

RESNET® Standards Public Comment and Proposed Change Form

Comment/Explanation*:

Include your justification for your proposed change to the draft standard below.

Page 119, Appendix C, Section C1. Material Thermal Properties, Table C.1(2) Concrete Masonry Unit R-Value should ALSO include aminoplast, pre-expanded injection foam insulation.

Aminoplast injection foam is the most commonly used foam to insulate Concrete Masonry Unit (CMU) walls throughout the US as recognized by the American Concrete Institute (ACI), the Masonry Society (TMS) and the Mason Contractors Association of America (MCAA).

In their recently published residential energy code (*ACI/TMS 122.2-24 – Thermal Properties of Concrete and Masonry for Use in Determining Energy Code Compliance for Low-Rise Residential Buildings – Code Requirements and Commentary*) ACI and TMS explicitly include aminoplast injection foam (R-4.6/in) in their series of similar tables. See one ACI/TMS table example included via the UPLOAD file link.

In an attempt to offer many user and design solutions the new ACI/TMS insulated CMU tables include:

- Multiple CMU sizes, concrete densities and web thickness (expressed as cross-web normalized area)
- Multiple grout pore percentages to capture many options of vertical and/or horizontal re-bar spacings ranging from 0% to 100% in 10% increments.
- And, for northern climate zones, the option of using a generic rigid insert in the grouted cells, to boost R-Values.

It is also important to note the the new ACI/TMS code does not include spray polyurethane foam (SPF) as it is well known that SPF foams, while having a slightly higher thermal resistivity, are very difficult to install into CMU hollow cores and can even crack open face shells because of their powerful expansion properties.

For these reasons I respectfully request that aminoplast injection foam be included in Table C.1(2) and, as Chair of the ACI/TMS 122 committee, I am willing to assist in creating new, more suited to one and two-family dwellings, tables that include the latest state-of-the-art technical data per the new ACI/TMS 122.2 Residential Energy Code.

Changes proposed in CMU tables 'Foamed-in-place' column headers and in footnote 3.

Proposed Change to the Draft Standard*

Use "strikethrough" and "underline" formatting to indicate all proposed changes. Changes must be shown with "hard-formatting" strikethrough and underline, *not* "track changes".

For concrete masonry units (CMU) the R-value of the CMU shall be selected from Table C.1(2).

Table C.1(2) Concrete Masonry Unit R-Value

R-Values¹ for 8" x 16" Concrete Masonry Units (CMU)²

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<u>CMU characteristics</u>		<u>Foamed-in-place cores of R-4.6/in or R-5.9/in³</u>			<u>Without core insulation</u>	
<u>concrete Density⁴</u>	<u>concrete Resistivity⁵</u>	<u>core pours⁶ at 96" o.c.</u>	<u>core pours at 48" o.c.</u>	<u>all cores poured</u>	<u>core pours at 96" o.c.</u>	<u>core pours at 48" o.c.</u>
85	0.291	5.15	3.95	1.39	1.64	1.49
95	0.246	4.48	3.44	1.27	1.49	1.35
105	0.207	3.90	3.00	1.16	1.37	1.22
115	0.175	3.38	2.62	1.06	1.25	1.11
125	0.147	2.93	2.28	0.98	1.15	1.01
135	0.124	2.54	1.98	0.91	1.06	0.92

R-Values¹ for 12" x 16" Concrete Masonry Units (CMU)⁷

<u>CMU characteristics</u>		<u>Foamed-in-place cores of R4.6/in or R-5.9/in³</u>			<u>Without core insulation</u>	
<u>concrete Density⁴</u>	<u>concrete Resistivity⁵</u>	<u>core pours⁶ at 96" o.c.</u>	<u>core pours at 48" o.c.</u>	<u>all cores poured</u>	<u>core pours at 96" o.c.</u>	<u>core pours at 48" o.c.</u>
85	0.291	7.92	6.06	1.93	1.80	1.71
95	0.246	6.97	5.39	1.79	1.67	1.58
105	0.207	6.12	4.79	1.67	1.55	1.47
115	0.175	5.37	4.26	1.56	1.44	1.36
125	0.147	4.70	3.77	1.46	1.35	1.27
135	0.124	4.10	3.34	1.37	1.26	1.18

Table Notes:

1. R-Values exclude indoor and outdoor air film resistances of 0.68 and 0.17 respectively.
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 Aminoplast Injection Foam (R-4.6/in) or Spray polyurethane foamed-in-place (R5.9/in) insulations.
4. Concrete density units are pounds per cubic foot (lb/ft³).
5. Concrete resistivity is R-value per inch of thickness (h·ft²·°F/Btu·in).
6. Concrete density for core pours is 140 lb/ft³ with a resistivity of 0.114 h·ft²·°F/Btu·in.

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7. CMU dimensions are nominal. Subtract 3/8" mortar joint for actual. Each CMU has 3 each 1-1/8" web thicknesses and 2 each 1-1/4" face thickness.

An ACI and TMS Standard

Thermal Properties of Concrete and Masonry for Use in Determining Energy Code Compliance for Low- Rise Residential Buildings— Code Requirements and Commentary

Reported by Joint ACI-TMS Committee 122

**FOR
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Always advancing



Thermal Properties of Concrete and Masonry for Use in Determining Energy Code Compliance for Low-Rise Residential Buildings—Code Requirements and Commentary

An ACI and TMS Standard

Reported by Joint ACI-TMS Committee 122

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This Code prescribes minimum design and construction requirements for energy efficiency of building envelopes of new buildings and additions to buildings. It applies to buildings having concrete walls, roofs, or floors; masonry walls; and masonry veneer, including veneer attached to frame walls as part of the building envelope. It also provides minimum thermal properties for these assemblies for code compliance.

This Code is applicable to low-rise residential buildings that use either electricity from any generation source or fossil fuel. It can be used with applicable energy codes and standards such as the International Energy Conservation Code (IECC).

Keywords: energy efficiency; specific heat; thermal conductivity; thermal diffusivity; thermal resistance; thermal transmittance.

CONTENTS

PREFACE, p. 2

CHAPTER 1—GENERAL, p. 3

- 1.1—Scope, p. 3
- 1.2—General, p. 3
- 1.3—Purpose, p. 3
- 1.4—Applicability, p. 3
- 1.5—Interpretation, p. 4

CHAPTER 2—NOTATION AND DEFINITIONS, p. 5

- 2.1—Code notation, p. 5
- 2.2—Code definitions, p. 5

CHAPTER 3—REFERENCED STANDARDS, p. 7

- 3.1—American Concrete Institute (ACI), p. 7
- 3.2—American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), p. 7
- 3.3—ASTM International, p. 7
- 3.4—International Code Council (ICC), p. 8

CHAPTER 4—GENERAL REQUIREMENTS, p. 9

- 4.1—Material requirements, p. 9
- 4.2—Climate zones, p. 9
- 4.3—Building envelope compliance, p. 9

CHAPTER 5—PRESCRIPTIVE METHOD, p. 10

- 5.1—Concrete and masonry, p. 10
- 5.2—Other assemblies, p. 11

CHAPTER 6—BUILDING ENVELOPE TRADE-OFF METHOD, p. 13

- 6.1—Building envelope trade-off method, p. 13

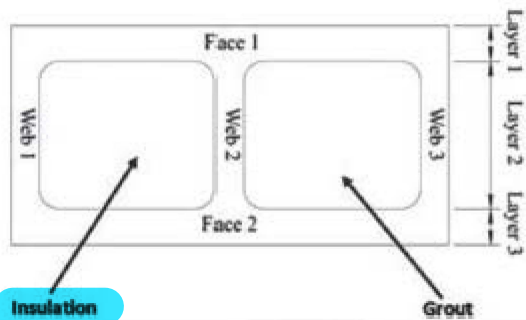
ACI-TMS CODE-122.2-24 was approved by the ACI Standards Board for publication January 2024 and published April 2024. Approved as a standard of the American Concrete Institute (January 2024) and The Masonry Society (January 2024) in accordance with each organization's standardization procedures.

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Table 8.1.1h—4 x 8 x 16 in. concrete masonry assembly with foam in-place insulation U-factors (Btu/h-ft²-°F) and heat capacity values (Btu/ft²-°F)



Normalized web area, in. ² /ft ²	Density CMU, lb/ft ³	Grout percentage																					
		0%		10%		20%		30%		40%		50%		60%		70%		80%		90%		100%	
		U	HC	U	HC	U	HC	U	HC	U	HC	U	HC	U	HC	U	HC	U	HC	U	HC	U	HC
6.5	85	0.138	2.6	0.193	3.1	0.247	3.5	0.301	4.0	0.355	4.4	0.410	5.1	0.464	5.5	0.518	5.9	0.572	6.4	0.626	6.8	0.681	7.3
	95	0.150	2.9	0.206	3.3	0.262	4.0	0.318	4.4	0.374	4.8	0.430	5.3	0.486	5.7	0.542	6.2	0.599	6.6	0.655	7.0	0.711	7.5
	105	0.164	3.3	0.222	3.7	0.279	4.2	0.337	4.6	0.394	5.1	0.452	5.5	0.509	5.9	0.567	6.4	0.624	6.8	0.682	7.3	0.739	7.7
	115	0.181	3.5	0.239	4.0	0.298	4.4	0.356	4.8	0.415	5.3	0.473	5.7	0.532	6.2	0.590	6.6	0.649	7.0	0.707	7.7	0.766	8.1
	125	0.200	3.7	0.259	4.2	0.318	4.6	0.377	5.1	0.436	5.5	0.495	5.9	0.554	6.6	0.613	7.0	0.672	7.5	0.731	7.9	0.790	8.4
	135	0.222	4.0	0.281	4.4	0.340	5.1	0.400	5.5	0.459	5.9	0.518	6.4	0.577	6.8	0.636	7.3	0.695	7.7	0.754	8.1	0.813	8.6
7.5	85	0.145	2.6	0.199	3.1	0.252	3.5	0.306	4.0	0.359	4.6	0.413	5.1	0.466	5.5	0.520	5.9	0.573	6.4	0.627	6.8	0.680	7.3
	95	0.158	3.1	0.214	3.5	0.269	4.0	0.324	4.4	0.379	4.8	0.434	5.3	0.489	5.7	0.545	6.2	0.600	6.6	0.655	7.0	0.710	7.5
	105	0.174	3.3	0.231	3.7	0.287	4.2	0.343	4.6	0.400	5.1	0.456	5.5	0.513	5.9	0.569	6.4	0.626	6.8	0.682	7.3	0.739	7.7
	115	0.193	3.5	0.250	4.0	0.307	4.4	0.364	4.8	0.422	5.3	0.479	5.7	0.536	6.2	0.594	6.8	0.651	7.3	0.708	7.7	0.765	8.1
	125	0.214	3.7	0.272	4.2	0.329	4.6	0.387	5.1	0.444	5.7	0.502	6.2	0.560	6.6	0.617	7.0	0.675	7.5	0.733	7.9	0.790	8.4
	135	0.239	4.2	0.296	4.6	0.354	5.1	0.411	5.5	0.469	5.9	0.526	6.4	0.583	6.8	0.641	7.3	0.698	7.7	0.755	8.1	0.813	8.6
8.5	85	0.152	2.6	0.205	3.1	0.257	3.7	0.310	4.2	0.363	4.6	0.416	5.1	0.469	5.5	0.521	5.9	0.574	6.4	0.627	6.8	0.680	7.3
	95	0.167	3.1	0.221	3.5	0.275	4.0	0.329	4.4	0.384	4.8	0.438	5.3	0.492	5.7	0.547	6.2	0.601	6.6	0.655	7.0	0.710	7.5
	105	0.184	3.3	0.239	3.7	0.295	4.2	0.350	4.6	0.406	5.1	0.461	5.5	0.516	5.9	0.572	6.4	0.627	6.8	0.683	7.5	0.738	7.9
	115	0.204	3.5	0.260	4.0	0.316	4.4	0.372	4.8	0.428	5.3	0.485	5.9	0.541	6.4	0.597	6.8	0.653	7.3	0.709	7.7	0.765	8.1
	125	0.228	3.7	0.284	4.4	0.340	4.8	0.396	5.3	0.453	5.7	0.509	6.2	0.565	6.6	0.621	7.0	0.677	7.5	0.734	7.9	0.790	8.4
	135	0.255	4.2	0.311	4.6	0.367	5.1	0.422	5.5	0.478	5.9	0.534	6.4	0.590	6.8	0.645	7.3	0.701	7.7	0.757	8.1	0.813	8.6



Table 8.1.1h, cont.—4 x 8 x 16 in. concrete masonry assembly with foam in-place insulation U-factors (Btu/h-ft²-°F) and heat capacity values (Btu/ft²-°F)

Normalized web area, in. ² /ft ²	Density CMU, lb/ft ³	Grout percentage																							
		0%		10%		20%		30%		40%		50%		60%		70%		80%		90%		100%			
		U	HC	U	HC	U	HC	U	HC	U	HC	U	HC	U	HC	U	HC	U	HC	U	HC	U	HC		
10	85	0.162	2.9	0.213	3.3	0.265	3.7	0.317	4.2	0.369	4.6	0.420	5.1	0.472	5.5	0.524	5.9	0.575	6.4	0.627	6.8	0.679	7.3		
	95	0.178	3.1	0.231	3.5	0.284	4.0	0.337	4.4	0.391	4.8	0.444	5.3	0.497	5.7	0.550	6.2	0.603	6.6	0.656	7.0	0.709	7.7		
	105	0.198	3.3	0.252	3.7	0.306	4.2	0.360	4.6	0.414	5.1	0.468	5.5	0.522	6.2	0.576	6.6	0.630	7.0	0.684	7.5	0.738	7.9		
	115	0.221	3.5	0.275	4.0	0.330	4.6	0.384	5.1	0.438	5.5	0.493	5.9	0.547	6.4	0.601	6.8	0.656	7.3	0.710	7.7	0.764	8.1		
	125	0.247	4.0	0.302	4.4	0.356	4.8	0.410	5.3	0.464	5.7	0.518	6.2	0.573	6.6	0.627	7.0	0.681	7.5	0.735	7.9	0.789	8.4		
	135	0.278	4.2	0.331	4.6	0.385	5.1	0.438	5.5	0.492	5.9	0.545	6.4	0.599	6.8	0.652	7.3	0.706	7.9	0.759	8.4	0.813	8.8		
12	85	0.174	2.9	0.225	3.3	0.275	3.7	0.325	4.2	0.376	4.6	0.426	5.1	0.476	5.5	0.527	5.9	0.577	6.4	0.628	6.8	0.678	7.3		
	95	0.193	3.1	0.245	3.5	0.296	4.0	0.348	4.4	0.399	4.8	0.451	5.3	0.502	5.7	0.554	6.4	0.605	6.8	0.656	7.3	0.708	7.7		
	105	0.216	3.3	0.268	3.7	0.320	4.2	0.372	4.8	0.424	5.3	0.476	5.7	0.528	6.2	0.580	6.6	0.632	7.0	0.685	7.5	0.737	7.9		
	115	0.242	3.7	0.294	4.2	0.346	4.6	0.398	5.1	0.451	5.5	0.503	5.9	0.555	6.4	0.607	6.8	0.659	7.3	0.712	7.7	0.764	8.1		
	125	0.272	4.0	0.324	4.4	0.375	4.8	0.427	5.3	0.479	5.7	0.530	6.2	0.582	6.6	0.634	7.0	0.686	7.7	0.737	8.1	0.789	8.6		
	135	0.306	4.2	0.357	4.6	0.407	5.1	0.458	5.5	0.508	6.2	0.559	6.6	0.610	7.0	0.660	7.5	0.711	7.9	0.762	8.4	0.812	8.8		
14	85	0.186	2.9	0.235	3.3	0.284	3.7	0.333	4.2	0.382	4.6	0.432	5.1	0.481	5.5	0.530	5.9	0.579	6.6	0.628	7.0	0.677	7.5		
	95	0.208	3.1	0.258	3.5	0.308	4.0	0.358	4.4	0.407	5.1	0.457	5.5	0.507	5.9	0.557	6.4	0.607	6.8	0.657	7.3	0.707	7.7		
	105	0.233	3.5	0.283	4.0	0.333	4.4	0.384	4.8	0.434	5.3	0.484	5.7	0.535	6.2	0.585	6.6	0.635	7.0	0.685	7.5	0.736	7.9		
	115	0.262	3.7	0.312	4.2	0.362	4.6	0.412	5.1	0.462	5.5	0.512	5.9	0.562	6.4	0.613	6.8	0.663	7.5	0.713	7.9	0.763	8.4		
	125	0.295	4.0	0.344	4.4	0.393	4.8	0.443	5.3	0.492	5.9	0.542	6.4	0.591	6.8	0.640	7.3	0.690	7.7	0.739	8.1	0.788	8.6		
	135	0.332	4.4	0.380	4.8	0.428	5.3	0.476	5.7	0.524	6.2	0.572	6.6	0.620	7.0	0.668	7.5	0.716	7.9	0.764	8.4	0.812	8.8		
16	85	0.198	2.9	0.246	3.3	0.293	3.7	0.341	4.2	0.389	4.6	0.437	5.3	0.485	5.7	0.532	6.2	0.580	6.6	0.628	7.0	0.676	7.5		
	95	0.222	3.3	0.270	3.7	0.318	4.2	0.367	4.6	0.415	5.1	0.464	5.5	0.512	5.9	0.561	6.4	0.609	6.8	0.657	7.3	0.706	7.7		
	105	0.249	3.5	0.298	4.0	0.346	4.4	0.395	4.8	0.443	5.3	0.492	5.7	0.540	6.2	0.589	6.6	0.638	7.0	0.686	7.7	0.735	8.1		
	115	0.280	3.7	0.329	4.2	0.377	4.6	0.425	5.1	0.473	5.7	0.521	6.2	0.570	6.6	0.618	7.0	0.666	7.5	0.714	7.9	0.762	8.4		
	125	0.316	4.2	0.363	4.6	0.410	5.1	0.458	5.5	0.505	5.9	0.552	6.4	0.599	6.8	0.646	7.3	0.694	7.7	0.741	8.1	0.788	8.6		
	135	0.356	4.4	0.402	4.8	0.447	5.3	0.493	5.7	0.538	6.2	0.584	6.6	0.630	7.0	0.675	7.5	0.721	8.1	0.766	8.6	0.812	9.0		

CODE

COMMENTARY

Table 8.1.1h, cont.—4 x 8 x 16 concrete masonry assembly with foam in-place insulation U-factors (Btu/h-ft²-°F) and heat capacity values (Btu/ft²-°F)

Normalized web area, in. ² /ft ²	Density CMU, lb/ft ³	Grout percentage																							
		0%		10%		20%		30%		40%		50%		60%		70%		80%		90%		100%			
		U	HC	U	HC	U	HC	U	HC	U	HC	U	HC	U	HC	U	HC	U	HC	U	HC	U	HC		
18	85	0.209	2.9	0.255	3.3	0.302	3.7	0.349	4.4	0.395	4.8	0.442	5.3	0.488	5.7	0.535	6.2	0.582	6.6	0.628	7.0	0.675	7.5		
	95	0.235	3.3	0.282	3.7	0.329	4.2	0.376	4.6	0.423	5.1	0.470	5.5	0.517	5.9	0.564	6.4	0.611	6.8	0.658	7.3	0.705	7.7		
	105	0.264	3.5	0.311	4.0	0.358	4.4	0.405	4.8	0.452	5.3	0.499	5.7	0.546	6.4	0.593	6.8	0.640	7.3	0.687	7.7	0.734	8.1		
	115	0.298	4.0	0.344	4.4	0.391	4.8	0.437	5.3	0.483	5.7	0.530	6.2	0.576	6.6	0.622	7.0	0.669	7.5	0.715	7.9	0.761	8.4		
	125	0.336	4.2	0.381	4.6	0.426	5.1	0.472	5.5	0.517	5.9	0.562	6.4	0.607	6.8	0.652	7.3	0.697	7.7	0.742	8.4	0.787	8.8		
	135	0.378	4.4	0.422	4.8	0.465	5.3	0.508	5.7	0.552	6.4	0.595	6.8	0.638	7.3	0.682	7.7	0.725	8.1	0.768	8.6	0.812	9.0		
20	85	0.220	3.1	0.265	3.5	0.310	4.0	0.356	4.4	0.401	4.8	0.447	5.3	0.492	5.7	0.537	6.2	0.583	6.6	0.628	7.0	0.674	7.5		
	95	0.247	3.3	0.293	3.7	0.339	4.2	0.384	4.6	0.430	5.1	0.476	5.5	0.521	5.9	0.567	6.4	0.613	7.0	0.658	7.5	0.704	7.9		
	105	0.279	3.5	0.324	4.0	0.370	4.6	0.415	5.1	0.461	5.5	0.506	5.9	0.551	6.4	0.597	6.8	0.642	7.3	0.688	7.7	0.733	8.1		
	115	0.315	4.0	0.359	4.4	0.404	4.8	0.449	5.3	0.493	5.7	0.538	6.2	0.582	6.6	0.627	7.0	0.672	7.5	0.716	7.9	0.761	8.6		
	125	0.355	4.2	0.398	4.6	0.441	5.1	0.485	5.5	0.528	5.9	0.571	6.6	0.614	7.0	0.657	7.5	0.700	7.9	0.744	8.4	0.787	8.8		
	135	0.399	4.6	0.440	5.1	0.482	5.5	0.523	5.9	0.564	6.4	0.605	6.8	0.647	7.3	0.688	7.7	0.729	8.1	0.770	8.6	0.811	9.0		
22	85	0.230	3.1	0.274	3.5	0.319	4.0	0.363	4.4	0.407	4.8	0.451	5.3	0.496	5.7	0.540	6.2	0.584	6.6	0.628	7.0	0.673	7.5		
	95	0.259	3.3	0.304	3.7	0.348	4.2	0.392	4.6	0.437	5.1	0.481	5.7	0.525	6.2	0.570	6.6	0.614	7.0	0.658	7.5	0.703	7.9		
	105	0.293	3.7	0.337	4.2	0.381	4.6	0.425	5.1	0.469	5.5	0.512	5.9	0.556	6.4	0.600	6.8	0.644	7.3	0.688	7.7	0.732	8.1		
	115	0.331	4.0	0.374	4.4	0.417	4.8	0.459	5.3	0.502	5.7	0.545	6.2	0.588	6.8	0.631	7.3	0.674	7.7	0.717	8.1	0.760	8.6		
	125	0.373	4.4	0.414	4.8	0.455	5.3	0.497	5.7	0.538	6.2	0.579	6.6	0.621	7.0	0.662	7.5	0.704	7.9	0.745	8.4	0.786	8.8		
	135	0.419	4.6	0.458	5.1	0.497	5.5	0.536	5.9	0.576	6.4	0.615	6.8	0.654	7.3	0.693	7.7	0.733	8.4	0.772	8.8	0.811	9.2		

1. Both face shell thickness: 3/4 in.
2. Mortar joint thickness: 3/8 in.
3. UngROUTED cells are filled with insulation.
4. R-value of insulation: 4.6.
5. Specific heat of concrete masonry unit: 0.22 Btu/lb-°F.
6. To calculate thermal resistance (R-value): $R = 1/U$ (hR-ft²-°F/Btu).
7. To determine grout percentage, refer to Table R.8.1.1a.
8. To determine normalized web area for typical concrete masonry unit, refer to Table R.8.1.1b.
9. Linear interpolation can be done to calculate U-factor and heat capacity values for intermediate grout percentage.
10. Mortar density: 125 lb/ft³.
11. Grout density: 140 lb/ft³.



Table 8.1.1i, cont.—6 x 8 x 16 in. concrete masonry assembly with foam insulation (Btu/ft²-°F)

Normalized web area, in. ² /ft ²	Density CMU, lb/ft ²										
		0%		10%		20%		30%		40%	
		<i>U</i>	HC	<i>U</i>	HC	<i>U</i>	HC	<i>U</i>	HC	<i>U</i>	HC
20	85	0.142	4.2	0.184	4.8	0.226	5.7	0.268	6.4	0.310	7.3
	95	0.162	4.6	0.205	5.3	0.247	6.2	0.290	6.8	0.333	7.7
	105	0.185	5.1	0.228	5.7	0.271	6.6	0.315	7.3	0.358	8.1
	115	0.211	5.5	0.255	6.2	0.298	7.0	0.341	7.7	0.384	8.6
	125	0.242	5.9	0.285	6.6	0.328	7.5	0.370	8.1	0.413	9.0
	135	0.277	6.4	0.319	7.0	0.360	7.9	0.402	8.6	0.444	9.5
22	85	0.150	4.2	0.191	5.1	0.232	5.7	0.273	6.6	0.314	7.3
	95	0.171	4.6	0.213	5.5	0.254	6.2	0.296	7.0	0.338	7.7
	105	0.195	5.1	0.237	5.9	0.279	6.6	0.322	7.5	0.364	8.1
	115	0.224	5.5	0.266	6.4	0.308	7.0	0.349	7.9	0.391	8.6
	125	0.256	5.9	0.297	6.8	0.339	7.5	0.380	8.4	0.421	9.0
	135	0.293	6.4	0.333	7.3	0.373	7.9	0.413	8.8	0.453	9.5

- Both face shell thickness: 1 in.
- Mortar joint thickness: 3/8 in.
- UngROUTED cells are filled with insulation.
- R*-value of insulation: 4.6.**
- Specific heat of concrete masonry unit: 0.22 Btu/lb·°F.
- To calculate thermal resistance (*R*-value): $R = 1/U$ (h-ft²-°F/Btu).
- To determine grout percentage, refer to Table R8.1.1a.
- To determine normalized web area for typical concrete masonry unit, refer to Table R8.1.1b.
- Linear interpolation can be done to calculate *U*-factor and heat capacity values for intermediate grout percentage.
- Mortar density: 125 lb/ft³.
- Grout density: 140 lb/ft³.

