulation areas shall not be permitted.

A-2.1.1.4 Closed-Cell Polyurethane Spray Foam
When installing closed-cell polyurethane spray foam the average of all thickness measurements shall be greater than the specified thickness required to obtain the specified R-Value. No more than 2 percent of the insulated area shall contain voids or be greater than ½ inch less than the specified thickness. The minimum installed thickness shall not be less than ¾ inch below the specified thickness at any point.
Voids extending from the interior to exterior of the intended insulation areas shall not be permitted.

A-2.1.1.5 Insulated Sheathing

Insulated sheathing insulation installations meeting the minimum installation, application, and material requirements above. Voids exceeding 1/8 inch through interior to exterior of the intended insulation areas shall not be permitted. Joints and other gaps or separations in sheathing used as an air barrier, vapor retarder or drainage plane shall be taped or sealed.

A-2.1.1.6 Pre-Expanded, Injectable Foam-in-Place Insulation
When installing injectable foam insulation via either the pressure-fill or top-fill technique, all open cavity spaces within the wall cavity shall be filled, including above and below window and door headers.[2] For CMU block walls, this shall be demonstrated by visually confirming the presence of foam coming out of inspection holes at the top and bottom of each injected cavity. No required application or inspection holes shall be missing, and no holes shall be lacking insulation seepage. For framed walls, this shall be demonstrated by visually confirming the presence of foam coming out of inspection holes or through probing of the insulated cavity.

[2] (Informative Note) For example, for a wall section comprised of two-core CMU blocks and a window that is six cores wide, 24 holes would be drilled – six holes across the top of the wall, six above the window, six below the window, and six at the bottom of the wall.

A-2.1.2 Grade II (Moderate Defects)
Installations not complying with the minimum installation requirements in ASTM standards C1015, C1320, and ASTM C1848, and the appropriate Grade I material installation grading requirements shall be considered a Grade II or Grade III installation in accordance with their level of defect.

A-2.1.2.1 Batt or Loose fill Insulation
When installing batt, or loose fill insulation, no more than 15 percent of the total insulated area (cavity) shall be compressed or contain gaps or voids in the insulation. These areas shall not be missing or compressed more than 3/4 inch of the specified insulation thickness in any given location. Inset staples are allowed for batt insulation. Voids through interior to exterior of the intended insulation areas shall not be permitted.

A-2.1.2.2 Open-Cell Polyurethane Spray Foam Insulation (cavity not filled and not trimmed)
When installing open-cell polyurethane spray foam the average of all thickness measurements shall be greater than the specified thickness required to obtain the specified R-Value. No more than 15 percent of the insulated area shall contain voids. The minimum thickness shall not be less than 3/4 inch below the specified thickness at any point. Voids extending from the interior to the exterior of the intended insulation areas shall not be permitted.

A-2.1.2.3 Open-Cell Polyurethane Spray Foam Insulation (cavity filled and trimmed)
When installing open-cell polyurethane spray foam, no more than 15 percent of the total insulated area (cavity) shall be below the thickness required to attain the specified thickness or contain gaps or voids in the insulation. The minimum installed thickness shall not be less than $^{1}/_{2}$ inch below the specified thickness at any point.
Voids extending from the interior to exterior of the intended insulation areas shall not be permitted.

A-2.1.2.4 Closed-Cell Polyurethane Spray Foam
When installing closed-cell polyurethane spray foam the average of all thickness measurements shall be greater than the specified thickness required to obtain the specified R-Value. No more than 15 percent of the insulated area shall contain voids. The minimum thickness shall not be less than $^{3}/_{4}$ inch below the specified thickness at any point. Voids extending from the interior to exterior of the intended insulation areas shall not be permitted.

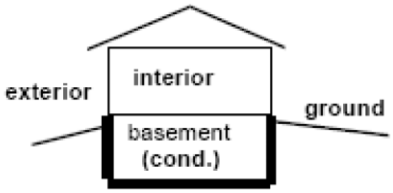
A-2.1.3 Grade III (Substantial Defects)
Installations not complying with the minimum installation requirements in ASTM standards C1015, C1320 and C1848 and the appropriate Grade I or Grade II material installation grading requirements shall be considered a Grade III installation.

Grade III installations shall be recorded and shall be modeled as specified by Section 4.2.2.2.2 of this Standard.

Modify Appendix B as shown in red print

Normative Appendix B

Inspection Procedures for Minimum Rated Features

Foundation insulation	Determine and record type, grade, location, and thickness of foundation insulation and resultant R-Value.	Use the inspection procedures in Normative Appendix A to determine and record the insulation type and grade. Visually confirm insulation location as interior, exterior or both[1] sides of the foundation wall, record R-Value and measure thickness. Visually confirm whether insulation product is installed for 100% of required area/perimeter and visually confirm and record R-Value. If insulation is observed without a labeled R-Value, the manufacturer's data sheet shall be used to determine and record the R-Value based on installed thickness.  If 100% of the area/perimeter of the foundation insulation cannot be visually confirmed, inspect according to the protocol below: 1. Visually confirm insulation product is installed for a minimum of 25% of the area/perimeter of the foundation insulation specified for insulation, and visually confirm and record R-Value. Where R-Value cannot be determined during site observation, the manufacturer's data sheet shall be used. Use the inspection procedures in Normative Appendix A to determine and record the grade of insulation. The grade of the visually confirmed area shall be applied to the rest of the area unless photos show any

[1] (Informative Note) For example, foam core ICF- insulated concrete forms.

		additional deficiencies, in which case the grade recorded shall be the worst case documented. 2. Collect photos to confirm installation at several site locations and in sufficient detail to confirm thickness, type, and grade of the insulation installation. If foundation insulation cannot be visually verified immediately after installation, it may be verified through comprehensive photographs that comply with the requirements given above. <u>For site-insulated Pre-Expanded, Injectable Foam-in-Place Insulated (FIPI) foundation walls verify the presence of insulation using inspection holes located at the top and bottom of each insulated cavity as outlined in Appendix A.</u>
Wall insulation installation	Determine type, grade and thickness of ~~framed~~ wall insulation and resultant R-Value.	Use the inspection procedures in Normative Appendix A to verify the insulation type and grade of ~~the~~ <u>wall</u> insulation. ~~installed in the framed wall stud cavity.~~ Visually confirm and record R-Value and measure thickness. If insulation is observed, but the R-Value cannot be determined during site observation, the manufacturer's data sheet shall be used.

	Determine type, grade and thickness of continuous exterior insulation and/or integral mass wall insulation, along with the ~~and~~ resultant R-Value.	Use the inspection procedures in Normative Appendix A to determine the insulation type and grade. Visually confirm whether insulation product is installed for 100% of area specified for insulation and visually confirm and record R-Value and measure thickness. If insulation is observed without a labeled R-Value, the manufacturer's data sheet shall be used to determine the R-Value based on installed thickness. If 100% of the area of the exterior insulation cannot be visually confirmed, inspect according to the protocol below: 1. Visually confirm insulation product is installed for a minimum of 25% of the area specified for insulation and visually confirm and record R-Value and measure thickness. If insulation is observed without a labeled R-Value, the manufacturer's data sheet shall be used to determine the R-Value based on installed thickness. Use the inspection procedures in Normative Appendix A to determine the type and grade of insulation. The grade of the visually confirmed area shall be applied to the rest of the area unless photos show any additional deficiencies, in which case the grade recorded shall be the worst case documented. 2. Photos to confirm installation at several site locations and in sufficient detail to confirm thickness, type, and grade of the insulation installation. If exterior insulation cannot be visually verified immediately after installation, it ~~may~~shall be verified through comprehensive photographs that comply with the requirements given above. For site-insulated Pre-Expanded, Injectable Foam-in-Place Insulated walls (FIPI) verify the presence of insulation using inspection holes located at the top and bottom of each insulated cavity as outlined in Appendix A.

		For assemblies that have been insulated with FIPI but that are not CMU walls, 3D printed, or Hollow Core Walls, document and record nominal depth (thickness) of cavity in inches and framing member spacing.

Existing insulation in walls	Determine if wall insulation exists in existing Dwelling Unit.	Check at plumbing outlet under sink or in order of preference, remove cable outlet plate, telephone plate, electrical switch plates or electrical outlet plates on exterior walls. Probe the cavity around the exposed plate with a nonmetal device. Determine type of insulation. Inspect outlets/switch plates on each side of the Dwelling Unit to verify that all walls are insulated. Multiply the wall framing member size in inches by the R-Value per inch. Use 3.5" for 2x4 walls and 5.5" for 2x6 walls constructed after 1945. When an addition has been added, check the walls of the addition separately. Where the Dwelling Unit has one more than one story, check each floor.
Color	Determine the color of the exterior walls.	Identify the color of the walls according to Table 4.2.2 (4), except where test data are provided for wall surfaces in accordance with ASTM C1549 or ASTM E903 using the ASTM G197 air-mass 1.5 sun-facing global vertical solar spectral irradiance for the measurement of Solar Reflectance. [2] The Solar Absorptance value is obtained by subtracting the measured Solar Reflectance value from the number one (Solar Absorptance = 1 – Solar Reflectance).
Thermal mass	Determine type and thickness of all mass walls.	Where the Dwelling Unit's walls are constructed of concrete, masonry or brick (other than brick veneer), determine and record their type and thickness.[3] 1. Solid concrete walls (poured) Measure the thickness of the poured concrete wall in inches. 2. Integrally-insulated mass walls, including Concrete Masonry Unit (CMU), 3D Printed or

[2] (Normative Note) Solar Reflectance is permitted to be measured in accordance with the CRRC-1 Product Rating Program Manual Appendix 8 “Standard Test Method for Determining the Directional-Hemispherical Solar Reflectance of Materials Using a Directional-Hemispherical Portable Reflectometer” with the ASTM G197 air-mass 1.5 sun-facing global vertical solar spectral irradiance.

[3] (Informative Note) For example, check window opening for wall thickness.

		Hollow Core Walls, Measure the thickness of the wall in inches. Inspect for ~~vermiculite or perlite~~ loose-fill ~~insulation~~ or foamed in place insulation using inspection holes at the tops and bottoms of all wall sections. ~~other additional insulation.~~ For CMU walls, document and record: nominal depth (thickness) of CMU in inches; density of CMU concrete in pounds/ft^3 or Appendix C default; number of CMU webs (either 2 or 3) or Appendix C default; thickness of CMU webs in inches or Appendix C default; on center distance between reinforcing CMU core pours or Appendix C default; core fill type (air, insulation or all poured) or Appendix C default; and if applicable, thermal resistivity of CMU core fill insulation in R/inch or Appendix C default.

Add to Appendix C as follows

Normative Appendix C
Modeling Assumptions

Material Thermal Properties.

C1.1 The following thermal properties shall be applied where the respective materials are used in a model:

Table C.1(1) Material Thermal Properties

Material	Conductivity (Btu/hr-F-ft)
Soil (adjacent to the home's foundation)	1.000
Wood	0.067
Drywall	0.092

C1.2 For concrete masonry units (CMU), the R-value of the CMU component shall be as provided by Tables C.1(2) for 3-web CMU and from Table C.1(3) for 2-web CMU. Except as expressly documented for the dwelling unit in question, values for 3-web CMU with 115 pound concrete density and core pours at 48" o.c. shall be used.

Table C.1(2) 3-Web CMU Blocks

R-Values[1] for 8" x 16" Concrete Masonry Units (CMU)[2]					
CMU	Foamed-in-place cores at R-4.6/in[3]			Without core insulation	
concrete density[4]	core pours[5] at 96" o.c.	core pours at 48" o.c.	all cores poured	core pours at 96" o.c.	core pours at 48" o.c.
85	4.85	4.21	1.31	1.66	1.63
95	4.34	3.79	1.21	1.54	1.51
105	3.87	3.40	1.12	1.44	1.41
115	3.44	3.05	1.04	1.34	1.31
125	3.05	2.73	0.97	1.25	1.23
135	2.70	2.44	0.90	1.17	1.14
R-Values[1] for 12" x 16" Concrete Masonry Units (CMU)[2]					
CMU	Foamed-in-place cores at R-4.6/in[3]			Without core insulation	
concrete density[4]	core pours[5] at 96" o.c.	core pours at 48" o.c.	all cores poured	core pours at 96" o.c.	core pours at 48" o.c.
85	7.29	6.15	1.82	1.79	1.79
95	6.60	5.61	1.71	1.69	1.68

105	5.96	5.12	1.61	1.59	1.59
115	5.36	4.65	1.52	1.50	1.50
125	4.81	4.22	1.44	1.42	1.42
135	4.31	3.82	1.36	1.34	1.34

Table Notes:

1. R-Values exclude indoor and outdoor air film resistances of 0.68 and 0.17. A bond beam at 8 foot wall height is assumed.
2. CMU dimensions are nominal. Subtract 3/8" mortar joint for actual. Each CMU has 3 each 1" web thicknesses and 2 each 1-1/4" face thickness.
3. Characteristic resistivity of pre-expanded foamed-in-place insulation.
4. Concrete density units are pounds per cubic foot (lb/ft^3).
5. Concrete density for core pours is 140 lb/ft^3.

Table 2.1(3) 2-Web CMU Blocks

R-Values[1] for 8" x 16" Concrete Masonry Units (CMU)[2]					
CMU	Foamed-in-place cores at R-4.6/in[3]			Without core insulation	
concrete density[4]	core pours[5] at 96" o.c.	core pours at 48" o.c.	all cores poured	core pours at 96" o.c.	core pours at 48" o.c.
85	5.58	4.67	1.29	1.64	1.61
95	5.06	4.25	1.20	1.53	1.50
105	4.58	3.87	1.11	1.43	1.40
115	4.13	3.52	1.03	1.35	1.31
125	3.72	3.20	0.96	1.26	1.23
135	3.34	2.90	0.90	1.19	1.16
R-Values[1] for 12" x 16" Concrete Masonry Units (CMU)[2]					
CMU	Foamed-in-place cores at R-4.6/in[3]			Without core insulation	
concrete density[4]	core pours[5] at 96" o.c.	core pours at 48" o.c.	all cores poured	core pours at 96" o.c.	core pours at 48" o.c.
85	8.24	6.68	1.78	1.75	1.75
95	7.57	6.18	1.68	1.65	1.65
105	6.93	5.71	1.59	1.56	1.56
115	6.34	5.27	1.50	1.48	1.48
125	5.78	4.85	1.43	1.40	1.40
135	5.25	4.46	1.36	1.34	1.34

Table Notes:

1. R-Values exclude indoor and outdoor air film resistances of 0.68 and 0.17. A bond beam at 8 foot wall height is assumed.

2. CMU dimensions are nominal. Subtract 3/8" mortar joint for actual. Each CMU has 2 each 1" web thicknesses and 2 each 1-1/4" face thickness.
3. Characteristic resistivity of pre-expanded foamed-in-place insulation.
4. Concrete density units are pounds per cubic foot (lb/ft^3).
5. Concrete density for core pours is 140 lb/ft^3.

The wall R-values provided by Table C2.1(2) and Table C2.1(3) can be reproduced using the following calculation procedures. Except as expressly documented for the dwelling unit in question, equation input values listed as defaults shall be used.

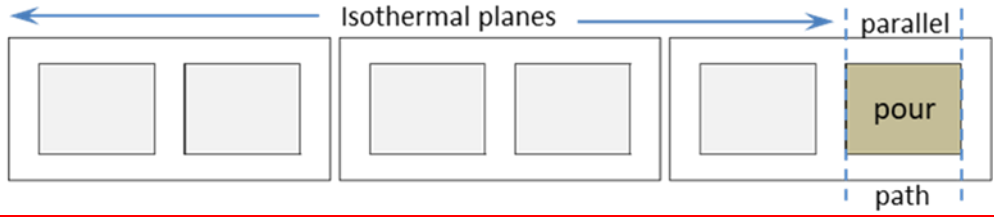


Figure C1. Representation of Concrete Masonry Unit (CMU) wall plan showing delineation of Isothermal Planes calculation method from ASHRAE Handbook of Fundamentals and Parallel Path calculation method from Concrete Masonry & Hardscape Association (CMHA) Tech Note TEK 06-02C.

$R_{wall} = \{1 / [U_{isothermal}*(1- pourFrac) + U_{pour}*pourFrac]\} – (R_i + R_o)$ Eq. 1

where:

$U_{isothermal}$ = U-Factor for isothermal planes segment of CMU wall
U_{pour} = U-Factor for poured core segment of CMU wall
pourFrac = fraction of wall core poured with reinforcing cement (grout)
pourFrac = coreLength / o.c.pours + bondFrac
coreLength = (15.625 – webs*webThick)/2
IF o.c.pours = 0
pourFrac = bondFrac
ELSE
o.c.pours = on center distance between CMU core pours
bondFrac= fraction of CMU wall face consisting of bond beam = 8 / (storyheight*12)
storyHeight = vertical height of single story CMU wall in feet
R_i = indoor air film resistance of CMU wall (0.68)
R_o = outdoor air film resistance of CMU wall (0.17)

$U_{isothermal} = 1 / [1 / (a_w / R_w + a_c*gradePC / 1.01 + a_c*(1-gradePC) / R_c) + R_f + R_i + R_o]$ Eq. 1a

where:

a_w = fraction of total area transverse to heat flow represented by CMU webs
R_w = thermal resistance of webs between CMU face shells
a_c = fraction of total area transverse to heat flow represented by CMU cores
R_c = thermal resistance of cores between CMU face shells
R_f = total thermal resistance of CMU face shells
R_i = indoor air film resistance of CMU wall (0.68)

R_o = outdoor air film resistance of CMU wall (0.17)

gradePC = insulation installation grade degradation percentage = 0% for Grade I, 2% for Grade II and 5% for Grade III installations where:

a_w = webs * webThick / 16 – (3/8*webs*webThick) / CMUarea

R_w = coreDepth * $CMU_{resistivity}$

a_c = (16 – webs * webThick) / 16 + (3/8*webs*webThick) / CMUarea

IF coreFill = air

R_c = 1.01

ELSE IF coreFill = all poured

R_c = coreDepth * $pour_{resistivity}$

$pour_{resistivity}$ = $1.2349 * e^{(-0.017*140)}$

ELSE

R_c = coreDepth * Kfill

R_f = 1/((1-jointFrac) / (2*faceThick*CMUresistivity) + jointFrac/(2*faceThick*pourResistivity))

where:

CMUarea = plan area of CMU and mortar head joint = 16*(CMUsize-3/8)

jointFrac = fraction of CMU face area comprising mortar joints = ((16+7.625)*3/8) / (16*8)

coreDepth = (CMU_{size} – 0.375) – 2*faceThick

$CMU_{resistivity}$ = $1.2349 * e^{(-0.017 * CMUdensity)}$

$CMU_{density}$ = density of CMU concrete

K_{fill} = thermal resistivity of CMU coreFill insulation

faceThick = 1.25

U_{pour} = $1/(R_{pour} + R_i + R_o)$ Eq. 1b

where:

R_{pour} = 2*faceThick*$CMU_{resistivity}$ + CoreDepth*$pour_{resistivity}$

where:

faceThick = 1.25

$pour_{resistivity}$ = $1.2349 * e^{(-0.017*140)}$

R_i = indoor air film resistance of CMU wall (0.68)

R_o = outdoor air film resistance of CMU wall (0.17)

User Inputs:

CMU_{size} = nominal depth (thickness) of CMU (inches) *{Default = 8 inches}*

$CMU_{density}$ = density of CMU concrete (pounds/ft^3) *{Default = 115 pcf}*

webs = number of CMU webs (integer – either 2 or 3) *{Default = 3}*

webThick = thickness of CMU webs (inches) *{Default = 1.0”}*

o.c. pours = on center distance between concrete CMU core pours. *{Default = 48”}*

coreFill = air, insulation or all poured *{Default = air}*

K_{fill} = thermal resistivity of core fill insulation (resistance/inch), if applicable *{Default = 4.6}*

storyHeight = vertical height of single story CMU wall *{Default = 8’}*