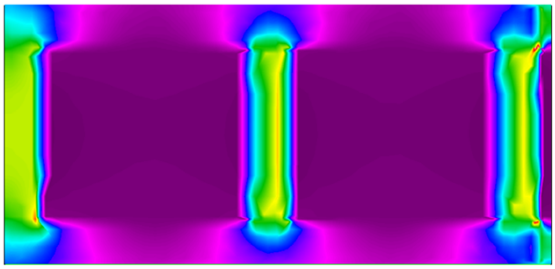
Meeting the Michigan Energy Code with Single Wythe CMU

Presented by Philippe Ledent, P.E., S.E.

MASONRY Institute of Michigan



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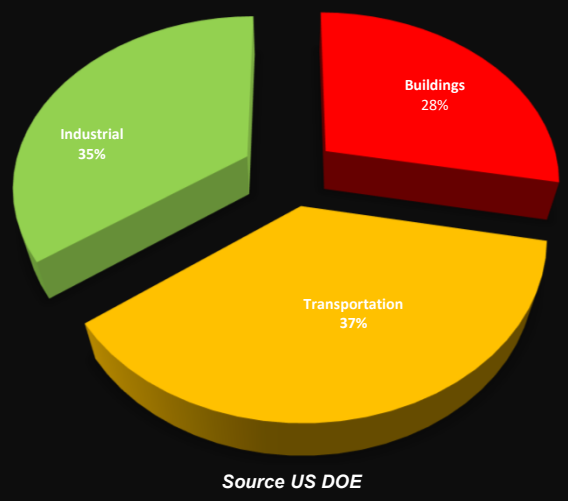

Why Energy Codes?

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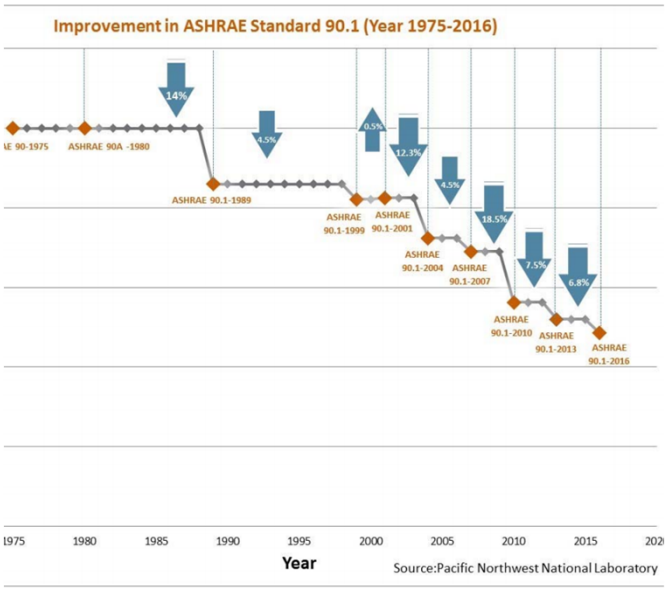
Why Energy Codes?

There has been a substantial decrease in energy usage in commercial buildings since the 1970s



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masonry fit in?

Most of the masonry market comprises *conventional* CMUs with three webs, two facesheils, and two cores.

Depending on the market in Michigan, we can have lightweight, medium weight, or normal weight units.

Structural clay units are also available in our area, as well!

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Where does masonry fit in?

Depending on the producer, our CMUs come in different colors, textures, and sizes.

Photos courtesy of Consumers Concrete Corporation

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Where does masonry fit in?

For these *conventional* units, NCMA has tabulated U-factors and R-values for various sizes and whether the cores are filled with insulation.

TEK 6-2C is available at ncma.org

Table 2—U-Factors (Btu/ hrft²·°F) and R-Values (hrft²·°F/Btu) of Concrete Masonry Walls [A]

Nominal wythe thickness, in. (mm)	Density of concrete, pcf	Cores empty U	Cores empty R	Cores filled with [B]: Perlite U	Perlite R	Vermiculite U	Vermiculite R	Polyurethane foamed-in-place U	Polyurethane foamed-in-place R	100% solid units U	100% solid units R
4 in. (102 mm)[F]	85	0.467	2.14	0.267	3.75	0.287	3.49	0.239	4.18	0.669	1.49
	95	0.492	2.03	0.298	3.36	0.317	3.16	0.272	3.67	0.699	1.43
	105	0.518	1.93	0.333	3.00	0.351	2.85	0.310	3.23	0.729	1.37
	115	0.546	1.83	0.373	2.68	0.388	2.57	0.351	2.85	0.757	1.32
	125	0.577	1.73	0.416	2.40	0.430	2.32	0.397	2.52	0.784	1.28
	135	0.609	1.64	0.463	2.16	0.476	2.10	0.446	2.24	0.809	1.24

Nominal wythe thickness, in. (mm)	Density of concrete, pcf	Cores empty U	Cores empty R	Cores filled with [B]: Perlite U	Perlite R	Vermiculite U	Vermiculite R	Polyurethane foamed-in-place U	Polyurethane foamed-in-place R	Solid Grouted U	Solid Grouted R
6 in. (152 mm)	85	0.421	2.37	0.177	5.65	0.192	5.20	0.157	6.38	0.555	1.80
	95	0.443	2.26	0.200	5.00	0.214	4.66	0.181	5.54	0.584	1.71
	105	0.465	2.15	0.227	4.41	0.240	4.16	0.208	4.80	0.612	1.63
	115	0.489	2.05	0.257	3.89	0.270	3.70	0.240	4.17	0.639	1.56
	125	0.514	1.95	0.292	3.43	0.304	3.29	0.276	3.63	0.666	1.50
	135	0.541	1.85	0.331	3.02	0.342	2.92	0.316	3.16	0.692	1.45
8 in. (152 mm)	85	0.391	2.56	0.133	7.54	0.145	6.92	0.117	8.58	0.475	2.11
	95	0.412	2.43	0.151	6.64	0.162	6.17	0.135	7.40	0.501	2.00
	105	0.433	2.31	0.172	5.83	0.183	5.47	0.157	6.38	0.527	1.90
	115	0.455	2.20	0.196	5.09	0.207	4.83	0.182	5.49	0.553	1.81
	125	0.478	2.09	0.225	4.45	0.235	4.26	0.211	4.73	0.579	1.73
	135	0.502	1.99	0.257	3.88	0.267	3.75	0.245	4.08	0.604	1.66
10 in. (254 mm)	85	0.383	2.61	0.108	9.29	0.117	8.56	0.095	10.47	0.425	2.35
	95	0.403	2.48	0.123	8.12	0.132	7.57	0.111	8.98	0.447	2.23
	105	0.423	2.37	0.142	7.07	0.150	6.65	0.130	7.69	0.470	2.13
	115	0.443	2.26	0.163	6.13	0.172	5.83	0.152	6.57	0.492	2.03
	125	0.464	2.15	0.188	5.31	0.196	5.10	0.178	5.62	0.514	1.95
	135	0.486	2.06	0.217	4.60	0.225	4.45	0.208	4.82	0.537	1.86
12 in. (305 mm)	85	0.380	2.63	0.087	11.47	0.095	10.53	0.077	12.99	0.387	2.58
	95	0.398	2.51	0.100	10.00	0.108	9.29	0.090	11.10	0.406	2.46
	105	0.417	2.40	0.115	8.68	0.123	8.15	0.106	9.47	0.425	2.35
	115	0.436	2.30	0.133	7.50	0.141	7.12	0.124	8.07	0.444	2.25
	125	0.455	2.20	0.155	6.47	0.161	6.19	0.146	6.87	0.463	2.16
	135	0.474	2.11	0.179	5.58	0.186	5.38	0.171	5.86	0.483	2.07
14 in. (356 mm)	85	0.377	2.65	0.073	13.66	0.080	12.51	0.065	15.50	0.355	2.82
	95	0.395	2.53	0.084	11.88	0.091	11.02	0.076	13.23	0.371	2.70
	105	0.413	2.42	0.097	10.29	0.104	9.65	0.089	11.26	0.388	2.58
	115	0.431	2.32	0.113	8.87	0.119	8.40	0.105	9.56	0.404	2.47
	125	0.448	2.23	0.131	7.63	0.137	7.29	0.123	8.12	0.421	2.37
	135	0.467	2.14	0.153	6.55	0.158	6.31	0.145	6.89	0.439	2.28
16 in. (406 mm)	85	0.376	2.66	0.063	15.84	0.069	14.48	0.056	18.02	0.328	3.05
	95	0.393	2.54	0.073	13.77	0.078	12.74	0.065	15.35	0.342	2.93
	105	0.410	2.44	0.084	11.90	0.090	11.14	0.077	13.04	0.356	2.81
	115	0.427	2.34	0.098	10.24	0.103	9.69	0.090	11.06	0.371	2.69
	125	0.444	2.25	0.114	8.79	0.119	8.39	0.107	9.36	0.387	2.59
	135	0.461	2.17	0.133	7.53	0.138	7.24	0.126	7.93	0.403	2.48

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Where does masonry fit in?

In recent years, other units configurations such as A and H have become available.

ASTM C90 (Specification for Loadbearing CMUs) has been changed in recent years to allow other configurations.

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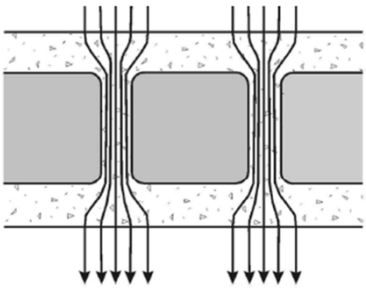
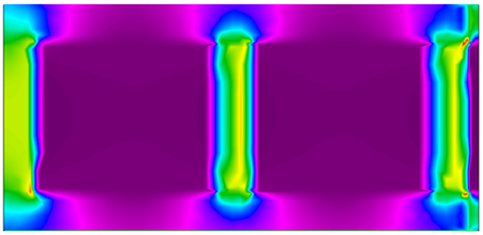
Thermal Bridging

The webs in a concrete masonry unit are essentially thermal bridges

Heat flows through the webs

By reducing the webs, we increase the R-value of the wall





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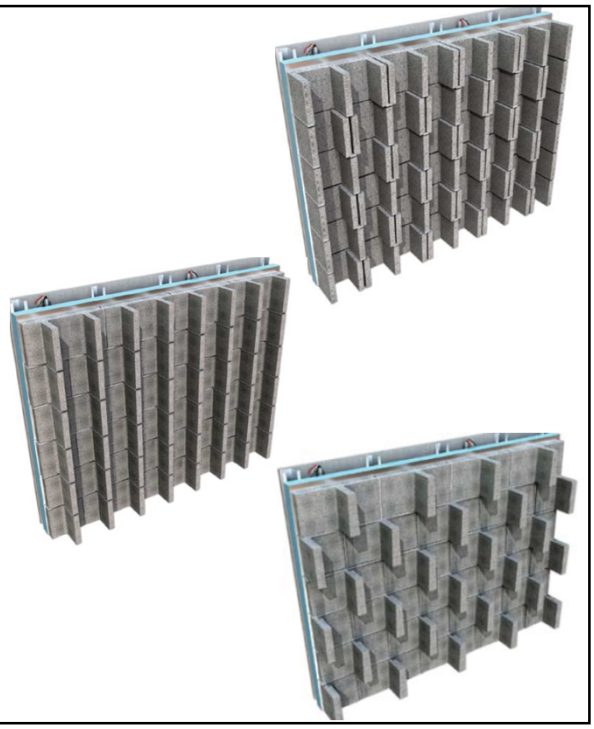

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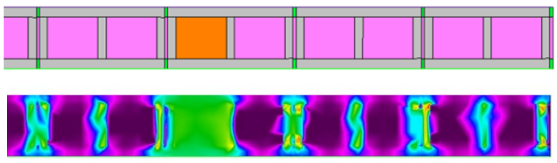
Thermal Bridging

In addition to the webs, any grouted cells also create a thermal bridge between the conditioned and unconditioned space.

Don’t overdesign your walls!



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Thermal Bridging

18 ft wall height
8-inch CMU
40 psf wind pressure
3,000 lb/ft axial load

Table 2 – Design Impact of TMS 402/602 Revisions		
Code Edition[1]	Reinforcement Size	Reinforcement Spacing
2009 IBC[2]	No. 5	40 inches
2012 IBC[2]	No. 5	48 inches
2015 IBC[3]	No. 5	96 inches[4]

[1]The 2009, 2012, and 2015 editions of the IBC adopt the 2008, 2011, and 2013 editions of TMS 402/602, respectively.
[2]f'_m = 1,500 psi
[3]f'_m = 2,000 psi
[4]Incorporating 9 gage bed joint reinforcement at 16 inches.

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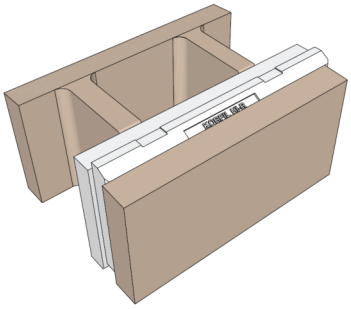
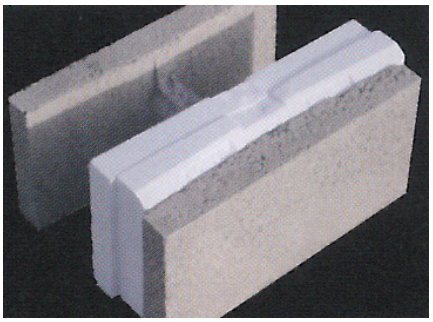
New(er) Masonry Units

Some manufacturers now produce open end and double open-end units with modified webs to allow continuous insulation.

This allows increased thermal efficiency and decreased bridging.





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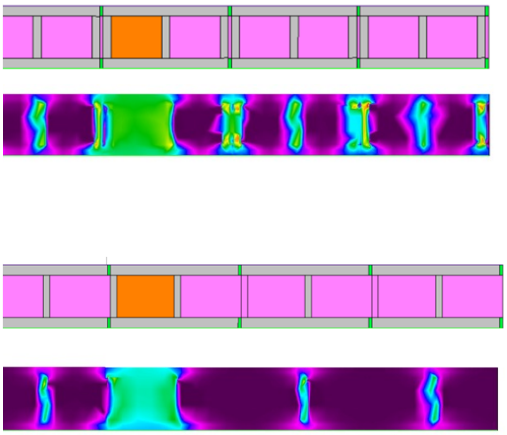

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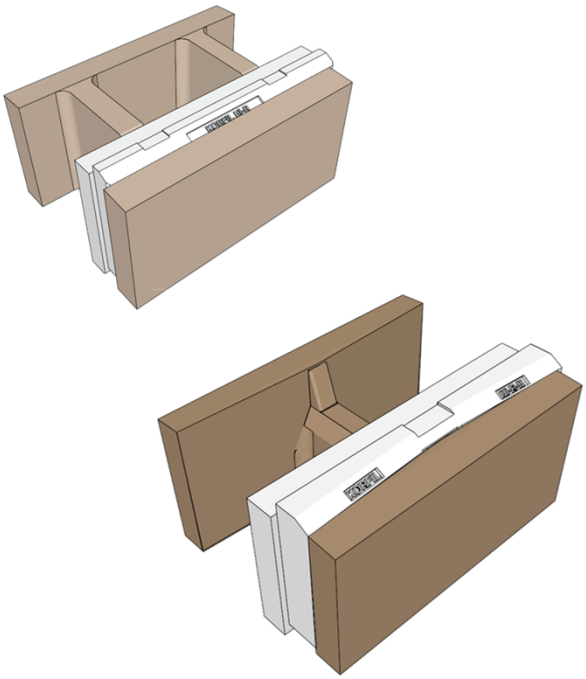
New(er) Masonry Units

Michigan producers represent Concrete Products Group which produces the Hi-R and Hi-R-H units.

These wall systems must be fully grouted.

Jambs, lintels, and control joints must also be accounted for in design.



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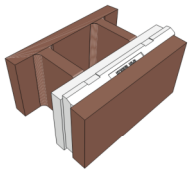
New(er) Masonry Units

The Hi-R and Hi-R-H units perform considerably better than conventional CMUs in regard to U-factors.

Additionally, since these units are fully grouted the equivalent thickness is greater for fire resistance.

Table 2.
HI-R®Grouted Cells



Korfil Hi-R Masonry Units (Grouted Cells)					
Type of Block (inches)	Density (pcf)				
	95	105	115	125	135
8×8×16					
R_t Value	10.00	9.07	8.18	7.36	6.59
U Factor	0.10	0.11	0.12	0.14	0.15
Heat Capacity	11.60	12.00	12.40	12.90	13.30
Equivalent Thickness	5.60	5.60	5.60	5.60	5.60
10×8×16					
R_t Value	11.82	10.82	9.85	8.94	8.08
U Factor	0.08	0.09	0.10	0.11	0.12
Heat Capacity	15.80	16.30	16.90	17.50	18.00
Equivalent Thickness	7.60	7.60	7.60	7.60	7.60
12×8×16					
R_t Value	12.58	11.56	10.57	9.62	8.72
U Factor	0.08	0.08	0.09	0.10	0.11
Heat Capacity	20.10	20.80	21.50	22.10	22.80
Equivalent Thickness	9.60	9.60	9.60	9.60	9.60

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The Hi-R and Hi-R-H units perform considerably better than conventional CMUs in regard to U-factors.

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Table 4.
HI-R-H (3.5" Insert)
Grouted Cells Only

Hi-R H Masonry Units (Grouted)					
Type of Block (inches)	Density (pcf)				
	95	105	115	125	135
10×8×16					
R_t Value	15.11	13.70	12.57	11.37	10.17
U Factor	0.066	0.073	0.080	0.088	0.098
Heat Capacity	15.80	16.30	16.90	17.50	18.00
Equivalent Thickness	7.60	7.60	7.60	7.60	7.60
12×8×16					
R_t Value	16.32	14.98	13.74	12.50	11.25
U Factor	0.061	0.067	0.073	0.080	0.089
Heat Capacity	20.10	20.80	21.50	22.10	22.80
Equivalent Thickness	9.60	9.60	9.60	9.60	9.60

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New(er) Masonry Units

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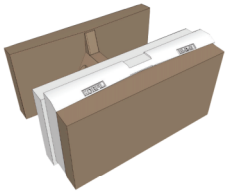
Table 5.
HI-R-H (4" Insert)
Grouted Cells Only



Hi-R H Masonry Units (Grouted)					
Type of Block (inches)	Density (pcf)				
	95	105	115	125	135
12×8×16					
R_c Value	17.56	16.12	14.78	13.45	12.11
U Factor	0.057	0.062	0.068	0.074	0.083
Heat Capacity	13.26	14.65	16.05	17.44	18.84
Equivalent Thickness	8.06	8.06	8.06	8.06	8.06

Check with your local manufacturer to confirm the density of concrete block they offer. Since this depends on locally available materials, density offerings will vary by location.

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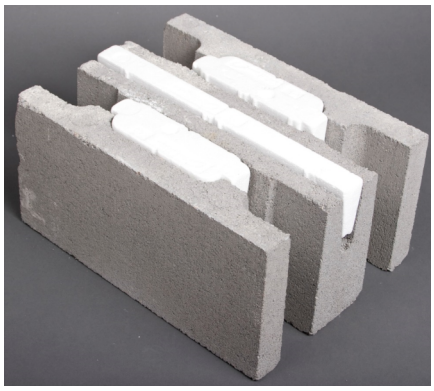
New(er) Masonry Units

Other units, such as the Omni Block are available in the Michigan markets, as well.

These units meet the Energy Code prescriptively!

These units are also available in a variety of colors and finishes.



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GROUTED VERTICALLY EVERY 48"						
Omni Block Masonry Units (Grouted)						
	Omni Block - Density of Block (pcf)					
	85	95	105	115	125	135
8x8x16						
R-Value	19.9	19.2	18.9	18.5	18.2	17.9
U-Factor	0.050	0.052	0.053	0.054	0.055	0.056
Heat Capacity	9.66	10.11	11.08	11.56	12.61	13.60
Equivalent Thickness	4.36	4.36	4.36	4.36	4.36	4.36
12x8x16						
R-Value	28.1	27.4	27.1	26.7	26.4	26.1
U-Factor	0.035	0.036	0.037	0.037	0.038	0.038
Heat Capacity	13.48	14.38	16.28	17.70	19.53	20.52
Equivalent Thickness	6.29	6.29	6.29	6.29	6.29	6.29

Thermal Properties: Omni Block System 8 and System 12; Reinforced Masonry Engineering Manual (RMEH) Table B-3a, page 300

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DEPARTMENT OF LICENSING AND REGULATORY AFFAIRS

DIRECTOR'S OFFICE

CONSTRUCTION CODE

Filed with the Secretary of State May 23, 2017
These rules take effect 120 days after filed with the Secretary of State

R 408.31087 Applicable code.
Rule 1087. Rules governing the energy efficiency for the design and construction of buildings and structures, not including residential buildings, shall be those contained in the international energy conservation code, 2015 edition, except for sections C107.2 to C107.5, C108.2 to C108.4, C301.2, C301.3, C302, C401.2.1 to C408.3.2, C502.2 to C502.2.6.2, C503.2 to C503.6 and the ASHRAE energy standard for buildings except low-rise residential buildings, ANSI/ASHRAE/IESNA standard 90.1-2013 (hereafter the standard), including appendices A, B, C, D, and G, except for sections 8.4.2, 8.4.3 to 8.4.3.2 . With the amendments noted, the international energy conservation code and the standard are adopted in these rules by reference. The Michigan energy code is available for inspection at the Lansing office of the
Michigan Department of Licensing and Regulatory Affairs, Bureau of Construction Codes, 611 W. Ottawa Street, Lansing, Michigan 48933. The code may be purchased from the International Code Council, through the bureau's website at www.michigan.gov/bcc, at a cost as of the time of adoption of these rules of $44.00. The ASHRAE 90.1-2013 standard is available for inspection at the Lansing office of the Michigan Department of Licensing and Regulatory Affairs, Bureau of Construction Codes. The standard may be purchased from the American Society of Heating, Refrigeration and Air-Conditioning Engineers, Inc., 1791 Tullie Circle, NE, Atlanta, Georgia 30329, at a cost as of the time of adoption of these rules of $135 .00 each.

Energy Code Compliance

Essentially all the technical sections from the IECC are exempt from the Michigan Energy Code for commercial and high rise (>3 stories) residential defaulting to ASHRAE 90.1

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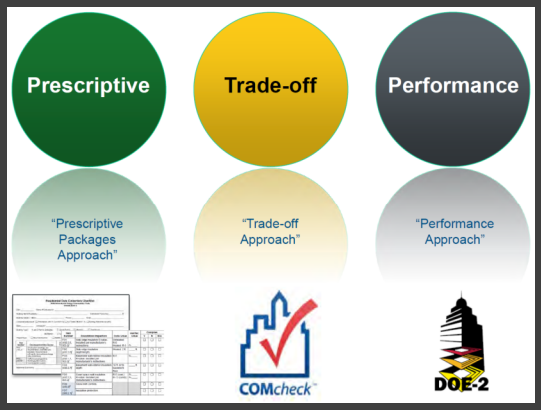

Energy Code Compliance

Through the Michigan Energy Code and ASHRAE 90.1 there are three paths for demonstration compliance.

The Prescriptive Packages Approach is typically the simplest, but most architects use the Trade-Off Approach in design.

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STANDARD

ANSI/ASHRAE/IES Standard 90.1-2013
(Supersedes ANSI/ASHRAE/IES Standard 90.1-2010)
Includes ANSI/ASHRAE/IES Addenda listed in Appendix F

Energy Standard for Buildings Except Low-Rise Residential Buildings

(I-P Edition)

Energy Code Compliance

Under our current adopted standards, ASHRAE 90.1-2013 is our adopted standard.

Again, this would apply to commercial and high-rise residential construction.

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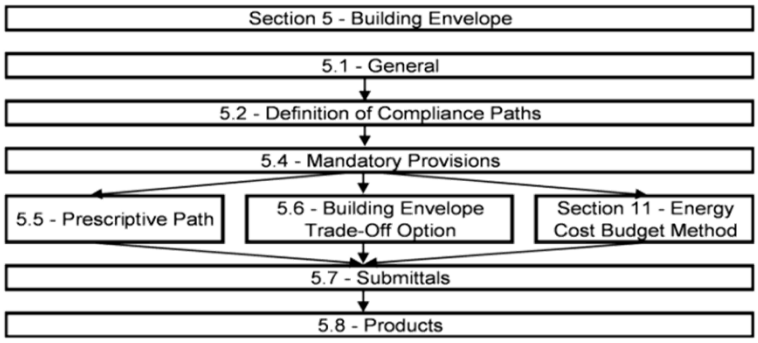

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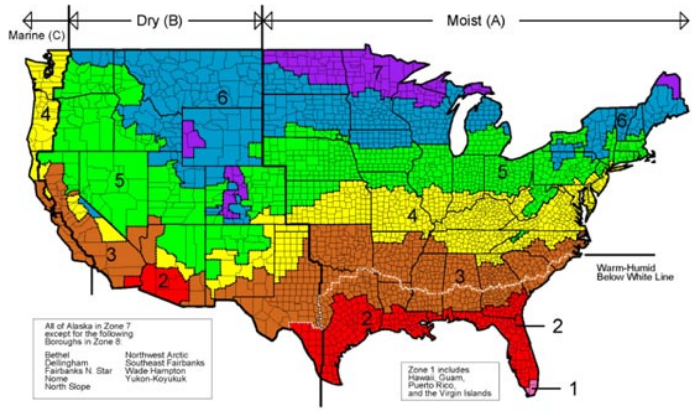
Energy Code Compliance



ASHRAE 90.1 has broken the U.S. into different climate zones.

Michigan contains climate zones 5, 6, and 7, as shown.

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Prescriptive Path

Table 5.5-5 Building Envelope Requirements for Climate Zone 5 (A,B,C)*

	Nonresidential		Residential		Semiheated	
Opaque Elements	**Assembly Maximum**	**Insulation Min. R-Value**	**Assembly Maximum**	**Insulation Min. R-Value**	**Assembly Maximum**	**Insulation Min. R-Value**
Roofs						
Insulation Entirely above Deck	U-0.032	R-30 c.i.	U-0.032	R-30 c.i.	U-0.063	R-15 c.i.
Metal Building[a]	U-0.037	R-19 + R-11 Ls or R-25 + R-8 Ls	U-0.037	R-19 + R-11 Ls or R-25 + R-8 Ls	U-0.082	R-19
Attic and Other	U-0.021	R-49	U-0.021	R-49	U-0.034	R-30
Walls, above Grade						
Mass	U-0.090	R-11.4 c.i.	U-0.080	R-13.3 c.i.	U-0.151[b]	R-5.7 c.i.[b]
Metal Building	U-0.050	R-0 + R-19 c.i.	U-0.050	R-0 + R-19 c.i.	U-0.094	R-0 + R-9.8 c.i.
Steel Framed	U-0.055	R-13 + R-10 c.i.	U-0.055	R-13 + R-10 c.i.	U-0.084	R-13+R-3.8 c.i.
Wood Framed and Other	U-0.051	R-13 + R-7.5 c.i. or R-19 + R-5 c.i.	U-0.051	R-13 + R-7.5 c.i. or R-19 + R-5 c.i.	U-0.089	R-13

ASHRAE 90.1 Table 5.5 contains minimum values for the Assembly Maximum U-factor and the Insulation Minimum R-value.

A free read-only version of ASHRAE 90.1 is available at ashrae.org.

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Prescriptive Path

Table 5.5-6 Building Envelope Requirements for Climate Zone 6 (A,B)*

Opaque Elements	Nonresidential		Residential		Semiheated	
	Assembly Maximum	Insulation Min. R-Value	Assembly Maximum	Insulation Min. R-Value	Assembly Maximum	Insulation Min. R-Value
Roofs						
Insulation Entirely above Deck	U-0.032	R-30 c.i.	U-0.032	R-30 c.i.	U-0.063	R-15 c.i.
Metal Building[a]	U-0.031	R-25 + R-11 Ls	U-0.029	R-30 + R-11 Ls	U-0.060	R-19 + R-19
Attic and Other	U-0.021	R-49	U-0.021	R-49	U-0.034	R-30
Walls, above Grade						
Mass	U-0.080	R-13.3 c.i.	U-0.071	R-15.2 c.i.	U-0.151[b]	R-5.7 c.i.[b]
Metal Building	U-0.050	R-0 + R-19 c.i.	U-0.050	R-0 + R-19 c.i.	U-0.094	R-0 + R-9.8 c.i.
Steel Framed	U-0.049	R-13 + R-12.5 c.i.	U-0.049	R-13 + R-12.5 c.i.	U-0.084	R-13 + R-3.8 c.i.
Wood Framed and Other	U-0.051	R-13 + R-7.5 c.i. or R-19 + R-5 c.i.	U-0.051	R-13 + R-7.5 c.i. or R-19 + R-5 c.i.	U-0.089	R-13

ASHRAE 90.1 Table 5.5 contains minimum values for the Assembly Maximum U-factor and the Insulation Minimum R-value.

A free read-only version of ASHRAE 90.1 is available at ashrae.org.

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Prescriptive Path

Table 5.5-7 Building Envelope Requirements for Climate Zone 7*

Opaque Elements	Nonresidential		Residential		Semiheated	
	Assembly Maximum	Insulation Min. R-Value	Assembly Maximum	Insulation Min. R-Value	Assembly Maximum	Insulation Min. R-Value
Roofs						
Insulation Entirely above Deck	U-0.028	R-35 c.i.	U-0.028	R-35 c.i.	U-0.039	R-25 c.i.
Metal Building[a]	U-0.029	R-30 + R-11 Ls	U-0.029	R-30 + R-11 Ls	U-0.037	R-19 + R-11 Ls or R-25 + R-8 Ls
Attic and Other	U-0.017	R-60	U-0.017	R-60	U-0.027	R-38
Walls, above Grade						
Mass	U-0.071	R-15.2 c.i.	U-0.071	R-15.2 c.i.	U-0.123	R-7.6 c.i.
Metal Building	U-0.044	R-0 + R.22.1 c.i.	U-.044	R-0 + R.22.1 c.i.	U-0.072	R-0 + R-13 c.i.
Steel Framed	U-0.049	R-13 + R-12.5 c.i.	U-0.042	R-13 + R-15.6 c.i.	U-0.064	R-13 + R-7.5 c.i.
Wood Framed and Other	U-0.051	R-13 + R-7.5 c.i. or R-19 + R-5 c.i.	U-0.051	R-13 + R-7.5 c.i. or R-19 + R-5 c.i.	U-0.064	R-13 + R-3.8 c.i.

ASHRAE 90.1 Table 5.5 contains minimum values for the Assembly Maximum U-factor and the Insulation Minimum R-value.

A free read-only version of ASHRAE 90.1 is available at ashrae.org.

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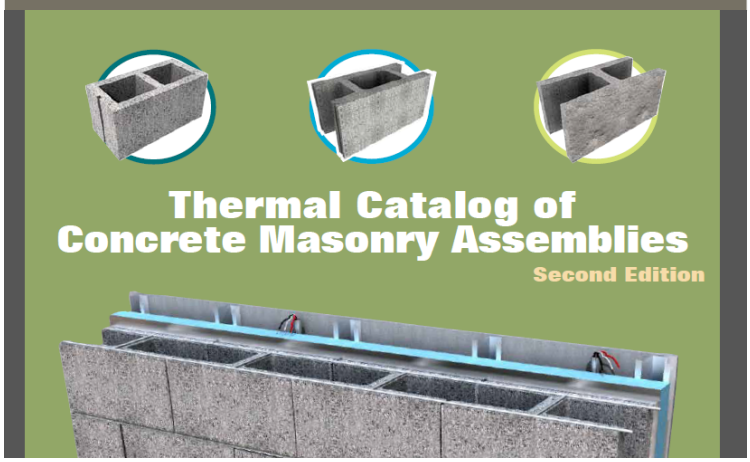
Prescriptive Path



Numerous tools are available to determine the thermal properties of masonry wall assemblies.

The NCMA Thermal Catalog includes all relevant thermal properties for various unit configurations.

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Prescriptive Path

Concrete Masonry Assembly R-Values (hr·ft²·°F/Btu) and U-Factors (Btu/hr·ft²·°F)

Density of CMU, PCF	6-in. Concrete Masonry				8-in. Concrete Masonry			
	Ungrouted	Lightly Reinforced	Heavily Reinforced	Fully Grouted	Ungrouted	Lightly Reinforced	Heavily Reinforced	Fully Grouted
85	6.38 (0.157)	4.45 (0.225)	3.29 (0.304)	1.80 (0.555)	8.58 (0.117)	5.63 (0.177)	4.01 (0.249)	2.11 (0.475)
95	5.54 (0.181)	4.01 (0.249)	3.03 (0.330)	1.71 (0.584)	7.40 (0.135)	5.07 (0.197)	3.70 (0.270)	2.00 (0.501)
105	4.80 (0.208)	3.61 (0.277)	2.80 (0.358)	1.63 (0.612)	6.38 (0.157)	4.55 (0.220)	3.40 (0.294)	1.90 (0.527)
115	4.17 (0.240)	3.25 (0.308)	2.58 (0.388)	1.56 (0.639)	5.49 (0.182)	4.08 (0.245)	3.13 (0.319)	1.81 (0.553)
125	3.63 (0.276)	2.92 (0.342)	2.38 (0.420)	1.50 (0.666)	4.73 (0.211)	3.65 (0.274)	2.88 (0.347)	1.73 (0.579)
135	3.16 (0.316)	2.63 (0.380)	2.20 (0.455)	1.45 (0.692)	4.08 (0.245)	3.27 (0.306)	2.65 (0.378)	1.66 (0.604)

Concrete Masonry Assembly R-Values (hr·ft²·°F/Btu) and U-Factors (Btu/hr·ft²·°F)

Density of CMU, PCF	6-in. Concrete Masonry				8-in. Concrete Masonry			
	Ungrouted	Lightly Reinforced	Heavily Reinforced	Fully Grouted	Ungrouted	Lightly Reinforced	Heavily Reinforced	Fully Grouted
85	9.48 (0.105)	5.45 (0.183)	3.64 (0.275)	1.77 (0.564)	12.97 (0.077)	6.84 (0.146)	4.40 (0.227)	2.07 (0.483)
95	8.37 (0.119)	5.01 (0.200)	3.40 (0.294)	1.69 (0.592)	11.41 (0.088)	6.28 (0.159)	4.10 (0.244)	1.96 (0.509)
105	7.36 (0.136)	4.59 (0.218)	3.18 (0.315)	1.62 (0.619)	9.98 (0.100)	5.75 (0.174)	3.83 (0.261)	1.87 (0.535)
115	6.43 (0.155)	4.19 (0.239)	2.97 (0.337)	1.55 (0.645)	8.69 (0.115)	5.25 (0.191)	3.58 (0.279)	1.79 (0.559)
125	5.61 (0.178)	3.82 (0.262)	2.78 (0.360)	1.49 (0.670)	7.53 (0.133)	4.78 (0.209)	3.34 (0.299)	1.72 (0.583)
135	4.88 (0.205)	3.47 (0.288)	2.59 (0.386)	1.44 (0.693)	6.51 (0.154)	4.34 (0.230)	3.12 (0.321)	1.65 (0.605)

Concrete Masonry Assembly R-Values (hr·ft²·°F/Btu) and U-Factors (Btu/hr·ft²·°F)

Density of CMU, PCF	6-in. Concrete Masonry				8-in. Concrete Masonry			
	Ungrouted	Lightly Reinforced	Heavily Reinforced	Fully Grouted	Ungrouted	Lightly Reinforced	Heavily Reinforced	Fully Grouted
85	13.07 (0.077)	6.30 (0.159)	4.24 (0.236)	1.76 (0.567)	18.04 (0.055)	7.85 (0.127)	5.12 (0.195)	2.05 (0.487)
95	11.87 (0.084)	5.89 (0.170)	3.99 (0.250)	1.68 (0.595)	16.35 (0.061)	7.32 (0.137)	4.81 (0.208)	1.95 (0.513)
105	10.69 (0.094)	5.49 (0.182)	3.76 (0.266)	1.61 (0.622)	14.69 (0.068)	6.81 (0.147)	4.53 (0.221)	1.86 (0.538)
115	9.55 (0.105)	5.10 (0.196)	3.55 (0.282)	1.54 (0.648)	13.10 (0.076)	6.33 (0.158)	4.26 (0.235)	1.78 (0.562)
125	8.48 (0.118)	4.73 (0.211)	3.34 (0.299)	1.49 (0.672)	11.59 (0.086)	5.87 (0.170)	4.01 (0.249)	1.71 (0.585)
135	7.48 (0.134)	4.37 (0.229)	3.14 (0.318)	1.44 (0.694)	10.19 (0.098)	5.43 (0.184)	3.77 (0.265)	1.65 (0.606)

Numerous tools are available to determine the thermal properties of masonry wall assemblies.

The NCMA Thermal Catalog includes all relevant thermal properties for various unit configurations.

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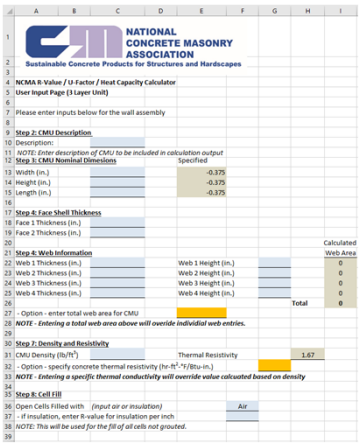
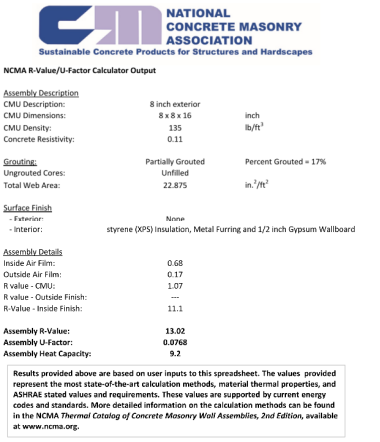
Prescriptive Path





Numerous tools are available to determine the thermal properties of masonry wall assemblies.

The NCMA Thermal Calculator allows users to quickly determine thermal properties for various wall assemblies.

Heat capacity values are provided in NCMA TEK 6-16A.

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Prescriptive Path

	Meets Code: $U_{assembly}$[1] $\leq U_{max}$		
	U_{max}		
	Zone 5	Zone 6	Zone 7
Commercial	0.090	0.080	0.071
High-Rise Residential	0.080	0.071	0.071

[1]Calculate U-Value (NCMA Thermal Calculator or NCMA Thermal Catalog)

12" CMU Exposed on Both Faces			
	density[1], pcf	grout spacing, in.	U - factor[2,3,4]
conventional[5]	135	48	0.224
	125	48	0.200
	115	48	0.178
	105	48	0.160
A- Block[5]	135	48	0.160
	125	48	0.146
	115	48	0.134
	105	48	0.124
H - Block[5]	135	48	0.130
	125	48	0.121
	115	48	0.114
	105	48	0.106
Hi R	135	48	0.110
	125	48	0.100
	115	48	0.090
	105	48	0.080
Hi R H	135	48	0.083
	125	48	0.074
	115	48	0.068
	105	48	0.062
Omni Block	135	48	0.038
	125	48	0.037
	115	48	0.037
	105	48	0.036

Footnote 1: To obtain color uniformity use a density of 135 pcf or greater
Footnote 2: Weather Climate: Zone 5 - U_{max}=0.090, Zone 6 - U_{max}=0.080, Zone 7 - U_{max}=0.071
Footnote 3: Cell fill is polyurethane foamed-in-place, R value of 5.9 per inch
Footnote 4: assumes bond beam every 120 inches
Footnote 5: NCMA Thermal Calculator

Numerous tools are available to determine the thermal properties of masonry wall assemblies.

The NCMA Thermal Calculator allows users to quickly determine thermal properties for various wall assemblies.

Heat capacity values are provided in NCMA TEK 6-16A.

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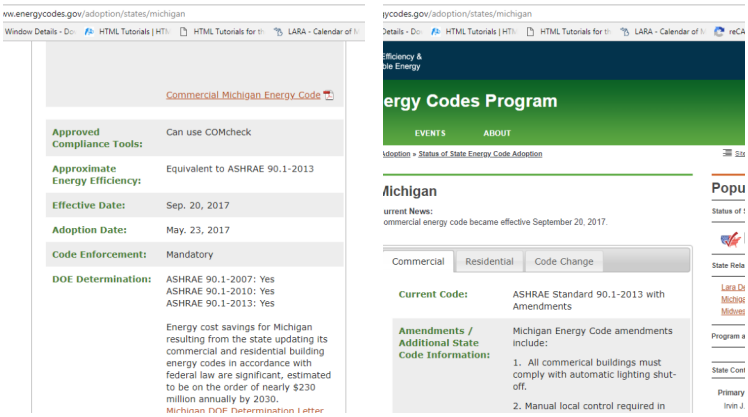
Trade-Off Option



The U.S. Department of Energy permits COMcheck to be used to demonstrate ASHRAE 90.1 code compliance.

Envelope tradeoffs are defined to allow trades to be made between various parts of the building envelope.

These will be discussed in our Guide.

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MIM Single Wythe Energy Guide

1. **Can single wythe masonry walls meet the energy code?**

   Answer: Yes, they can. There are several options for meeting the energy code. For example, for semi-heated buildings the masonry walls can meet the prescriptive option. For heated buildings, the masonry walls can meet the prescriptive option or with the trade-off option.

2. **Can single wythe masonry walls meet the energy code due to the insulation not being continuous?**

   Answer: Yes, they can. With the prescriptive option, the masonry walls can meet the U_{max} factor of the assembly or the R_{min} of the insulation. The R_{min} of the insulation requires the insulation to be continuous. The U_{max} factor of the assembly does not require continuous insulation.

3. **Can I use other U-values then the default U-values for masonry walls in COMcheck?**

   Answer: Yes, you can. Under "Exterior Wall" in COMcheck, click on "Other (U-factor Option)", then click on "Mass Wall", enter "U-Factors" from the sources in FAQ 4 and then enter the "Heat Capacity".

4. **What tools are available for determining compliance for masonry walls meeting the energy code?**

   Answer:

   a. MIM Energy Guide

   b. NCMA Thermal Calculator

   c. NCMA Thermal Catalog

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MIM Single Wythe Energy Guide

ENERGY GUIDE

		Insulation			Meets Code		
CMU	Option	Exterior Face	Interior Face	Cell	Prescriptive	Trade-Off	Tools
Semi-Heated Buildings							
8" Conventional	1	exposed	exposed	full height	yes		NCMA TEK 6-2C (Table 5)
12" Conventional	1	exposed	exposed	full height	yes		NCMA TEK 6-2C (Table 5)
Heated Buildings							
8" Conventional	2	exposed	full height		yes		NCMA Thermal Calculator
	3	exposed	upper height	lower height		yes	Tables 1, 4, and 6, NCMA TEK 06-16A, COMcheck
	4	exposed	exposed	full height		yes	Tables 2, 4 , and 6, NCMA TEK 06-16A, COMcheck
8"Hi-Performance	5	exposed	exposed		yes		See Table 7
12" Conventional	6	exposed	full height		yes		NCMA Thermal Calculator
	7	exposed	upper height	lower height		yes	Tables 3, 5, and 8, NCMA TEK 06-16A, COMcheck
	8	exposed	upper height	full height		yes	See Option 8, NCMA TEK 06-16A, COMcheck
12"Hi-Performance	9	exposed	exposed		yes		See Tables 9 and 10

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MIM Single Wythe Energy Guide

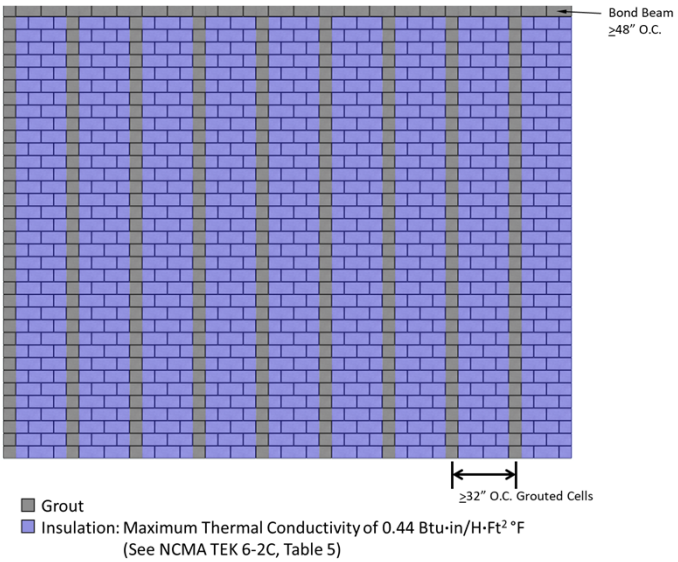
Option 1

Semi-Heated Building Conventional CMU

Exposed

Prescriptive (Applies to Zones 5 & 6)

Meets Code
ASTM C90 Concrete Block Walls, ungrouted or partially grouted at 32" or less on center vertically and 48" or less on center horizontally, with all ungrouted cores filled with material having a maximum thermal conductivity of 0.44 BTU·in/h· ft^{2}· °F , Comply per Section 5.5.3.2



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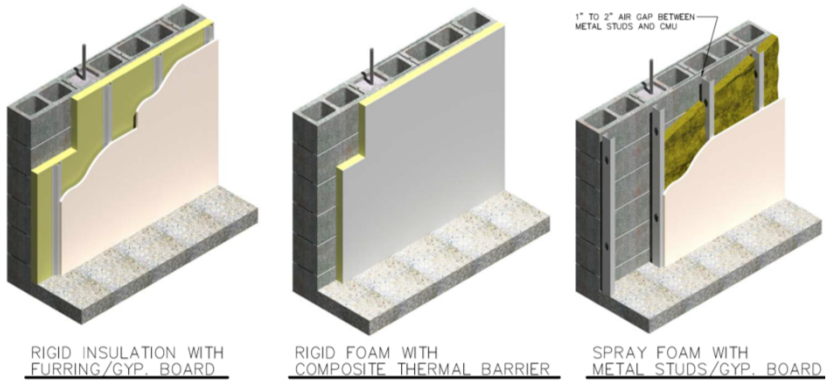
MIM Single Wythe Energy Guide

Option 2

8" Conventional CMU

Fully insulated
Prescriptive



1) ARE JUST A FEW REPRESENTATIVE SAMPLES OF THE MULTITUDE OF AVAILABLE INTERIOR INSULATION SYSTEMS:
A) RIGID BOARD – EXTRUDED OR EXPANDED POLYSTYRENE, OR POLYISOCYANURATE
B) CLOSED–CELL SPRAY POLYURETHANE FOAM
C) CELLULAR GLASS
D) FIBROUS BATT
E) FIBROUS BLOW–IN

	Meets Code: $U_{assembly}$[1] $\leq U_{max}$		
	U_{max}		
	Zone 5	Zone 6	Zone 7
Commercial	0.090	0.080	0.071
High-Rise Residential	0.080	0.071	0.071

[1]Calculate U-Value (NCMA Thermal Calculator or NCMA Thermal Catalog)

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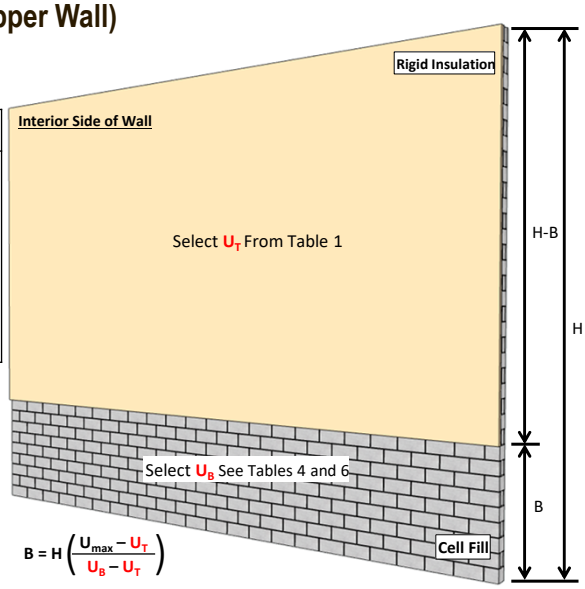
MIM Single Wythe Energy Guide

Option 3

8" Conventional CMU

Partially Insulated (Upper Wall)
Cell Fill (Lower Wall)
COMcheck

Meets Code: **COMcheck**
STEP 1: Select U_{max}, U_T, and U_B
STEP 2: Calculate "B"
STEP 3: Open COMcheck
STEP 4: Select Exterior Wall
STEP 5: Select Other U- Factor
STEP 6: Select Mass Wall
STEP 7: Enter Wall Areas
STEP 8: Enter U_T and U_B
STEP 9: Enter Heat Capacities



$$B = H\left(\frac{U_{max} - U_T}{U_B - U_T}\right)$$

	Meets Code: $U_{assembly}$[1] $\leq U_{max}$		
	U_{max}		
	Zone 5	Zone 6	Zone 7
Commercial	0.090	0.080	0.071
High-Rise Residential	0.080	0.071	0.071

[1]Calculate U-Value (NCMA Thermal Calculator or NCMA Thermal Catalog)

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MIM Single Wythe Energy Guide

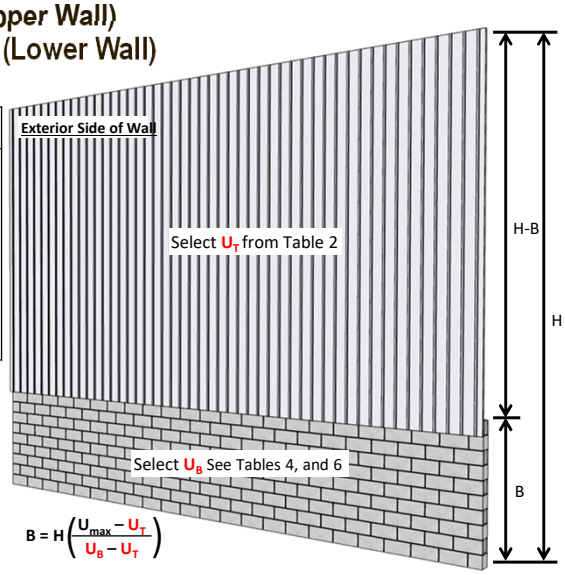
Option 4

8" Conventional CMU Wainscot

Partially Insulated (Upper Wall)
Exposed and Cell Fill (Lower Wall)

Meets Code: **COMcheck**

STEP 1: Select U_{max}, U_T, and U_B
STEP 2: Calculate "B"
STEP 3: Open COMcheck
STEP 4: Select Exterior Wall
STEP 5: Select Other U- Factor
STEP 6: Select Mass Wall
STEP 7: Enter Wall Areas
STEP 8: Enter U_T and U_B
STEP 9: Enter Heat Capacities



$$B = H\left(\frac{U_{max} - U_T}{U_B - U_T}\right)$$

	Meets Code: $U_{assembly}$[1] $\leq U_{max}$		
	U_{max}		
	Zone 5	**Zone 6**	**Zone 7**
Commercial	0.090	0.080	0.071
High-Rise Residential	0.080	0.071	0.071

[1]Calculate U-Value (NCMA Thermal Calculator or NCMA Thermal Catalog)

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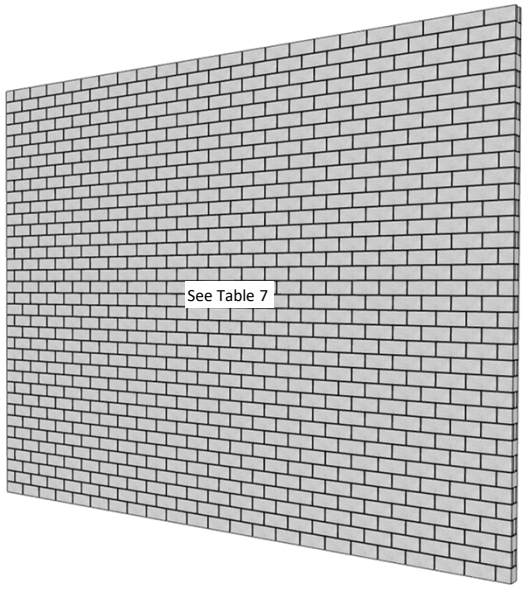
MIM Single Wythe Energy Guide

Option 5

8" Hi-Performance Units

Exposed
Prescriptive



	Meets Code: $U_{assembly}$[1] $\leq U_{max}$		
	U_{max}		
	Zone 5	**Zone 6**	**Zone 7**
Commercial	0.090	0.080	0.071
High-Rise Residential	0.080	0.071	0.071

[1]Calculate U-Value (NCMA Thermal Calculator or NCMA Thermal Catalog)

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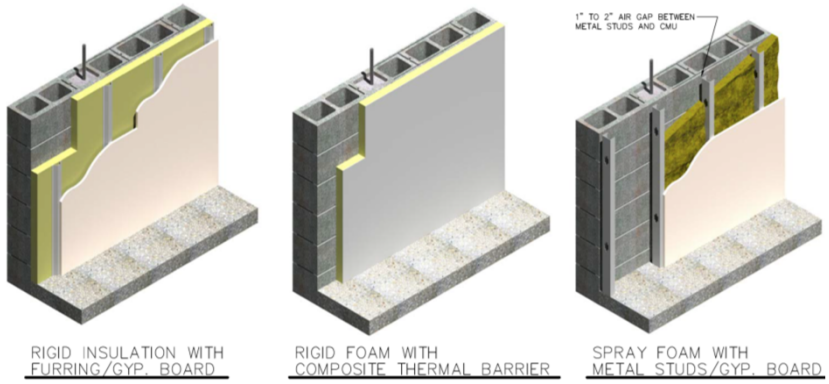
MIM Single Wythe Energy Guide

Option 6

12" Conventional CMU

Fully insulated
Prescriptive



1) ARE JUST A FEW REPRESENTATIVE SAMPLES OF THE MULTITUDE OF AVAILABLE INTERIOR INSULATION SYSTEMS:
A) RIGID BOARD – EXTRUDED OR EXPANDED POLYSTYRENE, OR POLYISOCYANURATE
B) CLOSED–CELL SPRAY POLYURETHANE FOAM
C) CELLULAR GLASS
D) FIBROUS BATT
E) FIBROUS BLOW–IN

	Meets Code: $U_{assembly}$[1] $\leq U_{max}$		
	U_{max}		
	Zone 5	Zone 6	Zone 7
Commercial	0.090	0.080	0.071
High-Rise Residential	0.080	0.071	0.071

[1]Calculate U-Value (NCMA Thermal Calculator or NCMA Thermal Catalog)

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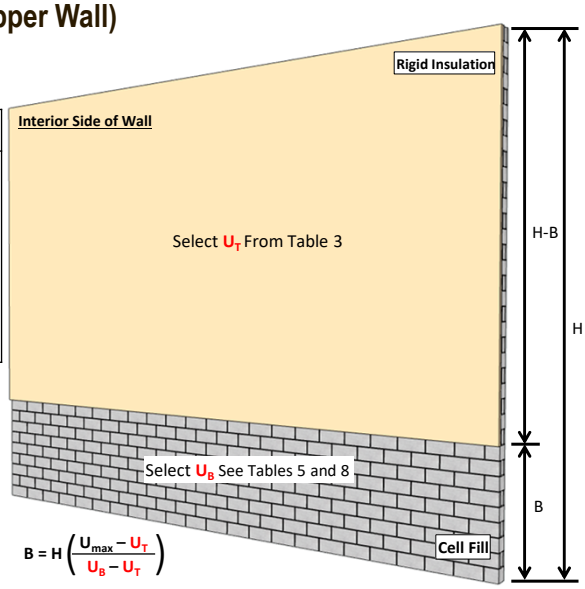
MIM Single Wythe Energy Guide

Option 7

12" Conventional CMU

Partially Insulated (Upper Wall)
Cell Fill (Lower Wall)
COMcheck

Meets Code: **COMcheck**
STEP 1: Select U_{max}, U_T, and U_B
STEP 2: Calculate "B"
STEP 3: Open COMcheck
STEP 4: Select Exterior Wall
STEP 5: Select Other U- Factor
STEP 6: Select Mass Wall
STEP 7: Enter Wall Areas
STEP 8: Enter U_T and U_B
STEP 9: Enter Heat Capacities



$$B = H\left(\frac{U_{max} - U_T}{U_B - U_T}\right)$$

	Meets Code: $U_{assembly}$[1] $\leq U_{max}$		
	U_{max}		
	Zone 5	Zone 6	Zone 7
Commercial	0.090	0.080	0.071
High-Rise Residential	0.080	0.071	0.071

[1]Calculate U-Value (NCMA Thermal Calculator or NCMA Thermal Catalog)

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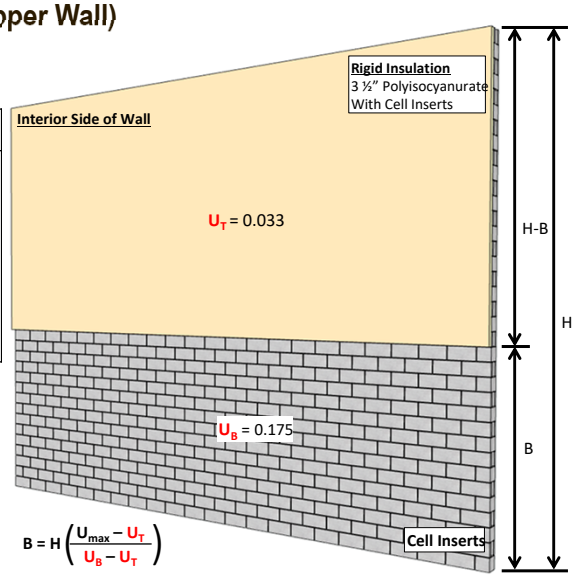
MIM Single Wythe Energy Guide

Option 8

12" Conventional CMU (125 pcf)

Partially Insulated (Upper Wall)
Cell Fill (Lower Wall)
COMcheck

Meets Code: **COMcheck**
STEP 1: Select U_{max}, U_T, and U_B
STEP 2: Calculate "B"
STEP 3: Open COMcheck
STEP 4: Select Exterior Wall
STEP 5: Select Other U- Factor
STEP 6: Select Mass Wall
STEP 7: Enter Wall Areas
STEP 8: Enter U_T and U_B
STEP 9: Enter Heat Capacities



$$B = H\left(\frac{U_{max} - U_T}{U_B - U_T}\right)$$

	Meets Code: $U_{assembly}$[1] $\leq U_{max}$		
	U_{max}		
	Zone 5	**Zone 6**	**Zone 7**
Commercial	0.090	0.080	0.071
High-Rise Residential	0.080	0.071	0.071

[1]Calculate U-Value (NCMA Thermal Calculator or NCMA Thermal Catalog)

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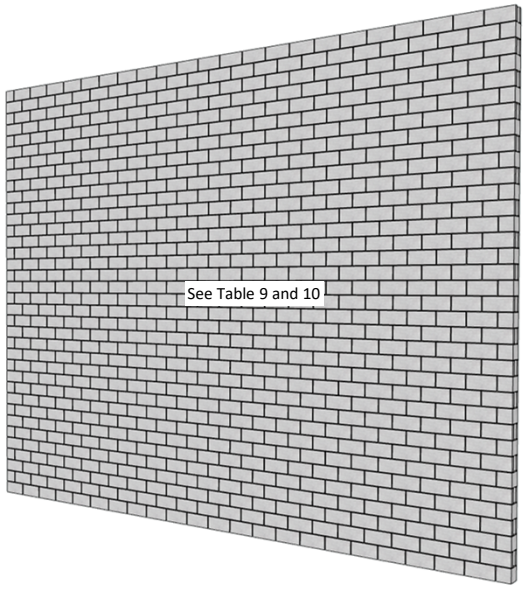
MIM Single Wythe Energy Guide

Option 9

8" Hi-Performance Units

Exposed
Prescriptive



	Meets Code: $U_{assembly}$[1] $\leq U_{max}$		
	U_{max}		
	Zone 5	**Zone 6**	**Zone 7**
Commercial	0.090	0.080	0.071
High-Rise Residential	0.080	0.071	0.071

[1]Calculate U-Value (NCMA Thermal Calculator or NCMA Thermal Catalog)

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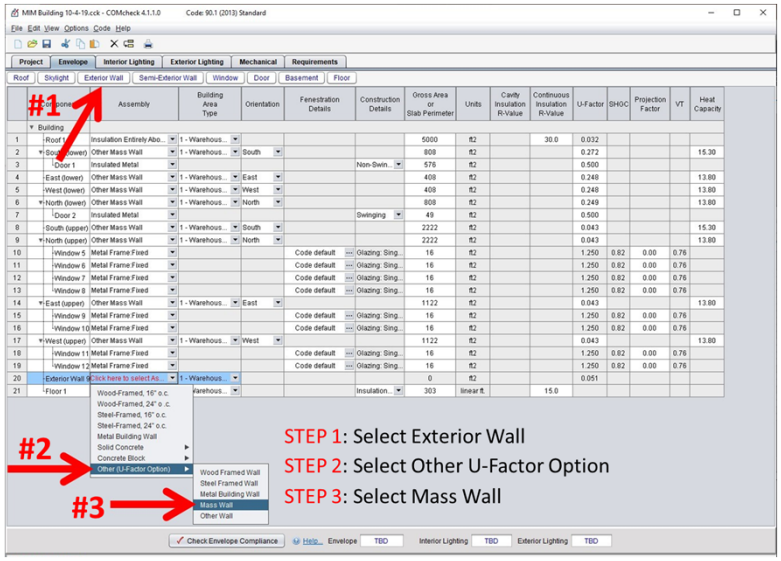
Appendix

COMcheck



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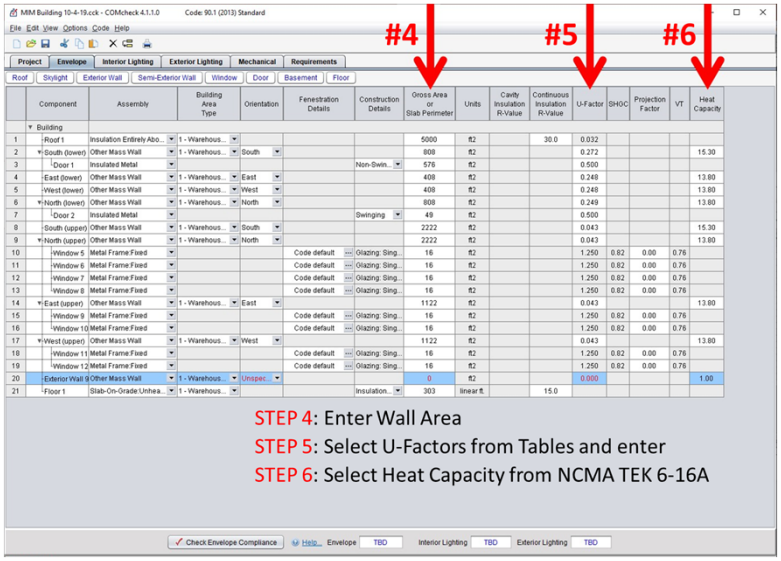
Appendix

COMcheck



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Appendix

Interior Face Insulation

Table 1

8" CMU	polyisocyanurate, HD (interior face)			
DENSITY	2"	2-1/2"	3"	3-1/2"
105	0.061	0.051	0.043	0.038
115	0.062	0.051	0.043	0.038
125	0.062	0.051	0.044	0.038
135	0.062	0.051	0.044	0.038

Table 2

Consult the Pre-Engineered Metal Frame Building Manufacturer for U-Value of Metal Panels.

Table 3

12" CMU	polyisocyanurate, HD (interior face)			
DENSITY	2"	2-1/2"	3"	3-1/2"
105	0.060	0.050	0.042	0.037
115	0.060	0.050	0.043	0.037
125	0.060	0.050	0.043	0.037
135	0.061	0.050	0.043	0.037

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Appendix

8” CMU Cell Fill Insulation (U-factors)

Table 4a

POLYURETHANE

8" CMU	BAR SPACING, polyurethane foamed-in-place, R=5.9 per in. (cell fill)														
DENSITY	8"	16"	24"	32"	40"	48"	56"	64"	72"	80"	88"	96"	104"	112"	120"
105	0.529	0.355	0.298	0.269	0.251	0.240	0.231	0.225	0.220	0.216	0.213	0.210	0.208	0.206	0.205
115	0.555	0.381	0.323	0.294	0.277	0.265	0.257	0.250	0.246	0.242	0.239	0.236	0.234	0.232	0.230
125	0.581	0.408	0.351	0.322	0.305	0.293	0.285	0.279	0.274	0.271	0.268	0.265	0.262	0.261	0.259
135	0.606	0.437	0.381	0.353	0.336	0.325	0.317	0.311	0.306	0.303	0.300	0.297	0.295	0.293	0.292

Table 4b

AMINOPLAST

8" CMU	BAR SPACING, aminoplast foamed-in-place, R=4.6 per in. (cell fill)														
DENSITY	8"	16"	24"	32"	40"	48"	56"	64"	72"	80"	88"	96"	104"	112"	120"
105	0.529	0.358	0.301	0.272	0.255	0.243	0.235	0.229	0.224	0.220	0.218	0.215	0.212	0.211	0.209
115	0.555	0.383	0.326	0.297	0.280	0.269	0.260	0.254	0.249	0.246	0.243	0.240	0.238	0.236	0.234
125	0.581	0.410	0.354	0.325	0.308	0.297	0.289	0.283	0.278	0.274	0.271	0.268	0.266	0.264	0.263
135	0.606	0.439	0.384	0.356	0.339	0.328	0.320	0.314	0.309	0.306	0.303	0.300	0.298	0.296	0.295

Table 4c

PERLITE

8" CMU	BAR SPACING, perlite, R=3.12 per in. (cell fill)														
DENSITY	8"	16"	24"	32"	40"	48"	56"	64"	72"	80"	88"	96"	104"	112"	120"
105	0.529	0.362	0.307	0.279	0.262	0.251	0.243	0.237	0.232	0.229	0.226	0.223	0.221	0.219	0.218
115	0.555	0.388	0.332	0.304	0.287	0.276	0.268	0.262	0.257	0.254	0.251	0.248	0.246	0.244	0.243
125	0.581	0.415	0.359	0.332	0.315	0.304	0.296	0.290	0.285	0.282	0.279	0.276	0.274	0.272	0.271
135	0.606	0.443	0.389	0.362	0.346	0.335	0.327	0.321	0.317	0.313	0.310	0.308	0.306	0.304	0.304

Table 4d

VERMICULITE

8" CMU	BAR SPACING, vermiculite, R=2.27 per in. (cell fill)														
DENSITY	8"	16"	24"	32"	40"	48"	56"	64"	72"	80"	88"	96"	104"	112"	120"
105	0.529	0.367	0.314	0.287	0.271	0.260	0.252	0.246	0.242	0.238	0.236	0.233	0.231	0.229	0.228
115	0.555	0.393	0.339	0.312	0.295	0.284	0.277	0.271	0.266	0.263	0.260	0.257	0.255	0.253	0.252
125	0.581	0.419	0.366	0.339	0.323	0.312	0.304	0.298	0.294	0.290	0.288	0.285	0.283	0.281	0.280
135	0.606	0.448	0.395	0.369	0.353	0.342	0.335	0.329	0.325	0.321	0.319	0.316	0.314	0.312	0.311

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Appendix

12” CMU Cell Fill Insulation (U-factors)

Table 5a

POLYURETHANE

12" CMU	BAR SPACING, polyurethane foamed-in-place, R=5.9 per in. (cell fill)														
DENSITY	8"	16"	24"	32"	40"	48"	56"	64"	72"	80"	88"	96"	104"	112"	120"
105	0.427	0.277	0.227	0.202	0.187	0.177	0.170	0.164	0.160	0.157	0.154	0.152	0.150	0.148	0.147
115	0.446	0.296	0.246	0.221	0.206	0.196	0.188	0.183	0.179	0.176	0.173	0.170	0.168	0.167	0.166
125	0.466	0.316	0.267	0.242	0.227	0.217	0.210	0.204	0.200	0.197	0.194	0.192	0.190	0.188	0.187
135	0.485	0.339	0.290	0.265	0.250	0.241	0.234	0.228	0.224	0.221	0.219	0.216	0.214	0.213	0.211

Table 5b

AMINOPLAST

12" CMU	BAR SPACING, aminoplast foamed-in-place, R=4.6 per in. (cell fill)														
DENSITY	8"	16"	24"	32"	40"	48"	56"	64"	72"	80"	88"	96"	104"	112"	120"
105	0.427	0.278	0.229	0.204	0.189	0.179	0.172	0.167	0.163	0.160	0.157	0.155	0.153	0.151	0.150
115	0.446	0.297	0.248	0.223	0.208	0.198	0.191	0.185	0.181	0.178	0.176	0.173	0.171	0.169	0.168
125	0.466	0.317	0.268	0.244	0.229	0.219	0.212	0.207	0.202	0.199	0.197	0.194	0.192	0.191	0.189
135	0.485	0.340	0.291	0.267	0.252	0.243	0.236	0.231	0.227	0.223	0.221	0.218	0.217	0.215	0.214

Table 5c

PERLITE

12" CMU	BAR SPACING, perlite, R=3.12 per in. (cell fill)														
DENSITY	8"	16"	24"	32"	40"	48"	56"	64"	72"	80"	88"	96"	104"	112"	120"
105	0.427	0.281	0.233	0.209	0.194	0.184	0.178	0.172	0.168	0.165	0.163	0.160	0.158	0.157	0.155
115	0.446	0.300	0.252	0.227	0.212	0.203	0.196	0.191	0.187	0.183	0.181	0.178	0.177	0.175	0.174
125	0.466	0.320	0.272	0.248	0.233	0.224	0.217	0.211	0.207	0.204	0.202	0.199	0.197	0.196	0.195
135	0.485	0.342	0.295	0.271	0.257	0.247	0.241	0.235	0.231	0.228	0.226	0.223	0.222	0.220	0.219

Table 5d

VERMICULITE

12" CMU	BAR SPACING, vermiculite, R=2.27 per in. (cell fill)														
DENSITY	8"	16"	24"	32"	40"	48"	56"	64"	72"	80"	88"	96"	104"	112"	120"
105	0.427	0.285	0.238	0.214	0.200	0.190	0.184	0.178	0.174	0.171	0.169	0.167	0.165	0.163	0.162
115	0.446	0.303	0.256	0.232	0.218	0.208	0.202	0.196	0.193	0.189	0.187	0.185	0.183	0.181	0.180
125	0.466	0.324	0.276	0.253	0.238	0.229	0.222	0.217	0.213	0.210	0.208	0.205	0.203	0.202	0.201
135	0.485	0.346	0.299	0.276	0.262	0.252	0.246	0.241	0.237	0.234	0.232	0.229	0.227	0.226	0.225

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Appendix

8” Hi-Performance Units*

Table 6

	Conventional Unit w/Insert (Typical U-factors range from 0.175 to 0.252)	Basis of design for Conventional Units with inserts is “Korfil ICON”

Table 7

	Typical U-factors range from 0.055 (48” o.c) to 0.090 (8” o.c.) for 135 pcf	Basis of design for Special Energy Unit is “Omni Block”

* These are proprietary products, consult the manufacturer for U-Values and technical information and guidance for structural design

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Appendix

12” Hi-Performance Units*

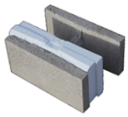
Table 8

	Conventional Unit w/Insert* (Typical U-factors range from 0.139 to 0.198)	Basis of design for Conventional Units with inserts is “Korfil ICON”

Table 9

	Typical U-factors range from 0.038 (48” o.c.) to 0.052 (8”o.c.) for 135 pcf	Basis of design is “Omni Block”

Table 10

	Typical U-factors is 0.083 for 135 pcf	Basis of design is “Korfil Hi-R-H”

* These are proprietary products, consult the manufacturer for U-Values and technical information and guidance for structural design

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