STATE OF WASHINGTON

STATE BUILDING CODE COUNCIL

2024 Washington State Energy Code Development

Energy Code Proposal Short Form

For editorial **Coordination, Clarifications & Corrections** only,
without substantive energy or cost impacts

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Code being amended: ☒ Commercial Provisions ☐ Residential Provisions
(A MS Word version of the code is linked to the name)

Code Section # Appendix A- Default Heat Loss Coefficients

Brief Description:

The default envelope look up tables in App A are not fully consistent with the equivalent tables in ASHRAE 90.1-2022 App A. The origins of many of the WSEC specific tables are not clear, and it appears that is some cases the construction types are more relevant to type of construction governed by the residential energy code provisions, not commercial construction (note the residential energy code doesn't have its own standalone Appendix A equivalent, it references the commercial energy code appendix A, so presumably we have to leave the residential construction look-ups in there).

Proposal is to :

- Delete any table that is fully duplicative of ASHRAE 90.1 App A (so we don't have to update to stay consistent)
- Delete tables that are incomplete compared to ASHRAE 90.1
- Retain tables that provide unique and relevant information.

C402.1.2.1 already references ASHRAE 90.1 App A as an acceptable source for U-factors. 90.1-2022 is available for free online viewing (read only).

Proposed code change text: (Copy the existing text from the Integrated Draft, linked above, and then use underline for new text and ~~strikeout~~ for text to be deleted.)

See full edited copy of 2024 WSEC Appendix A provided as supplementary information to this proposal.

Table by Table commentary:

TABLE CA101.4 R-VALUE OF FIBERGLASS BATTS COMPRESSED WITHIN VARIOUS DEPTH CAVITIES- Retain as is, useful for custom U-Factor calculations, don't see equivalent table in 90.1.

TABLE CA101.5 DEFAULT R-VALUES FOR BUILDING MATERIAL- - Retain as is, useful for custom U-factor calculations, ASHRAE Fundamentals has a more complete table, but I don't believe that's as widely available (for free) as 90.1. Also note that 90.1 Table A9.4.4-1 has some similar information but isn't fully duplicative.

UNLABELED TABLE IN SECTION CA102.2- Delete, this table isn't clearly referenced, and only includes two insulation values (R-30 + R-38) for different pitched roofs? It's unclear how to apply this, though no equivalent is provided in 90.1.

TABLE CA102.1 -DEFAULT U-FACTORS FOR CEILINGS- Retain, as this is probably useful for WSEC-R projects. However, this table 90.1 App A Table A2.2.3, A2.4.2, A2.4.3 seem much more relevant for commercial projects, especially given the

limited number of Roof Deck options. Perhaps add note to table that commercial projects will likely reference ASHRAE App A?

TABLES CA102.2.4(1) - TABLE CA102.2.4(5) - STEEL TRUSS FRAMED CEILING UO with varying sheathing- Retain, appear to be unique, defined for 2' OC "trusses" of varying span vs 90.1 App A Table A2.5.2 is for 4' on center metal "joists" and doesn't include sheathing.

TABLE CA102.2.5 DEFAULT U-FACTORS FOR METAL BUILDING ROOFS- Delete, this is a copy of 90.1 Table A2.3.3, but is incomplete compared to 90.1 version. Delete reference text of CA102.2.5 and subsections.

TABLE CA102.2.6(1) - CA102.2.6(3) - ASSEMBLY U-FACTORS FOR ROOFS WITH TAPERED INSULATION ENTIRELY ABOVE DECK in varying sloping configurations- Retain, useful information originally from RDH study for sloping insulation that is not contained in 90.1 App A.

TABLES CA103.3.1(1) - TABLE CA103.3.1(8) – Wood stud walls of varying stud depth- This is the toughest call, but I think we need to retain. WSEC tables give more options for stud depth and std-adv framing (though adv framing is pretty rare in commercial construction). ASHRAE tables give more continuous insulation options, and contain option for insulated headers that similar to intermediate framing. ASHRAE only goes up to 6" studs though, where as WSEC contains 8" options that works prescriptively with our prescribed U-factor, so this is probably the deciding factor until the point that ASHRAE adds 2x8 to their table. Note that neither of the siding options in the WSEC tables is particularly appropriate for commercial projects (lapped wood vs. T1-11)

TABLE CA103.3.2 2 X 6: STRAP WALL- Retain, unique in WSEC, though unclear how often it is used.

TABLE CA103.3.3(1) - TABLE CA103.3.3(2) – Various Double Wood Stud Wall options- retain, unique to WSEC, unclear of often these are utilized.

TABLE CA103.3.5 STRESS SKIN PANEL- Retain, it is unique, but is also a very niche assembly.

TABLES CA103.3.6.1(1) - TABLE CA105.3.6.1(2) OVERALL ASSEMBLY U-FACTORS FOR METAL STUD WALLS with adjustments for exterior insulation attachment system- Retain because the Z-furring derate table is useful and not included in ASHRAE. Table A103.3.6.1(1) is duplicative of ASHRAE table A3.3.3.1, but contains less continuous insulation entries.

TABLE CA103.3.6.2 EFFECTIVE R-VALUES FOR METAL FRAMING AND CAVITY ONLY – Retain, useful for custom U-factor calculations, not found in ASHRAE.

TABLE CA103.3.6.3 DEFAULT METAL BUILDING WALL U-FACTORS- Delete, this table basically duplicates the information in ASHRAE A3.2.3 but has significantly less entries. Delete/change references in CA103.1, CA103.3.6, CA103.3.6.3

TABLE A103.3.7.1(1) DEFAULT U-FACTORS FOR CONCRETE AND MASONRY WALLS- Delete. These tables aren't even internally consistent with Table A103.3.7.1(2), unclear when you'd use one vs the other (maybe one is more applicable to Resi construction?). Only unique information is perlite and vermiculite core fills. Delete reference in A103.3.7.1.

TABLE CA103.3.7.1(2) DEFAULT U-FACTORS FOR CONCRETE AND MASONRY WALL- Delete, table is duplicative of ASHRAE A3.1-1. Delete references in A103.3.7.1.

TABLE CA103.3.7.2 DEFAULT U-FACTORS FOR PERIPHERAL EDGES OF INTERMEDIATE CONCRETE FLOORS- Retain, not explicitly in ASHRAE. Note this may cause confusion if thermal bridges of concrete floors are instead addressed with psi-factors per table C402.1.4…

TABLE CA104.1 DEFAULT WALL U-FACTORS AND SLAB F-FACTORS FOR BASEMENTS- Delete. This table is super confusing as you are supposed to ONLY use the BG wall U-factors *with* the accompanying below-grade-slab F-factors, but our calculations and forms are not set up for this. I'd be willing to bet only the U-factor column is used (incorrectly) in many instances. Since the performance varies by depth of the BG wall that also introduces more complexity. ASHRAE Table A4.2.1 Provides C-factors (U-factor w/o the exterior air films) that can be used in a more straight forward fashion.

TABLE CA105.1(1) DEFAULT U-FACTORS FOR WOOD-FRAMED FLOORS OVER VENTED CRAWLSPACE OR UNHEATED BASEMENT- Retain, presumably this is useful for residential calculations.

TABLE CA105.1(2) DEFAULT U-FACTORS FOR WOOD-FRAMED FLOORS OVER HEATED PLENUM CRAWLSPACES- Retain, very limited table, but maybe it's useful for resi?

TABLE CA105.1(3) DEFAULT U-FACTORS FOR EXPOSED FLOORS- Delete, far too many floor types are covered by this one small table (concrete / wood joist / metal joist). Additionally the joist assembly values appear to have significant divergence from the ASHRAE values for equivalent insulation levels. Utilize ASHRAE Tables A 5.2.3.1 – A 5.4.3.1.

TABLE A106.1 DEFAULT F-FACTORS FOR ON-GRADE SLABS- Delete- duplicate information as ASHRAE Table A6.3.1-1 + A6.3.1-2, but ASHRAE tables have more entries. Delete references in CA106.1.

TABLES CA107.1(1)- CA107.1(4)- DEFAULT U-FACTORS FOR DOORS- Retain, no equivalent in ASHRAE

Purpose of code change:

ASHRAE performs more active updates and research than SBCC. If we want to reference their tables, we should just reference them as opposed to copying and pasting versions into our appendix. Additionally, many of the WSEC App A tables are from unclear origins and are relatively incomplete in the options provided. We should only retain tables that supplement and compliment the tables found in 90.1 Appendix A.

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Instructions: For use with Coordination, Clarifications & Corrections **ONLY**. Send this form as an email attachment, along with any other documentation available, to: sbcc@des.wa.gov. For further information, call the State Building Code Council at 360-407-9277.

Appendix CA

DEFAULT HEAT LOSS COEFFICIENTS

SECTION CA101
GENERAL REQUIREMENTS

CA101.1 Scope. The following defaults shall apply to Chapter 4 of both the Residential and Commercial Provisions of the WSEC. This chapter includes tables of seasonal average heat loss coefficients for specified nominal insulation.

CA101.2 Description. These coefficients were developed primarily from data and procedures from the ASHRAE Fundamentals Handbook.

Coefficients not contained in this chapter may be computed using the procedures listed in this reference if the assumptions in the following sections are used, along with data from the sources referenced above.

CA101.3 Air films. Default R-values used for air films shall be as follows:

R-Value	Condition
0.17	All exterior surfaces
0.61	Interior horizontal surfaces, heat flow up
0.92	Interior horizontal surfaces, heat flow down
0.68	Interior vertical surfaces

CA101.4 Compression of Insulation: Insulation which is compressed shall be rated in accordance with Table CA101.4 or reduction in value may be calculated in accordance with the procedures in the ASHRAE Fundamentals Handbook.

CA101.5 Building materials. Default R-values used for building materials shall be as shown in Table CA101.5.

TABLE CA101.4
R-VALUE OF FIBERGLASS BATTS COMPRESSED WITHIN VARIOUS DEPTH CAVITIES

Insulation R-Values at Standard Thickness

Rated R-Value		**82**	**71**	**60**	**49**	**38**	**30**	**22**	**21**	**19**	**15**	**13**	**11**
Standard Thickness, Inches		**26.0**	**22.5**	**19.0**	**15.5**	**12”**	**9.5**	**6.5**	**5.5**	**6**	**3.5**	**3.5**	**3.5**
Nominal Lumber Sizes, Inches	Actual Depth of Cavity, Inches	Insulation R-Values When Installed in a Confined Cavity											
Truss	26.0	82	—	—	—	—	—	—	—	—	—	—	—
Truss	22.5	—	71	—	—	—	—	—	—	—	—	—	—
Truss	19.0	—	—	60	—	—	—	—	—	—	—	—	—
Truss	15.5	—	—	—	49	—	—	—	—	—	—	—	—
Truss	12.0	—	—	—	—	38	—	—	—	—	—	—	—
2x12	11.25	—	—	—	—	37	—	—	—	—	—	—	—
2x10	9.25	—	—	—	—	32	30	—	—	—	—	—	—
2x8	7.25	—	—	—	—	27	26	22	21	19	—	—	—
2x6	5.5	—	—	—	—	—	21	20	21	18	—	—	—
2x4	3.5	—	—	—	—	—	—	14	—	13	15	13	11
	2.5	—	—	—	—	—	—	—	—	—	—	9.8	—
	1.5	—	—	—	—	—	—	—	—	—	—	6.3	6.0

TABLE CA101.5
DEFAULT R-VALUES FOR BUILDING MATERIALS

Material	Nominal Size (in.)	Actual Size (in.)	R-Value (Heat Capacity[3])
Air cavity (unventilated), between metal studs at 16 inches on center[a]	-	-	0.79
Air cavity (unventilated), all other depths and framing materials[1]	-	-	0.91
Airfilm, exterior surfaces[2]	-	-	0.17
Airfilm, interior horizontal surfaces, heat flow up[2]	-	-	0.61
Airfilm, interior horizontal surfaces, heat flow down[2]	-	-	0.92
Airfilm, interior vertical surfaces[2]	-	-	0.68
Brick at R-0.12/in. (face brick, 75% solid/25% core area, 130 lbs/ft^3)	4	3.5	0.32 (5.9)
Carpet and rubber pad	-	-	1.23
Concrete at R-0.0625/in., heavyweight (144 lbs/ft^3)	- - - - - -	2 4 6 8 10 12	0.13 (HC-4.8) 0.25 (HC-9.6) 0.38 (HC-14.4) 0.50 (HC-19.2) 0.63 (HC-24.0) 0.75 (HC-28.8)
Concrete masonry units, solid grouted, lightweight (95 lbs/ft3)	6	-	0.80 (HC-11.4)
Concrete masonry units, solid grouted, normal weight (135 lbs/ft3)	6	-	0.51 (HC-13.2)
Concrete masonry units, partly grouted, lightweight (95 lbs/ft3)	6	-	1.33 (HC-6.7)
Concrete masonry units, partly grouted, normal weight (135 lbs/ft3)	6	-	0.82 (HC-9.0)
Concrete masonry units, solid grouted, lightweight (95 lbs/ft3)	8	-	1.05 (HC-15.5)
Concrete masonry units, solid grouted, normal weight (135 lbs/ft3)	8	-	0.69 (HC-17.9)
Concrete masonry units, partly grouted, lightweight (95 lbs/ft3)	8	-	1.44 (HC-9.6)
Concrete masonry units, partly grouted, normal weight (135 lbs/ft3)	8	-	0.98 (HC-12.0)
Concrete masonry units, solid grouted, lightweight (95 lbs/ft3)	10	-	1.30 (HC-19.7)
Concrete masonry units, solid grouted, normal weight (135 lbs/ft3)	10	-	0.87 (HC-22.6)
Concrete masonry units, partly grouted, lightweight (95 lbs/ft3)	10	-	1.61 (HC-11.9)
Concrete masonry units, partly grouted, normal weight (135 lbs/ft3)	10	-	1.11 (HC-14.8)
Concrete masonry units, solid grouted, lightweight (95 lbs/ft3)	12	-	1.53 (HC-23.9)
Concrete masonry units, solid grouted, normal weight (135 lbs/ft3)	12	-	1.06 (HC-27.2)
Concrete masonry units, partly grouted, lightweight (95 lbs/ft3)	12	-	1.75 (HC-14.2)
Concrete masonry units, partly grouted, normal weight (135 lbs/ft3)	12	-	1.23 (HC-17.5)
Flooring, wood subfloor	-	0.75	0.94
Gypsum board	- -	0.5 0.625	0.45 0.56
Metal deck	-	-	0
Roofing, built-up	-	0.375	0.33
Sheathing, vegetable fiber board, 0.78 in.	-	0.78	2.06
Soil at R-0.104/in.	-	12	1.25
Steel, mild		1	0.0031807
Stucco	-	0.75	0.08

a. There is no credit for cavities that are open to outside air.
b. Air films do not apply to air cavities within an assembly.
c. For heat capacity for concrete and concrete masonry materials with densities other than the values listed in Table CA101.5, see Tables A3.1B and A3.1C in ASHRAE/IESNA Standard 90.1.

SECTION CA102
CEILINGS

CA102.1 General. Table CA102.1 lists heat loss coefficients for the opaque portion of exterior ceilings below vented attics, vaulted ceilings and roof decks in units of Btu/h × ft^2 × °F of ceiling.

They are derived from procedures listed in the ASHRAE Fundamentals Handbook. Ceiling U-factors are modified for the buffering effect of the attic, assuming an indoor temperature of 65°F and an outdoor temperature of 45°F.

CA102.1.1 Metal framed ceilings. The nominal R-values in Table CA103.3.6.2: Effective R-Values for Metal Framing and Cavity Only may be used for purposes of calculating metal framed ceiling section U-factors in lieu of the ASHRAE zone calculation method as provided in Chapter 27 of the ASHRAE Fundamentals Handbook.

Metal building roofs have a different construction and are addressed in ~~Table CA102.2.5~~ ASHRAE 90.1 Normative Appendix A Table A2.3.3.

CA102.2 Component description. The four types of ceilings are characterized as follows:

CA102.2.1 Ceilings below a vented attic. Attic insulation is assumed to be blown-in, loose-fill fiberglass with a K-value of 2.6 h × ft^2 •× °F/Btu per inch. Full bag count for specified R-value is assumed in all cases. Ceiling dimensions for flat ceiling calculations are 45 by 30 feet, with a gabled roof having a 4/12 pitch. The attic is assumed to vent naturally at the rate of 3 air changes per hour through soffit and ridge vents. A void fraction of 0.002 is assumed for all attics with insulation baffles. Standard-framed, unbaffled attics assume a void fraction of 0.008.

Attic framing is either standard or advanced. Standard framing assumes tapering of insulation depth around the perimeter with resultant decrease in thermal resistance. An increased R-value is assumed in the center of the ceiling due to the effect of piling leftover insulation. Advanced framing assumes full and even depth of insulation extending to the outside edge of exterior walls. Advanced framing does not change from the default value. U-factors for flat ceilings below vented attics with standard framing may be modified with the following table:

~~Roof Pitch~~	~~U-factor for Standard Framing~~	
	~~R-30~~	~~R-38~~
~~4/12~~	~~0.036~~	~~0.031~~
~~5/12~~	~~0.035~~	~~0.030~~
~~6/12~~	~~0.034~~	~~0.029~~
~~7/12~~	~~0.034~~	~~0.029~~
~~8/12~~	~~0.034~~	~~0.028~~
~~9/12~~	~~0.034~~	~~0.028~~
~~10/12~~	~~0.033~~	~~0.028~~
~~11/12~~	~~0.033~~	~~0.027~~
~~12/12~~	~~0.033~~	~~0.027~~

Vented scissors truss attics assume a ceiling pitch of 2/12 with a roof pitch of either 4/12 or 5/12. Unbaffled standard framed scissors truss attics are assumed to have a void fraction of 0.016.

CA102.2.2 Vaulted ceilings. Insulation is assumed to be fiberglass batts installed in roof joist cavities. In the vented case, at least 1.5 inches between the top of the batts and the underside of the roof sheathing is left open for ventilation in each cavity. A ventilation rate of 3.0 air changes per hour is assumed. In the unvented or dense pack case, the ceiling cavity is assumed to be fully packed with insulation, leaving no space for ventilation.

CA102.2.3 Roof decks. Rigid insulation is applied to the top of roof decking with no space left for ventilation. Roofing materials are attached directly on top of the insulation. Framing members are often left exposed on the interior side.

CA102.2.4 Metal truss framing. Overall system tested values for the roof/ceiling U_o for metal framed truss assemblies from approved laboratories shall be used, when such data is acceptable to the building official.

Alternatively, the U_o for roof/ceiling assemblies using metal truss framing may be obtained from Tables CA102.2.4(1) through CA102.2.4(5).

TABLE CA102.1
DEFAULT U-FACTORS FOR CEILINGS

	Standard Frame	Advanced Frame
Ceilings Below Vented Attics		
Flat	**Baffled**	
R-19	0.049	0.047
R-30	0.036	0.032
R-38	0.031	0.026
R-49	0.027	0.020
R-60	0.025	0.017
Scissors Truss		
R-30 (4/12 roof pitch)	0.043	0.031
R-38 (4/12 roof pitch)	0.040	0.025
R-49 (4/12 roof pitch)	0.038	0.020
R-30 (5/12 roof pitch)	0.039	0.032
R-38 (5/12 roof pitch)	0.035	0.026
R-49 (5/12 roof pitch)	0.032	0.020
Vaulted Ceilings	**16" O.C.**	**24" O.C.**
Vented		
R-19 2x10 joist	0.049	0.048
R-30 2x12 joist	0.034	0.033
R-38 2x14 joist	0.027	0.027
Unvented		
R-30 2x10 joist	0.034	0.033
R-38 2x12 joist	0.029	0.027
R-21 + R-21 2x12 joist	0.026	0.025
Roof Deck	**4x Beams, 48" O.C.**	
R-12.5 2" Rigid insulation	0.064	
R-21.9 3.5" Rigid insulation	0.040	
R-37.5 6" Rigid insulation	0.025	
R-50 8" Rigid insulation	0.019	

TABLE CA102.2.4(1)
STEEL TRUSS[a] FRAMED CEILING U_o

Cavity R-value	Truss Span (ft)												
	12	**14**	**16**	**18**	**20**	**22**	**24**	**26**	**28**	**30**	**32**	**34**	**36**
19	0.1075	0.0991	0.0928	0.0878	0.0839	0.0807	0.0780	0.0757	0.0737	0.0720	0.0706	0.0693	0.0681
30	0.0907	0.0823	0.0760	0.0710	0.0671	0.0638	0.0612	0.0589	0.0569	0.0552	0.0538	0.0525	0.0513
38	0.0844	0.0759	0.0696	0.0647	0.0607	0.0575	0.0548	0.0525	0.0506	0.0489	0.0474	0.0461	0.0449
49	0.0789	0.0704	0.0641	0.0592	0.0552	0.0520	0.0493	0.0470	0.0451	0.0434	0.0419	0.0406	0.0395

TABLE CA102.2.4(2)
STEEL TRUSS[a] FRAMED CEILING U_o WITH R-3 SHEATHING

Cavity R-value	Truss Span (ft)												
	12	**14**	**16**	**18**	**20**	**22**	**24**	**26**	**28**	**30**	**32**	**34**	**36**
19	0.0809	0.0763	0.0728	0.0701	0.0679	0.0661	0.0647	0.0634	0.0623	0.0614	0.0606	0.0599	0.0592
30	0.0641	0.0595	0.0560	0.0533	0.0511	0.0493	0.0478	0.0466	0.0455	0.0446	0.0438	0.0431	0.0424
38	0.0577	0.0531	0.0496	0.0469	0.0447	0.0430	0.0415	0.0402	0.0392	0.0382	0.0374	0.0367	0.0361
49	0.0523	0.0476	0.0441	0.0414	0.0393	0.0375	0.0360	0.0348	0.0337	0.0328	0.0319	0.0312	0.0306

TABLE CA102.2.4(3)
STEEL TRUSS[a] FRAMED CEILING U_O WITH R-5 SHEATHING

Cavity R-value	Truss Span (ft)												
	12	14	16	18	20	22	24	26	28	30	32	34	36
19	0.0732	0.0697	0.0670	0.0649	0.0633	0.0619	0.0608	0.0598	0.0590	0.0583	0.0577	0.0571	0.0567
30	0.0564	0.0529	0.0502	0.0481	0.0465	0.0451	0.0440	0.0430	0.0422	0.0415	0.0409	0.0403	0.0399
38	0.0501	0.0465	0.0438	0.0418	0.0401	0.0388	0.0376	0.0367	0.0359	0.0351	0.0345	0.0340	0.0335
49	0.0446	0.0410	0.0384	0.0363	0.0346	0.0333	0.0322	0.0312	0.0304	0.0297	0.0291	0.0285	0.0280

TABLE CA102.2.4(4)
STEEL TRUSS[a] FRAMED CEILING U_O WITH R-10 SHEATHING

Cavity R-value	Truss Span (ft)												
	12	14	16	18	20	22	24	26	28	30	32	34	36
19	0.0626	0.0606	0.0590	0.0578	0.0569	0.0561	0.0555	0.0549	0.0545	0.0541	0.0537	0.0534	0.0531
30	0.0458	0.0437	0.0422	0.0410	0.0401	0.0393	0.0387	0.0381	0.0377	0.0373	0.0369	0.0366	0.0363
38	0.0394	0.0374	0.0359	0.0347	0.0337	0.0330	0.0323	0.0318	0.0313	0.0309	0.0305	0.0302	0.0299
49	0.0339	0.0319	0.0304	0.0292	0.0283	0.0275	0.0268	0.0263	0.0258	0.0254	0.0251	0.0247	0.0245

TABLE CA102.2.4(5)
STEEL TRUSS[a] FRAMED CEILING U_O WITH R-15 SHEATHING

Cavity R-value	Truss Span (ft)												
	12	14	16	18	20	22	24	26	28	30	32	34	36
19	0.0561	0.0550	0.0541	0.0535	0.0530	0.0526	0.0522	0.0519	0.0517	0.0515	0.0513	0.0511	0.0509
30	0.0393	0.0382	0.0373	0.0367	0.0362	0.0358	0.0354	0.0351	0.0349	0.0347	0.0345	0.0343	0.0341
38	0.0329	0.0318	0.0310	0.0303	0.0298	0.0294	0.0291	0.0288	0.0285	0.0283	0.0281	0.0279	0.0278
49	0.0274	0.0263	0.0255	0.0249	0.0244	0.0239	0.0236	0.0233	0.0230	0.0228	0.0226	0.0225	0.0223

Footnotes for Tables CA102.2.4(1) through CA102.2.4(5)

a. Assembly values based on 24 inch on center truss spacing; 11 Truss member connections penetrating insulation (4 at the eaves, 7 in the interior space); ½ inch drywall ceiling; all truss members are 2x4 "C" channels with a solid web.

b. Ceiling sheathing installed between bottom chord and drywall.

~~**CA102.2.5 Metal building roof.** Table CA102.2.5: The base assembly is a roof where the insulation is compressed when installed beneath metal roof panels attached to the steel structure (purlins). Additional assemblies include continuous insulation, uncompressed and uninterrupted by framing.~~

~~U-factors for metal building roofs shall be taken from Table CA102.2.5, provided the average purlin spacing is at least 52 inches and the R-value of the thermal spacer block is greater than or equal to the thermal spacer block R-value indicated in Table CA107.2.5 for the assembly. It is not acceptable to use the U-factors in Tables CA102.2.6(1), CA102.2.6(2) or CA102.2.6(3) if additional insulated sheathing is not continuous.~~

~~**CA102.2.5.1 Single layer.** The rated R-value of insulation is for insulation installed perpendicular to and draped over purlins and then compressed when the metal roof panels are attached. A minimum R-3 (R-0.5) thermal spacer block between the purlins and the metal roof panels is required, unless compliance is shown by the overall assembly U-factor.~~

~~**CA102.2.5.2 Double layer.** The first rated R-value of insulation is for insulation installed perpendicular to and draped over purlins. The second rated R-value of insulation is for unfaced insulation installed above the first layer and parallel to the purlins and then compressed when the metal roof panels are attached. A minimum R-3 (R-0.5) thermal spacer block between the purlins and the metal roof panels is required, unless compliance is shown by the overall assembly U-factor.~~

~~**CA102.2.5.3 Continuous insulation.** For continuous insulation (e.g., insulation boards or blankets), it is assumed that the insulation is installed below the purlins and is uninterrupted by framing members. Insulation exposed to the conditioned space or semi-heated space shall have a facing, and all insulation seams shall be continuously sealed to provide a continuous air barrier.~~

~~**CA102.2.5.4 Liner system (Ls).** A continuous membrane is installed below the purlins and uninterrupted by framing members. Uncompressed, unfaced insulation rests on top of the membrane between the purlins. For multilayer installations, the last rated R-value of insulation is for unfaced insulation draped over purlins and then compressed when the metal roof panels are attached. A minimum R-3 (R-0.5) thermal spacer block between the purlins and the metal roof panels is required, unless compliance is shown by the overall assembly U-factor.~~

~~**CA102.2.5.5 Filled cavity.** The first rated R-value of insulation is for faced insulation installed parallel to the purlins. The second rated R-value of insulation is for unfaced insulation installed above the first layer, parallel to and between the purlins and compressed when the metal roof panels are attached. The facer of the first layer of insulation is of sufficient width to be continuously sealed to the top flange of the purlins and to accommodate the full thickness of the second layer of insulation. A supporting structure retains the bottom of the first layer at the prescribed depth required for the full thickness of the second layer of insulation being installed above it. A minimum R-5 (R-0.9) thermal spacer block between the purlins and the metal roof panels is required, unless compliance is shown by the overall assembly U-factor.~~

CA102.2.6 Roofs with insulation entirely above deck (uninterrupted by framing). Table CA102.2.6(1) through CA102.2.6(3): The base assembly is continuous insulation over a structural deck. These tables indicate effective U-factors for tapered roof insulation, sloped from a maximum R-value (R_{max}) at the peak of the slope to a minimum R-value (R_{min}) at the low point of the slope. The rows of the tables represent the rated R-value of the insulation at the minimum conditions (except at roof drains) and the columns of the table represent the rated R-value of the insulation at the maximum conditions. The slope of the tapered insulation shall be no greater than 1/4 inch per foot.

TABLE CA102.2.5
DEFAULT U-FACTORS FOR METAL BUILDING ROOFS

Insulation System	Rated R-Value of Insulation	Overall U-Factor for Entire Base Roof Assembly	Overall U-Factor for Assembly of Base Roof Plus Continuous Insulation (uninterrupted by framing) Rated R-Value of Continuous Insulation					
			R-6.5	R-13	R-19.5	R-26	R-32.5	R-39
Standing Seam Roofs with Thermal Spacer Blocks[a,b]								
Single Layer	None	1.280	0.137	0.073	0.049	0.037	0.030	0.025
	R-10	0.115	0.066	0.046	0.035	0.029	0.024	0.021
	R-11	0.107	0.063	0.045	0.035	0.028	0.024	0.021
	R-13	0.101	0.061	0.044	0.034	0.028	0.024	0.020
	R-16	0.096	0.059	0.043	0.033	0.027	0.023	0.020
	R-19	0.082	0.053	0.040	0.031	0.026	0.022	0.020
Double Layer	R-10 + R-10	0.088	0.056	0.041	0.032	0.027	0.023	0.020
	R-10 + R-11	0.086	0.055	0.041	0.032	0.027	0.023	0.020
	R-11 + R-11	0.085	0.055	0.040	0.032	0.026	0.023	0.020
	R-10 + R-13	0.084	0.054	0.040	0.032	0.026	0.023	0.020
	R-11 + R-13	0.082	0.053	0.040	0.032	0.026	0.022	0.020
	R-13 + R-13	0.075	0.050	0.038	0.030	0.025	0.022	0.019
	R10 + R-19	0.074	0.050	0.038	0.030	0.025	0.022	0.019
	R-11 + R-19	0.072	0.049	0.037	0.030	0.025	0.022	0.019
	R-13 + R-19	0.068	0.047	0.036	0.029	0.025	0.021	0.019
	R-16 + R-19	0.065	0.046	0.035	0.029	0.024	0.021	0.018
	R-19 + R-19	0.060	0.043	0.034	0.028	0.023	0.020	0.018
Liner System	R-19 + R-11	0.035						
	R-25 + R-11	0.031						
	R-30 + R-11	0.029						
	R-25 + R-11 + R-11	0.026						
Filled Cavity with Thermal Spacer Blocks[c]								
	R-10 + R-19	0.057	0.042	0.033	0.027	0.023	0.020	0.018
Standing Seam Roofs without Thermal Spacer Blocks								
Liner System	R-19 + R-11	0.040						
Thru-Fastened Roofs without Thermal Spacer Blocks								
Single Layer	R-10	0.184						
	R-11	0.182						
	R-13	0.174						
	R-16	0.157						
	R-19	0.151						
Liner System	R-19 + R-11	0.044						

(Multiple R-values are listed in order from inside to outside)

a. A standing seam roof clip that provides a minimum 1.5 in. distance between the top of the purlins and the underside of the metal roof panels is required.

b. A minimum R-3 thermal spacer block is required.

c. A minimum R-5 thermal spacer block is required.

TABLE CA102.2.6(1)
ASSEMBLY U-FACTORS FOR ROOFS WITH TAPERED INSULATION ENTIRELY ABOVE DECK
SINGLE SLOPE RECTANGULAR TO ONE-SIDE[d,f,g,h,i]
(UNINTERRUPTED BY FRAMING)

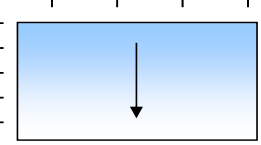
Rated R-value of Insulation at Minimum Condition (Rmin[3])	Rated R-Value of Insulation at Maximum Condition (Rmax[1])												
	1	5	10	15	20	25	30	35	40	45	50	55	60
1	0.562	0.306	0.213	0.168	0.140	0.121	0.107	0.097	0.088	0.081	0.075	0.070	0.066
5	-	0.173	0.125	0.101	0.086	0.076	0.068	0.062	0.057	0.053	0.049	0.046	0.044
10	-	-	0.093	0.076	0.066	0.058	0.053	0.048	0.045	0.042	0.039	0.037	0.035
15	-	-	-	0.063	0.055	0.049	0.045	0.041	0.038	0.036	0.034	0.032	0.030
20	-	-	-	-	0.048	0.043	0.039	0.036	0.034	0.032	0.030	0.028	0.027
25					-	0.039	0.035	0.033	0.031	0.029	0.027	0.026	0.025
30					-	-	0.032	0.030	0.028	0.026	0.025	0.024	0.023
35					-	-	-	0.028	0.026	0.025	0.023	0.022	0.021
40					-	-	-	-	0.025	0.023	0.022	0.021	0.020
45					-	-	-	-	-	0.022	0.021	0.020	0.019
50					-	-	-	-	-	-	0.020	0.019	0.018
55	-	-	-	-	-	-	-	-	-	-	-	0.018	0.017
60	-	-	-	-	-	-	-	-	-	-	-	-	0.016

TABLE CA102.2.6(2)
ASSEMBLY U-FACTORS FOR ROOFS WITH TAPERED INSULATION ENTIRELY ABOVE DECK
SLOPED TRIANGLE (ROOF WITH CENTER DRAIN)[e,f,g,h,i]
(UNINTERRUPTED BY FRAMING)

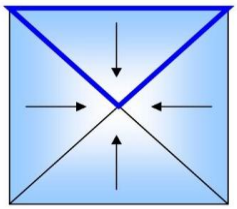
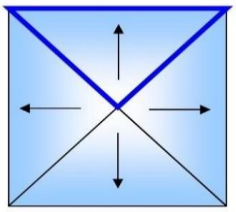
Rated R-value of Insulation at Minimum Condition (Rmin[3])	Rated R-Value of Insulation at Maximum Condition (Rmax[2])												
	1	5	10	15	20	25	30	35	40	45	50	55	60
1	0.562	0.242	0.146	0.106	0.083	0.068	0.058	0.051	0.045	0.040	0.036	0.033	0.031
5	-	0.173	0.112	0.084	0.068	0.057	0.049	0.044	0.039	0.035	0.032	0.030	0.028
10	-	-	0.093	0.071	0.059	0.050	0.044	0.039	0.035	0.032	0.029	0.027	0.025
15	-	-	-	0.063	0.053	0.045	0.040	0.035	0.032	0.029	0.027	0.025	0.023
20					0.048	0.042	0.037	0.033	0.030	0.027	0.025	0.024	0.022
25					-	0.039	0.034	0.031	0.028	0.026	0.024	0.022	0.021
30					-	-	0.032	0.029	0.027	0.025	0.023	0.021	0.020
35					-	-	-	0.028	0.026	0.024	0.022	0.021	0.019
40					-	-	-	-	0.025	0.023	0.021	0.020	0.019
45					-	-	-	-	-	0.022	0.020	0.019	0.018
50					-	-	-	-	-	-	0.020	0.018	0.017
55					-	-	-	-	-	-	-	0.018	0.017
60					-	-	-	-	-	-	-	-	0.016

TABLE CA102.2.6(3)
ASSEMBLY U-FACTORS FOR ROOFS WITH TAPERED INSULATION ENTIRELY ABOVE DECK
SLOPED TRIANGLE (ROOF WITH PERIMETER DRAINS)[e,f,g,h,i]
(UNINTERRUPTED BY FRAMING)

Rated R-value of Insulation at Minimum Condition (R_{min}[3])	Rated R-Value of Insulation at Maximum Condition (R_{max}[3])												
	1	5	10	15	20	25	30	35	40	45	50	55	60
1	0.562	0.363	0.273	0.224	0.193	0.170	0.153	0.139	0.128	0.119	0.111	0.105	0.099
5	-	0.173	0.138	0.118	0.104	0.094	0.086	0.079	0.074	0.070	0.066	0.062	0.059
10	-	-	0.093	0.081	0.073	0.067	0.062	0.058	0.054	0.051	0.049	0.046	0.044
15	-	-	-	0.063	0.058	0.053	0.050	0.047	0.044	0.042	0.040	0.038	0.037
20					0.048	0.045	0.042	0.040	0.037	0.036	0.034	0.033	0.032
25					-	0.039	0.037	0.035	0.033	0.031	0.030	0.029	0.028
30					-	-	0.032	0.031	0.029	0.028	0.027	0.026	0.025
35					-	-	-	0.028	0.027	0.026	0.025	0.024	0.023
40					-	-	-	-	0.025	0.024	0.023	0.022	0.021
45					-	-	-	-	-	0.022	0.021	0.020	0.020
50					-	-	-	-	-	-	0.020	0.019	0.019
55					-	-	-	-	-	-	-	0.018	0.017
60					-	-	-	-	-	-	-	-	0.016

Footnotes to Tables CA102.2.6.1, CA102.2.6.2, and CA102.2.6.3:

a. R_{max} and R_{min} are determined along the linearly tapered cross section for the respective minimum and maximum thickness values for the roof section being analyzed. For triangular roof sections

b. R_{max} refers to the insulation value along the long edge of the triangle and R_{min} to the insulation at the point of the triangle which assumes that the insulation slopes to the center.

c. R_{max} refers to the insulation value at the point of the triangle and R_{min} to the insulation along the long edge of the triangle which assumes that the insulation slopes to the perimeter.

d. Effective U-factor for rectangular tapered insulation is calculated as follows: $$R_{eff} = \frac{R_{max} - R_{min}}{\ln\left[\frac{R_{max}}{R_{min}}\right]}$$

e. Effective U-factor for triangular tapered insulation is calculated as follows:
$$R_{eff} = \left[\frac{2}{R_{max} - R_{min}}\left[1 + \frac{R_{min}}{R_{max} - R_{min}}\ln\left(\frac{R_{min}}{R_{max}}\right)\right]\right]^{-1}$$

f. Assembly U-factors include an exterior air film (R=0.17) and an interior air film, horizontal with heat flow up (R=0.61).

g. For effective U-factors of roof assemblies with different R_{max} or R_{min} values not listed in the tables interpolation is allowed.

h. This table shall only be applied to tapered insulation that is tapered along only one axis.

i. In areas of differing insulation slopes/configurations, individual U-values shall be calculated and an area weighted U-value calculation shall be used to determine the effective value of the roof.

SECTION CA103
ABOVE GRADE WALLS

CA103.1 General. The tables in this section list heat loss coefficients for the opaque portion of above-grade wood stud frame walls, metal stud frame walls and concrete masonry walls (Btu/h × ft^2 × °F). They are derived from procedures listed in the ASHRAE Fundamentals Handbook. For intermediate floor slabs which penetrate the insulated wall, use the concrete wall U-factors in ~~Table CA103.3.7.1(1)~~ Table CA103.3.7.2.

Insulation is assumed to uniformly fill the entire cavity and to be installed as per manufacturer's directions. All walls are assumed to be finished on the inside with 1/2 inch gypsum wallboard, and on the outside with either beveled wood siding over 1/2 inch plywood sheathing or with 5/8 inch T1-11 siding. Insulated sheathing (either interior or exterior) is assumed to cover the entire opaque wall surface, except where modified in accordance with footnote g to Table C402.1.3.

Metal building walls have a different construction and are addressed in ~~Table CA103.3.6.3~~ ASHRAE 90.1 Normative Appendix A Table A3.2.3.

CA103.2 Framing description. For wood stud frame walls, three framing types are considered and defined as follows:

CA103.2.1 Standard. Studs framed on 16 inch centers with double top plate and single bottom plate. Corners use three studs and each opening is framed using two studs. Headers consist of double 2x or single 4x material with an air space left between the header and the exterior sheathing. Interior partition wall/exterior wall intersections use two studs in the exterior wall.

Standard framing weighting factors:

Studs and plates	0.19
Insulated cavity	0.77
Headers	0.04

CA103.2.2 Intermediate. Studs framed on 16 inch centers with double top plate and single bottom plate. Corners use two studs or other means of fully insulating corners, and each opening is framed by two studs. Headers consist of double 2x material with R-10 insulation. Interior partition wall/exterior wall intersections are fully insulated in the exterior wall.

Intermediate framing weighting factors:

Studs and plates	0.18
Insulated cavity	0.78
Headers	0.04

CA103.2.3 Advanced. Studs framed on 24 inch centers with double top plate and single bottom plate. Corners use two studs or other means of fully insulating corners, and one stud is used to support each header. Headers consist of double 2x material with R-10 insulation. Interior partition wall/exterior wall intersections are fully insulated in the exterior wall.

Advanced framing weighting factors:

Studs and plates	0.13
Insulated cavity	0.83
Headers	0.04

CA103.3 Component description. Default coefficients for the following types of walls are listed: Single-stud walls, strap walls, double-stud walls, log walls, stress-skin panels, metal stud walls, and metal building walls.

CA103.3.1 Single-stud wall. Tables CA103.3.1(1) through CA103.3.1(8): Assumes either 2 x 4 or 2 x 6 studs framed on 16 or 24 inch centers. Headers are solid for 2 x 4 walls and double 2x for 2 x 6 walls, with either dead-air or rigid-board insulation in the remaining space.

Commented [NM1]: This is a reference correction unrelated to the rest of this proposal.

TABLE CA103.3.1(1)
2 x 4 Single Wood Stud: R-11 Batt

NOTE:
Nominal Batt R-value:
R-11 at 3.5 inch thickness

Installed Batt R-value:
R-11 in 3.5 inch cavity

Siding Material/Framing Type				
R-value of Foam Board	Lapped Wood		T1-11	
	STD	ADV	STD	ADV
0	0.088	0.084	0.094	0.090
1	0.080	0.077	0.085	0.082
2	0.074	0.071	0.078	0.075
3	0.069	0.066	0.072	0.070
4	0.064	0.062	0.067	0.065
5	0.060	0.058	0.063	0.061
6	0.056	0.055	0.059	0.057
7	0.053	0.052	0.055	0.054
8	0.051	0.049	0.052	0.051
9	0.048	0.047	0.050	0.049
10	0.046	0.045	0.047	0.046
11	0.044	0.043	0.045	0.044
12	0.042	0.041	0.043	0.042

TABLE CA103.3.1(2)
2 x 4 Single Wood Stud: R-13 Batt

NOTE:
Nominal Batt R-value:
R-13 at 3.63 inch thickness

Installed Batt R-value:
R-12.7 in 3.5 inch cavity

Siding Material/Framing Type				
R-value of Foam Board	Lapped Wood		T1-11	
	STD	ADV	STD	ADV
0	0.082	0.078	0.088	0.083
1	0.075	0.072	0.080	0.076
2	0.069	0.066	0.073	0.070
3	0.065	0.062	0.068	0.065
4	0.060	0.058	0.063	0.061
5	0.057	0.055	0.059	0.057
6	0.053	0.052	0.056	0.054
7	0.051	0.049	0.052	0.051
8	0.048	0.047	0.050	0.048
9	0.046	0.045	0.047	0.046
10	0.044	0.043	0.045	0.044
11	0.042	0.041	0.043	0.042
12	0.040	0.039	0.041	0.040

TABLE CA103.3.1(3)
2 x 4 Single Wood Stud: R-15 Batt

R-value of Foam Board	Siding Material/Framing Type			
	Lapped Wood		T1-11	
	STD	ADV	STD	ADV
0	0.076	0.071	0.081	0.075
1	0.069	0.065	0.073	0.069
2	0.064	0.061	0.068	0.069
3	0.060	0.057	0.063	0.059
4	0.056	0.053	0.059	0.056
5	0.053	0.051	0.055	0.052
6	0.050	0.048	0.052	0.050
7	0.047	0.046	0.049	0.047
8	0.045	0.044	0.047	0.045
9	0.043	0.042	0.044	0.043
10	0.041	0.040	0.042	0.041
11	0.039	0.038	0.041	0.039
12	0.038	0.037	0.039	0.038

NOTE:
Nominal Batt R-value:
R-15 at 3.5 inch thickness

Installed Batt R-value:
R-15 in 3.5 inch cavity

TABLE CA103.3.1(4)
2 x 6 Single Wood Stud: R-19 Batt

R-value of Foam Board	Siding Material/Framing Type					
	Lapped Wood			T1-11		
	STD	INT	ADV	STD	INT	ADV
0	0.062	0.058	0.055	0.065	0.061	0.058
1	0.058	0.055	0.052	0.060	0.057	0.055
2	0.054	0.052	0.050	0.056	0.054	0.051
3	0.051	0.049	0.047	0.053	0.051	0.049
4	0.048	0.046	0.045	0.050	0.048	0.046
5	0.046	0.044	0.043	0.048	0.046	0.044
6	0.044	0.042	0.041	0.045	0.044	0.042
7	0.042	0.040	0.039	0.043	0.042	0.040
8	0.040	0.039	0.038	0.041	0.040	0.039
9	0.038	0.037	0.035	0.039	0.038	0.037
10	0.037	0.036	0.035	0.038	0.037	0.036
11	0.036	0.035	0.034	0.036	0.035	0.035
12	0.034	0.033	0.033	0.035	0.034	0.033

NOTE:
Nominal Batt R-value:
R-19 at 6 inch thickness

Installed Batt R-value:
R-18 in 5.5 inch cavity

TABLE CA103.3.1(5)
2 x 6 Single Wood Stud: R-21 Batt

NOTE:
Nominal Batt R-value:
R-21 at 5.5 inch thickness

Installed Batt R-value:
R-21 in 5.5 inch cavity

Siding Material/Framing Type						
R-value of Foam Board	Lapped Wood			T1-11		
	STD	INT	ADV	STD	INT	ADV
0	0.057	0.054	0.051	0.060	0.056	0.053
1	0.054	0.051	0.048	0.056	0.053	0.050
2	0.050	0.048	0.045	0.052	0.050	0.047
3	0.048	0.045	0.043	0.049	0.047	0.045
4	0.045	0.043	0.041	0.047	0.045	0.043
5	0.043	0.041	0.040	0.044	0.042	0.041
6	0.041	0.039	0.038	0.042	0.041	0.039
7	0.039	0.038	0.036	0.040	0.039	0.037
8	0.038	0.036	0.035	0.039	0.037	0.036
9	0.036	0.035	0.034	0.037	0.036	0.035
10	0.035	0.034	0.033	0.036	0.035	0.033
11	0.033	0.033	0.032	0.034	0.033	0.032
12	0.032	0.031	0.031	0.033	0.032	0.031

TABLE CA103.3.1(6)
2 x 6 Single Wood Stud: R-22 Batt

NOTE:
Nominal Batt R-value:
R-22 at 6.75 inch thickness

Installed Batt R-value:
R-20 in 5.5 inch cavity

Siding Material/Framing Type						
R-value of Foam Board	Lapped Wood			T1-11		
	STD	INT	ADV	STD	INT	ADV
0	0.059	0.055	0.052	0.062	0.058	0.054
1	0.055	0.052	0.049	0.057	0.054	0.051
2	0.052	0.049	0.047	0.054	0.051	0.048
3	0.049	0.046	0.044	0.050	0.048	0.046
4	0.046	0.044	0.042	0.048	0.046	0.044
5	0.044	0.042	0.041	0.045	0.043	0.042
6	0.042	0.040	0.039	0.043	0.042	0.040
7	0.040	0.039	0.037	0.041	0.040	0.038
8	0.038	0.037	0.036	0.039	0.038	0.037
9	0.037	0.036	0.035	0.038	0.037	0.035
10	0.035	0.034	0.033	0.036	0.035	0.034
11	0.034	0.033	0.032	0.035	0.034	0.033
12	0.033	0.032	0.031	0.034	0.033	0.032

TABLE CA103.3.1(7)
2 x 6 Single Wood Stud: Two R-11 Batts

R-value of Foam Board	Siding Material/Framing Type					
	Lapped Wood			T1-11		
	STD	INT	ADV	STD	INT	ADV
0	0.060	0.057	0.054	0.063	0.059	0.056
1	0.056	0.053	0.051	0.059	0.056	0.053
2	0.053	0.050	0.048	0.055	0.052	0.050
3	0.050	0.048	0.046	0.052	0.049	0.047
4	0.047	0.045	0.044	0.049	0.047	0.045
5	0.045	0.043	0.042	0.046	0.045	0.043
6	0.043	0.041	0.040	0.044	0.043	0.041
7	0.041	0.040	0.038	0.042	0.041	0.039
8	0.039	0.038	0.037	0.040	0.039	0.038
9	0.038	0.037	0.036	0.039	0.038	0.036
10	0.036	0.035	0.034	0.037	0.036	0.035
11	0.035	0.034	0.033	0.036	0.035	0.034
12	0.034	0.033	0.032	0.034	0.034	0.033

NOTE:
Nominal Batt R-value:
R-22 at 7 inch thickness

Installed Batt R-value:
R-18.9 in 5.5 inch cavity

TABLE CA103.3.1(8)
2 x 8 Single Stud: R-25 Batt

R-value of Foam Board	Siding Material/Framing Type					
	Lapped Wood			T1-11		
	STD	INT	ADV	STD	INT	ADV
0	0.051	0.047	0.045	0.053	0.049	0.046
1	0.048	0.045	0.043	0.049	0.046	0.044
2	0.045	0.043	0.041	0.047	0.044	0.042
3	0.043	0.041	0.039	0.044	0.042	0.040
4	0.041	0.039	0.037	0.042	0.040	0.038
5	0.039	0.037	0.036	0.040	0.038	0.037
6	0.037	0.036	0.035	0.038	0.037	0.036
7	0.036	0.035	0.033	0.037	0.035	0.034
8	0.035	0.033	0.032	0.035	0.034	0.033
9	0.033	0.032	0.031	0.034	0.033	0.032
10	0.032	0.031	0.030	0.033	0.032	0.031
11	0.031	0.030	0.029	0.032	0.031	0.030
12	0.030	0.029	0.028	0.031	0.030	0.029

NOTE:
Nominal Batt R-value:
R-25 at 8 inch thickness

Installed Batt R-value:
R-23.6 in 7.25 inch cavity

CA103.3.2 Strap wall. Table CA103.3.2: Assumes 2 x 6 studs framed on 16 or 24 inch centers. 2 x 3 or 2 x 4 strapping is run horizontally along the interior surface of the wall to provide additional space for insulation.

CA103.3.3 Double stud wall. Tables CA103.3.3(1) and CA103.3.3(2): Assumes an exterior structural wall and a separate interior, nonstructural wall. Insulation is placed in both wall cavities and in the space between the two walls. Stud spacing is assumed to be on 24 inch centers for both walls.

CA103.3.4 Log wall. U-factors for log walls shall be determined using ICC 400 Table 305.3.1.1, U-Factor of Log Wall (U_W) by Log Thickness (W_L) and Specific Gravity.

CA103.3.5 Stress-skin panel. See Table CA103.3.5.

TABLE CA103.3.2
2 X 6: STRAP WALL

	Siding Material/Frame Type			
	Lapped Wood		T1-11	
	STD	ADV	STD	ADV
R-19 + R-11 Batts	0.036	0.035	0.038	0.036
R-19 + R-8 Batts	0.041	0.039	0.042	0.040

TABLE CA103.3.3(1)
2 X 6 + 2 X 4: DOUBLE WOOD STUD

Batt Configuration			Siding Material/Frame Type			
			Lapped Wood		T1-11	
Exterior	Middle	Interior	STD	ADV	STD	ADV
R-19	--	R-11	0.040	0.037	0.041	0.038
R-19	--	R-19	0.034	0.031	0.035	0.032
R-19	R-8	R-11	0.029	0.028	0.031	0.029
R-19	R-11	R-11	0.027	0.026	0.028	0.027
R-19	R-11	R-19	0.024	0.023	0.025	0.023
R-19	R-19	R-19	0.021	0.020	0.021	0.020

TABLE CA103.3.3(2)
2 X 4 + 2 X 4: DOUBLE WOOD STUD

Batt Configuration			Siding Material/Frame Type			
			Lapped Wood		T1-11	
Exterior	Middle	Interior	STD	ADV	STD	ADV
R-11	--	R-11	0.050	0.046	0.052	0.048
R-19	--	R-11	0.039	0.037	0.043	0.039
R-11	R-8	R-11	0.037	0.035	0.036	0.036
R-11	R-11	R-11	0.032	0.031	0.033	0.032
R-13	R-13	R-13	0.029	0.028	0.029	0.028
R-11	R-19	R-11	0.026	0.026	0.027	0.026

TABLE CA103.3.5
STRESS SKIN PANEL

Panel Thickness, Inches	U-factor
3 1/2	0.071
5 1/2	0.048
7 1/4	0.037
9 1/4	0.030
11 1/4	0.025

NOTE:
R-value of expanded polystyrene: R-3.85 per inch

Framing: 6%

Spline: 8%

No thermal bridging between interior and exterior splines

CA103.3.6 Metal stud walls. The nominal R-values in Tables CA103.3.6.1 through CA103.3.6.3 may be used for purposes of calculating metal stud wall section U-factors in lieu of the ASHRAE zone calculation method as provided in Chapter 27 of the ASHRAE Fundamentals Handbook.

CA103.3.6.1 Metal stud wall, overall assembly U-factors. Tables CA103.3.6.1(1) and CA103.6.1(2): Assumes metal studs spaced on 16 or 24 inch centers with insulation installed to fill wall cavities. Continuous rigid board insulation is applied without creating uninsulated voids in the wall assembly.

CA103.3.6.2 Metal stud wall, effective R-values for metal framing and cavity only. Table CA103.3.6.2: These values may be used for the metal-framing/cavity layers in walls with metal studs spaced on 16- or 24-inch centers with insulation installed to fill wall cavities in lieu of using the zone method provided in Chapter 25 of the ASHRAE Fundamentals Handbook.

~~**CA103.3.6.3 Metal building wall.** Table CA103.3.6.3: A wall whose structure consists of metal spanning panels supported by steel structural members (does not include spandrel glass or metal panels in curtain wall systems). The first nominal R-value is for insulation compressed between metal wall panels and the steel structure. For double-layer installations, the second rated R-value of insulation is for insulation installed from the inside, covering the girts. For continuous insulation (e.g., insulation boards) it is assumed that the insulation boards are installed on the inside of the girts and uninterrupted by the framing members. Insulation exposed to the conditioned space or semi-heated space shall have a facing, and all insulation seams shall be continuously sealed to provide a continuous air barrier.~~

CA103.3.7 Concrete and masonry walls.

CA103.3.7.1 Concrete masonry walls. ~~The nominal R-values in Tables CA103.3.7.1(1) and CA103.3.7.1(2)~~ The U-factors from ASHRAE 90.1 Normative Appendix A Table A3.1-1 may be used for purposes of calculating concrete masonry wall section U-factors in lieu of the ASHRAE isothermal planes calculation method as provided in Chapter 27 of the ASHRAE Fundamentals Handbook

CA103.3.7.2 Peripheral edges of intermediate concrete floors. See Table CA103.3.7.2.

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TABLE CA103.3.6.1(1)
OVERALL ASSEMBLY U-FACTORS
FOR METAL STUD WALLS WITH CONTINUOUS INSULATION

Metal Framing	R-Value of Continuous Foam Board Insulation	Cavity Insulation					
		R-0	R-11	R-13	R-15	R-19	R-21
16” o.c.	R-0 (none)	0.352	0.132	0.124	0.118	0.109	0.106
	R-1	0.260	0.117	0.111	0.106	0.099	0.096
	R-2	0.207	0.105	0.100	0.096	0.090	0.087
	R-3	0.171	0.095	0.091	0.087	0.082	0.080
	R-4	0.146	0.087	0.083	0.080	0.076	0.074
	R-5	0.128	0.080	0.077	0.074	0.071	0.069
	R-6	0.113	0.074	0.071	0.069	0.066	0.065
	R-7	0.102	0.069	0.066	0.065	0.062	0.061
	R-8	0.092	0.064	0.062	0.061	0.058	0.057
	R-9	0.084	0.060	0.059	0.057	0.055	0.054
	R-10	0.078	0.057	0.055	0.054	0.052	0.051
	R-11	0.072	0.054	0.052	0.051	0.050	0.049
	R-12	0.067	0.051	0.050	0.049	0.047	0.047
	R-13	0.063	0.049	0.048	0.047	0.045	0.045
	R-14	0.059	0.046	0.045	0.045	0.043	0.043
	R-15	0.056	0.044	0.043	0.043	0.041	0.041
	R-20	0.044	0.036	0.036	0.035	0.034	0.034
24” o.c	R-0 (none)	0.338	0.116	0.108	0.102	0.094	0.090
	R-1	0.253	0.104	0.098	0.092	0.086	0.083
	R-2	0.202	0.094	0.089	0.084	0.079	0.077
	R-3	0.168	0.086	0.082	0.078	0.073	0.071
	R-4	0.144	0.079	0.075	0.072	0.068	0.066
	R-5	0.126	0.073	0.070	0.067	0.064	0.062
	R-6	0.112	0.068	0.066	0.063	0.060	0.059
	R-7	0.100	0.064	0.062	0.059	0.057	0.055
	R-8	0.091	0.060	0.058	0.056	0.054	0.052
	R-9	0.084	0.057	0.055	0.053	0.051	0.050
	R-10	0.077	0.054	0.052	0.050	0.048	0.048
	R-11	0.072	0.051	0.049	0.048	0.046	0.045
	R-12	0.067	0.048	0.047	0.046	0.044	0.043
	R-13	0.063	0.046	0.045	0.044	0.042	0.042
	R-14	0.059	0.044	0.043	0.042	0.041	0.040
	R-15	0.056	0.042	0.041	0.040	0.039	0.038
	R-20	0.044	0.035	0.034	0.034	0.033	0.032

Continuous foam board insulation: Continuous insulation assumes no thermal bridging of insulation by framing or z-furring through applied foam board. Zone calculation method as provided in the ASHRAE Fundamentals Handbook must be used for thermally bridged foam board insulation. Values for attachment of insulation with z-furring are given in Table CA103.3.6.1(2).

TABLE CA105.3.6.1(2)
OVERALL ASSEMBLY U-FACTORS FOR METAL STUD WALLS
WITH INSULATION SUPPORTED BY Z-FURRING

Metal Framing	R-value of Foam Board Insulation	Z-furring Attachment	Cavity Insulation					
			R-0	R-11	R-13	R-15	R-19	R-21
16" o.c.	R-0 (none)	Horizontal	0.352	0.132	0.124	0.118	0.109	0.106
	R-5	Horizontal	0.155	0.089	0.086	0.083	0.078	0.077
	R-7.5	Horizontal	0.128	0.080	0.077	0.074	0.071	0.069
	R-10	Horizontal	0.110	0.072	0.070	0.068	0.065	0.064
	R-12.5	Horizontal	0.099	0.068	0.065	0.064	0.061	0.060
	R-15	Horizontal	0.091	0.064	0.062	0.060	0.058	0.057
	R-17.5	Horizontal	0.084	0.060	0.058	0.057	0.055	0.054
	R-20	Horizontal	0.078	0.057	0.056	0.054	0.052	0.052
	R-22.5	Horizontal	0.074	0.055	0.054	0.052	0.051	0.050
	R-25	Horizontal	0.071	0.053	0.052	0.051	0.049	0.048
	R-0 (none)	Vertical	0.352	0.132	0.124	0.118	0.109	0.106
	R-5	Vertical	0.165	0.093	0.089	0.086	0.081	0.079
	R-7.5	Vertical	0.142	0.085	0.081	0.079	0.075	0.073
	R-10	Vertical	0.126	0.079	0.076	0.074	0.070	0.069
	R-12.5	Vertical	0.115	0.074	0.072	0.070	0.066	0.065
	R-15	Vertical	0.107	0.071	0.069	0.067	0.064	0.063
	R-17.5	Vertical	0.100	0.068	0.065	0.064	0.061	0.060
	R-20	Vertical	0.094	0.065	0.063	0.061	0.059	0.058
	R-22.5	Vertical	0.090	0.063	0.061	0.060	0.057	0.056
	R-25	Vertical	0.086	0.061	0.059	0.058	0.056	0.055
24" o.c.	R-0 (none)	Horizontal	0.338	0.116	0.108	0.102	0.094	0.09
	R-5	Horizontal	0.152	0.082	0.078	0.074	0.070	0.068
	R-7.5	Horizontal	0.126	0.074	0.070	0.068	0.064	0.062
	R-10	Horizontal	0.109	0.067	0.065	0.062	0.059	0.058
	R-12.5	Horizontal	0.098	0.063	0.061	0.059	0.056	0.055
	R-15	Horizontal	0.090	0.060	0.058	0.056	0.053	0.052
	R-17.5	Horizontal	0.083	0.057	0.055	0.053	0.051	0.050
	R-20	Horizontal	0.078	0.054	0.052	0.051	0.049	0.048
	R-22.5	Horizontal	0.074	0.052	0.050	0.049	0.047	0.046
	R-25	Horizontal	0.070	0.050	0.049	0.047	0.046	0.045
	R-0 (none)	Vertical	0.338	0.116	0.108	0.102	0.094	0.09
	R-5	Vertical	0.162	0.084	0.080	0.077	0.072	0.070
	R-7.5	Vertical	0.140	0.078	0.074	0.071	0.067	0.065
	R-10	Vertical	0.124	0.073	0.070	0.067	0.063	0.062
	R-12.5	Vertical	0.113	0.069	0.066	0.064	0.061	0.059
	R-15	Vertical	0.106	0.066	0.063	0.061	0.058	0.057
	R-17.5	Vertical	0.098	0.063	0.061	0.059	0.056	0.055
	R-20	Vertical	0.093	0.061	0.059	0.057	0.054	0.053
	R-22.5	Vertical	0.089	0.059	0.057	0.055	0.053	0.051
	R-25	Vertical	0.085	0.057	0.055	0.054	0.051	0.050

Values may in Table CA105.3.6.1(2) may not interpolated between. The value of the foam board insulation must meet exceed the value listed in the table in order to use the value shown.

TABLE CA103.3.6.2
EFFECTIVE R-VALUES FOR METAL FRAMING AND CAVITY ONLY

	Cavity		Insulation		
	Nominal Depth, Inches	Actual Depth, Inches	Nominal R-Value	Effective R-Value	
				16" O.C.	24" O.C.
Air Cavity	Any	Any	R-0.91 (air)	0.79	0.91
Wall	4	3-1/2	R-11	5.5	6.6
	4	3-1/2	R-13	6.0	7.2
	4	3-1/2	R-15	6.4	7.8
	6	5-1/2	R-19	7.1	8.6
	6	5-1/2	R-21	7.4	9.0
	8	7-1/4	R-25	7.8	9.6
Roof		Insulation is uncompressed	R-11	5.5	6.1
			R-19	7.0	9.1
			R-30	9.3	11.4

~~**TABLE CA103.3.6.3**~~
~~**DEFAULT METAL BUILDING WALL U-FACTORS**~~

~~Insulation System~~	~~Rated R-Value of Insulation~~	~~Overall U-fFactor for Entire Base Wall Assembly~~	~~Overall U-Factor for Assembly of Base Wall Plus Continuous Insulation (Uninterrupted by Framing)~~					
			~~R-6.5~~	~~R-13~~	~~R-19.5~~	~~R-26~~	~~R-32.5~~	~~R-39~~
~~Single Layer of Mineral Fiber~~								
	~~None~~	~~1.180~~	~~0.136~~	~~0.072~~	~~0.049~~	~~0.037~~	~~0.030~~	~~0.025~~
	~~R-10~~	~~0.186~~	~~0.084~~	~~0.054~~	~~0.040~~	~~0.032~~	~~0.026~~	~~0.023~~
	~~R-11~~	~~0.185~~	~~0.084~~	~~0.054~~	~~0.040~~	~~0.032~~	~~0.026~~	~~0.023~~
	~~R-13~~	~~0.162~~	~~0.079~~	~~0.052~~	~~0.039~~	~~0.031~~	~~0.026~~	~~0.022~~
	~~R-16~~	~~0.155~~	~~0.077~~	~~0.051~~	~~0.039~~	~~0.031~~	~~0.026~~	~~0.022~~
	~~R-19~~	~~0.147~~	~~0.075~~	~~0.050~~	~~0.038~~	~~0.030~~	~~0.025~~	~~0.022~~

TABLE CA103.3.7.1(1)
DEFAULT U-FACTORS FOR CONCRETE AND MASONRY WALLS

8" Concrete Masonry

WALL DESCRIPTION	CORE TREATMENT			
	Partial Grout with Ungrouted Cores			Solid Grout
	Empty	Loose-fill insulated		
		Perlite	Vermiculite	
Exposed Block, Both Sides	0.40	0.23	0.24	0.43
R-5 Interior Insulation, Wood Furring	0.14	0.11	0.12	0.15
R-6 Interior Insulation, Wood Furring	0.14	0.11	0.11	0.14
R-10.5 Interior Insulation, Wood Furring	0.11	0.09	0.09	0.11
R-8 Interior Insulation, Metal Clips	0.11	0.09	0.09	0.11
R-6 Exterior Insulation	0.12	0.10	0.10	0.12
R-10 Exterior Insulation	0.08	0.07	0.07	0.08
R-9.5 Rigid Polystyrene Integral Insulation, Two Webbed Block	0.11	0.09	0.09	0.12

12" Concrete Masonry

WALL DESCRIPTION	CORE TREATMENT			
	Partial Grout with Ungrouted Cores			Solid Grout
	Empty	Loose-fill insulated		
		Perlite	Vermiculite	
Exposed Block, Both Sides	0.35	0.17	0.18	0.33
R-5 Interior Insulation, Wood Furring	0.14	0.10	0.10	0.13
R-6 Interior Insulation, Wood Furring	0.13	0.09	0.10	0.13
R-10.5 Interior Insulation, Wood Furring	0.11	0.08	0.08	0.10
R-8 Interior Insulation, Metal Clips	0.10	0.08	0.08	0.09
R-6 Exterior Insulation	0.11	0.09	0.09	0.11
R-10 Exterior Insulation	0.08	0.06	0.06	0.08
R-9.5 Rigid Polystyrene Integral Insulation, Two Webbed Block	0.11	0.08	0.09	0.12

8" Clay Brick

WALL DESCRIPTION	CORE TREATMENT			
	Partial Grout with Ungrouted Cores			Solid Grout
	Empty	Loose-fill insulated		
		Perlite	Vermiculite	
Exposed Block, Both Sides	0.50	0.31	0.32	0.56
R-5 Interior Insulation, Wood Furring	0.15	0.13	0.13	0.16
R-6 Interior Insulation, Wood Furring	0.15	0.12	0.12	0.15
R-10.5 Interior Insulation, Wood Furring	0.12	0.10	0.10	0.12
R-8 Interior Insulation, Metal Clips	0.11	0.10	0.10	0.11
R-6 Exterior Insulation	0.12	0.11	0.11	0.13
R-10 Exterior Insulation	0.08	0.08	0.08	0.09

TABLE CA103.3.7.1(1) – continued
DEFAULT U-FACTORS FOR CONCRETE AND MASONRY WALLS

6" Concrete Poured or Precast

WALL DESCRIPTION	CORE TREATMENT			
	Partial Grout with Ungrouted Cores			Solid Grout
	Empty	Loose-fill insulated		
		Perlite	Vermiculite	
Exposed Concrete, Both Sides	NA	NA	NA	0.61
R-5 Interior Insulation, Wood Furring	NA	NA	NA	0.16
R-6 Interior Insulation, Wood Furring	NA	NA	NA	0.15
R-10.5 Interior Insulation, Wood Furring	NA	NA	NA	0.12
R-8 Interior Insulation, Metal Clips	NA	NA	NA	0.12
R-6 Exterior Insulation	NA	NA	NA	0.13
R-10 Exterior Insulation	NA	NA	NA	0.09

1. Grouted cores at 40" x 48" on center vertically and horizontally in partial grouted walls.
2. Interior insulation values include 1/2" gypsum board on the inner surface.
3. Furring and stud spacing is 16" on center. Insulation is assumed to fill furring space and is not compressed.
4. Intermediate values may be interpolated using this table. Values not contained in this table may be computed using the procedures listed in the ASHRAE Fundamentals Handbook.
5. Concrete Masonry Unit (CMU) assembly U-values are based on local test data for Washington state CMU block material using the ASTM C-236-87 steady state thermal conductance test. Tests included an 8"x8"x16" CMU with all cells filled with vermiculite (1995) and 8"x8"x16" CMU with all cells filled with polymaster foam in place insulation (1996). Refer to ASHRAE Standard 90.1 for additional nationally recognized data on the thermal performance of CMU block walls.

TABLE CA103.3.7.1(2)
DEFAULT U-FACTORS FOR CONCRETE AND MASONRY WALLS[a,b,c,d]

Framing Type and Depth	Rated R-Value of Insulation Alone	Assembly U-Factors for Solid Concrete Walls	Assembly U-Factors for Concrete Block Walls: Solid Grouted	Assembly U-Factors for Concrete Block Walls: Partially Grouted (cores uninsulated except where specified)
Base Wall only				
No Framing	R-0	U-0.740	U-0.580	U-0.480
	Ungrouted Cores Filled with Loose-Fill Insulation	N.A.	N.A.	U-0.350
Continuous Wood Framing				
0.75 in.	R-3.0	U-0.247	U-0.226	U-0.210
1.5 in.	R-6.0	U-0.160	U-0.151	U-0.143
2.0 in.	R-10.0	U-0.116	U-0.111	U-0.107
3.5 in.	R-11.0	U-0.094	U-0.091	U-0.088
3.5 in.	R-13.0	U-0.085	U-0.083	U-0.080
3.5 in.	R-15.0	U-0.079	U-0.077	U-0.075
5.5 in.	R-19.0	U-0.060	U-0.059	U-0.058
5.5 in.	R-21.0	U-0.057	U-0.055	U-0.054

TABLE CA103.3.7.1(2) (Continued)
DEFAULT U-FACTORS FOR CONCRETE AND MASONRY WALLS

Framing Type and Depth	Rated R-Value of Insulation Alone	Assembly U-Factors for Solid Concrete Walls	Assembly U-Factors for Concrete Block Walls: Solid Grouted	Assembly U-Factors for Concrete Block Walls: Partially Grouted (cores uninsulated except where specified)
Continuous Metal Framing at 24 in. on center horizontally				
1.0 in.	R-0.0	U-0.414	U-0.359	U-0.318
1.0 in.	R-3.8	U-0.325	U-0.290	U-0.263
1.0 in.	R-5.0	U-0.314	U-0.281	U-0.255
1.0 in.	R-6.5	U-0.305	U-0.274	U-0.249
1.5 in.	R-11.0	U-0.267	U-0.243	U-0.223
2.0 in.	R-7.6	U-0.230	U-0.212	U-0.197
2.0 in.	R-10.0	U-0.219	U-0.202	U-0.188
2.0 in.	R-13.0	U-0.210	U-0.195	U-0.182
3.0 in.	R-11.4	U-0.178	U-0.167	U-0.157
3.0 in.	R-15.0	U-0.168	U-0.158	U-0.149
3.0 in.	R-19.0	U-0.161	U-0.152	U-0.144
3.5 in.	R-11.0	U-0.168	U-0.158	U-0.149
3.5 in.	R-13.0	U-0.161	U-0.152	U-0.144
3.5 in.	R-15.0	U-0.155	U-0.147	U-0.140
4.5 in.	R-17.1	U-0.133	U-0.126	U-0.121
4.5 in.	R-22.5	U-0.124	U-0.119	U-0.114
4.5 in.	R-25.2	U-0.122	U-0.116	U-0.112
5.0 in.	R-19.0	U-0.122	U-0.117	U-0.112
5.0 in.	R-25.0	U-0.115	U-0.110	U-0.106
5.0 in.	R-28.0	U-0.112	U-0.107	U-0.103
5.0 in.	R-32.0	U-0.109	U-0.105	U-0.101
5.5 in.	R-19.0	U-0.118	U-0.113	U-0.109
5.5 in.	R-20.9	U-0.114	U-0.109	U-0.105
5.5 in.	R-21.0	U-0.113	U-0.109	U-0.105
5.5 in.	R-27.5	U-0.106	U-0.102	U-0.099
5.5 in.	R-30.8	U-0.104	U-0.100	U-0.096
6.0 in.	R-22.8	U-0.106	U-0.102	U-0.098
6.0 in.	R-30.0	U-0.099	U-0.095	U-0.092
6.0 in.	R-33.6	U-0.096	U-0.093	U-0.090
6.5 in.	R-24.7	U-0.099	U-0.096	U-0.092
7.0 in.	R-26.6	U-0.093	U-0.090	U-0.087
7.5 in.	R-28.5	U-0.088	U-0.085	U-0.083
8.0 in.	R-30.4	U-0.083	U-0.081	U-0.079

TABLE CA103.3.7.1(4) – continued
DEFAULT U-FACTORS FOR CONCRETE AND MASONRY WALLS

Framing Type and Depth	Rated R-Value of Insulation Alone	Assembly U-Factors for Solid Concrete Walls	Assembly U-Factors for Concrete Block Walls: Solid Grouted	Assembly U-Factors for Concrete Block Walls: Partially Grouted (cores uninsulated except where specified)
1 in Metal Clips at 24 in. on center horizontally and 16 in. vertically (also, where allowed by Section C402.1.3, for assemblies with a ratio of metal penetration area/ mass wall area of <0.0004 or <0.04% of the mass wall area)[5]				
1.0 in.	R-3.8	U-0.210	U-0.195	U-0.182
1.0 in.	R-5.0	U-0.184	U-0.172	U-0.162
1.0 in.	R-5.6	U-0.174	U-0.163	U-0.154
1.5 in.	R-5.7	U-0.160	U-0.151	U-0.143
1.5 in.	R-7.5	U-0.138	U-0.131	U-0.125
1.5 in.	R-8.4	U-0.129	U-0.123	U-0.118
2.0 in.	R-7.6	U-0.129	U-0.123	U-0.118
2.0 in.	R-10.0	U-0.110	U-0.106	U-0.102
2.0 in.	R-11.2	U-0.103	U-0.099	U-0.096
2.5 in.	R-9.5	U-0.109	U-0.104	U-0.101
2.5 in.	R-12.5	U-0.092	U-0.089	U-0.086
2.5 in.	R-14.0	U-0.086	U-0.083	U-0.080
3.0 in.	R-11.4	U-0.094	U-0.090	U-0.088
3.0 in.	R-15.0	U-0.078	U-0.076	U-0.074
3.0 in.	R-16.8	U-0.073	U-0.071	U-0.069
3.5 in.	R-13.3	U-0.082	U-0.080	U-0.077
3.5 in.	R-17.5	U-0.069	U-0.067	U-0.065
3.5 in.	R-19.6	U-0.064	U-0.062	U-0.061
4.0 in.	R-15.2	U-0.073	U-0.071	U-0.070
4.0 in.	R-20.0	U-0.061	U-0.060	U-0.058
4.0 in.	R-22.4	U-0.057	U-0.056	U-0.054
5.0 in.	R-28.0	U-0.046	U-0.046	U-0.045
6.0 in.	R-33.6	U-0.039	U-0.039	U-0.038
7.0 in.	R-39.2	U-0.034	U-0.034	U-0.033
8.0 in.	R-44.8	U-0.030	U-0.030	U-0.029
9.0 in.	R-50.4	U-0.027	U-0.027	U-0.026
10.0 in.	R-56.0	U-0.024	U-0.024	U-0.024
11.0 in.	R-61.6	U-0.022	U-0.022	U-0.022
Continuous Insulation Uninterrupted by Framing				
No Framing	R-1.0	U-0.425	U-0.367	U-0.324
	R-2.0	U-0.298	U-0.269	U-0.245
	R-3.0	U-0.230	U-0.212	U-0.197
	R-4.0	U-0.187	U-0.175	U-0.164
	R-5.0	U-0.157	U-0.149	U-0.141

TABLE CA103.3.7.1(2) – continued
DEFAULT U-FACTORS FOR CONCRETE AND MASONRY WALLS

Framing Type and Depth	Rated R-Value of Insulation Alone	Assembly U-Factors for Solid Concrete Walls	Assembly U-Factors for Concrete Block Walls: Solid Grouted	Assembly U-Factors for Concrete Block Walls: Partially Grouted (cores uninsulated except where specified)
No Framing	R-6.0	U-0.136	U-0.129	U-0.124
	R-7.0	U-0.120	U-0.115	U-0.110
	R-8.0	U-0.107	U-0.103	U-0.099
	R-9.0	U-0.097	U-0.093	U-0.090
	R-10.0	U-0.088	U-0.085	U-0.083
No Framing	R-11.0	U-0.081	U-0.079	U-0.076
	R-12.0	U-0.075	U-0.073	U-0.071
	R-13.0	U-0.070	U-0.068	U-0.066
	R-14.0	U-0.065	U-0.064	U-0.062
	R-15.0	U-0.061	U-0.060	U-0.059
No Framing	R-16.0	U-0.058	U-0.056	U-0.055
	R-17.0	U-0.054	U-0.053	U-0.052
	R-18.0	U-0.052	U-0.051	U-0.050
	R-19.0	U-0.049	U-0.048	U-0.047
	R-20.0	U-0.047	U-0.046	U-0.045
No Framing	R-21.0	U-0.045	U-0.044	U-0.043
	R-22.0	U-0.043	U-0.042	U-0.042
	R-3.0	U-0.041	U-0.040	U-0.040
	R-24.0	U-0.039	U-0.039	U-0.038
	R-25.0	U-0.038	U-0.037	U-0.037
No Framing	R-30.0	U-0.032	U-0.032	U-0.031
	R-35.0	U-0.028	U-0.027	U-0.027
	R-40.0	U-0.024	U-0.024	U-0.024
	R-45.0	U-0.022	U-0.021	U-0.021
	R-50.0	U-0.019	U-0.019	U-0.019
	R-55.0	U-0.018	U-0.018	U-0.018
	R-60.0	U-0.016	U-0.016	U-0.016
Brick cavity wall with continuous insulation				
No Framing	R-0.0	U-0.337	U-0.299	U-0.270
No Framing	R-3.8	U-0.148	U-0.140	U-0.133
No Framing	R-5.0	U-0.125	U-0.120	U-0.115
No Framing	R-6.5	U-0.106	U-0.102	U-0.098
No Framing	R-7.6	U-0.095	U-0.091	U-0.088
No Framing	R-10.0	U-0.077	U-0.075	U-0.073
No Framing	R-10.5	U-0.079	U-0.077	U-0.075
No Framing	R-11.4	U-0.070	U-0.068	U-0.066
No Framing	R-15.0	U-0.056	U-0.055	U-0.053
No Framing	R-16.5	U-0.054	U-0.053	U-0.052
No Framing	R-19.0	U-0.046	U-0.045	U-0.044
No Framing	R-22.5	U-0.041	U-0.040	U-0.039
No Framing	R-28.5	U-0.033	U-0.032	U-0.032

TABLE CA103.3.7.1(2) – continued
DEFAULT U-FACTORS FOR CONCRETE AND MASONRY WALLS

Framing Type and Depth	Rated R-Value of Insulation Alone	Assembly U-Factors for Solid Concrete Walls	Assembly U-Factors for Concrete Block Walls: Solid Grouted	Assembly U-Factors for Concrete Block Walls: Partially Grouted (cores uninsulated except where specified)
Continuous Insulation Uninterrupted by Framing with Stucco and Continuous Metal Framing at 24 in. on center horizontally				
1.0 in.	R-0.0 + R-19 c.i.	U-0.047	U-0.046	U-0.045
1.0 in.	R-3.8 + R-19 c.i.	U-0.045	U-0.044	U-0.044
1.0 in.	R-5.0 + R-19 c.i.	U-0.045	U-0.044	U-0.043
1.0 in.	R-6.5 + R-19 c.i.	U-0.045	U-0.044	U-0.043
1.5 in.	R-11.0 + R-19 c.i.	U-0.044	U-0.043	U-0.043
2.0 in.	R-7.6 + R-19 c.i.	U-0.043	U-0.042	U-0.041
2.0 in.	R-10.0 + R-19 c.i.	U-0.042	U-0.041	U-0.041
2.0 in.	R-13.0 + R-19 c.i.	U-0.042	U-0.041	U-0.041
3.0 in.	R-11.4 + R-19 c.i.	U-0.041	U-0.040	U-0.039
3.0 in.	R-15.0 + R-19 c.i.	U-0.040	U-0.039	U-0.039
3.0 in.	R-19.0 + R-19 c.i.	U-0.040	U-0.039	U-0.038
3.5 in.	R-11.0 + R-19 c.i.	U-0.040	U-0.039	U-0.039
3.5 in.	R-13.0 + R-19 c.i.	U-0.040	U-0.039	U-0.038
5.0 in.	R-19.0 + R-19 c.i.	U-0.037	U-0.036	U-0.036
5.0 in.	R-25.0 + R-19 c.i.	U-0.036	U-0.035	U-0.035
5.0 in.	R-32.5 + R-19 c.i.	U-0.035	U-0.035	U-0.034
5.5 in.	R-19.0 + R-19 c.i.	U-0.036	U-0.036	U-0.035
5.5 in.	R-21.0 + R-19 c.i.	U-0.035	U-0.035	U-0.035

Notes for Default Table CA103.3.7.1(12):

a. It is acceptable to use the U-factors in Table CA103.3.7.1(2) for all concrete and masonry walls, provided that the grouting is equal to or less than that specified.
   - For ungrouted walls, use the partially grouted column.
   - For metal studs and z-furring, use the continuous-metal-framing category.
   - For discontinuous metal clips 1 inch square or smaller, use the metal-clip category.
   - For insulation that is attached without any framing members (e.g. glued), use the continuous-insulation uninterrupted-by-framing category. Continuous insulation may be installed on the interior or exterior of masonry walls, or between stand-alone walls in multilayer masonry walls, or on the interior or exterior of the concrete.

b. For Table CA103.3.7.1(2), the U-factor includes R-0.17 for exterior air film and R-0.68 for interior air film-vertical surfaces. For insulated walls, the U-factor also includes R-0.45 for 0.5 in. gypsum board. U-factors are provided for the following configurations:
   1. Concrete wall: 8-in. normal weight concrete wall with a density of 145 lb/ft^3.
   2. Solid grouted concrete block wall: 8-in. medium weight ASTM C90 concrete block with a density of 115 lb/ft^3 and solid grouted cores.
   3. Partially grouted concrete block wall: 8-in. medium weight ASTM C90 concrete block with a density of 115 lb/ft^3 having reinforcing steel every 32 in. vertically and every 48 in. horizontally, with cores grouted in those areas only. Other cores are filled with insulating material only if there is no other insulation.

c. For walls with insulation contained in a framing layer, the U-factors in Table CA103.3.7.1(4) assume contact (and thermal bridging) between the mass wall and other framing. For wall assemblies with multiple layers where the wood or metal framing layer does not contact the concrete or masonry layer (i.e., walls with an airspace between the stud wall layer and the mass wall layer), it is acceptable to use the appropriate wood or metal frame wall default U-factors in Tables CA103.3.1 or CA103.3.6.1. Note: It is acceptable to use this approach where the insulation extends beyond the framing and is in contact with the mass wall layer (e.g. a nominal four-inch metal stud containing insulation that is nominally six inches thick and therefore extends two inches beyond the back of the metal stud).

d. Except for wall assemblies qualifying for note 3, if not taken from Table CA103.3.7.1(2), mass wall U-factors shall be determined in accordance with ASHRAE 90.1, Appendix A, Section A3.1 and Tables A3.1A to A3.1D, or Section A9.4.

Commented [NM2]: This is a reference fix unrelated to the rest of this proposal.

TABLE CA103.3.7.2
DEFAULT U-FACTORS FOR PERIPHERAL EDGES OF INTERMEDIATE CONCRETE FLOORS

Slab Edge Treatment	Average Thickness of Wall Above and Below			
	6 inches	8 inches	10 inches	12 inches
Exposed Concrete	0.816	0.741	0.678	0.625
R-5 Exterior Insulation	0.161	0.157	0.154	0.152
R-6 Exterior Insulation	0.138	0.136	0.134	0.132
R-7 Exterior Insulation	0.122	0.120	0.118	0.116
R-8 Exterior Insulation	0.108	0.107	0.106	0.104
R-9 Exterior Insulation	0.098	0.097	0.095	0.094
R-10 Exterior Insulation	0.089	0.088	0.087	0.086
R-11 Exterior Insulation	0.082	0.081	0.080	0.079
R-12 Exterior Insulation	0.076	0.075	0.074	0.074
R-13 Exterior Insulation	0.070	0.070	0.069	0.068
R-14 Exterior Insulation	0.066	0.065	0.065	0.064
R-15 Exterior Insulation	0.062	0.061	0.061	0.060

Notes for Table CA103.3.7.2:

a. Exterior insulation values listed above are continuous R-values on the exterior side of the concrete floor.

b. For conditions with an exterior wall above the peripheral edge of intermediate concrete floor but with no wall below the intermediate concrete floor this table may be used as long as the code minimum insulation is applied to the floor slab below the concrete floor.

c. Typical conditions where conditioned space building envelope wall thermal insulation values are broken concrete floors include, but are not limited to, the following examples:
   1. Elevator hoistway shafts that serve the conditioned building and pass through unconditioned floors such as parking garage levels;
   2. Stairwell enclosures that serve the conditioned building and pass through unconditioned floors such as parking garage levels;
   3. Walls between interior and exterior building envelope that separate the interior conditioned space from an exterior courtyard or roofdeck;
   4. Walls between interior and exterior building envelope that separate the interior conditioned space from an exterior unconditioned space on parking garage levels.

SECTION CA104
BELOW-GRADE WALLS AND SLABS

CA104.1 General. ASHRAE 90.1 Normative Appendix A Table A4.2.1 ~~Table CA104.1 lists~~ provides heat loss coefficients for below-grade walls ~~and floors.~~

~~Coefficients for below-grade walls are given as U-factors (Btu/h × ft² × °F of wall area). Coefficients for below-grade slabs are listed as F-factors (Btu/h × ft × °F per lineal foot of slab perimeter).~~

~~Below-grade wall U-factors are only valid when used with the accompanying below-grade slab F-factor, and vice versa.~~

CA104.2 Component description. All below-grade walls are assumed to be 8 inch concrete. The wall is assumed to extend from the slab upward to the top of the mud sill for the distance specified in Table CA104.1, with 6 inches of concrete wall extending above grade.

Interior insulation is assumed to be fiberglass batts placed in the cavity formed by 2 x 4 framing on 24 inch centers with 1/2 inch gypsum board as the interior finish material. Exterior insulation is assumed to be applied directly to the exterior of the below-grade wall from the top of the wall to the footing. The exterior case does not assume any interior framing or sheetrock.

In all cases, the entire wall surface is assumed to be insulated to the indicated nominal level with the appropriate framing and insulation application. Coefficients are listed for wall depths of 2, 3-1/2 and 7 feet below grade. Basements shallower than two feet should use on-grade slab coefficients.

Heat-loss calculations for wall areas above-grade should use above-grade wall U-factors, beginning at the mudsill.

TABLE CA104.1
DEFAULT WALL U-FACTORS AND SLAB F-FACTORS FOR BASEMENTS

	Below Grade Wall U-factor	Below Grade Slab F-factor
2 Foot Depth Below Grade		
Uninsulated	0.331	0.58
R-11 Interior	0.063	0.67
R-11 Interior w/TB	0.065	0.59
R-19 Interior	0.042	0.68
R-19 Interior w/TB	0.045	0.59
R-21 Interior	0.040	0.68
R-21 Interior w/TB	0.042	0.59
R-21+R-5 Interior	0.031	0.68
R-21+R-5 Interior w/TB	0.032	0.59
R-21+R-7 Interior	0.029	0.68
R-21+R-7 Interior w/TB	0.030	0.59
R-10 Exterior	0.089	0.56
R-12 Exterior	0.061	0.60
3.5 Foot Depth Below Grade		
Uninsulated	0.271	0.51
R-11 Interior	0.058	0.61
R-11 Interior w/TB	0.061	0.55
R-19 Interior	0.041	0.62
R-19 Interior w/TB	0.042	0.55
R-21 Interior	0.038	0.63
R-21 Interior w/TB	0.040	0.56
R-21+R-5 Interior	0.030	0.632
R-21+R-5 Interior w/TB	0.031	0.56
R-21+R-7 Interior	0.027	0.63
R-21+R-7 Interior w/TB	0.029	0.56
R-10 Exterior	0.075	0.52
R-12 Exterior	0.057	0.57
7 Foot Depth Below Grade		
Uninsulated	0.185	0.43
R-11 Interior	0.051	0.541
R-11 Interior w/TB	0.053	0.49
R-19 Interior	0.036	0.54
R-19 Interior w/TB	0.037	0.50
R-21 Interior	0.035	0.56
R-21 Interior w/TB	0.035	0.50
R-21+R-5 Interior	0.027	0.56
R-21+R-5 Interior w/TB	0.028	0.51
R-21+R-7 Interior	0.025	0.57
R-21+R-7 Interior w/TB	0.026	0.51
R-10 Exterior	0.058	0.47
R-12 Exterior	0.050	0.42

TB = Thermal Break

CA104.3 Insulation description. Coefficients are listed for the following four configurations:

1. **Uninsulated:** No insulation or interior finish.
2. **Interior insulation:** Interior 2 x 4 insulated wall without a thermal break between concrete wall and slab.
3. **Interior insulation with thermal break:** Interior 2 x 4 insulated wall with R-5 rigid board providing a thermal break between the concrete wall and the slab.
4. **Exterior insulation:** Insulation applied directly to the exterior surface of the concrete wall.

SECTION CA105
FLOORS OVER UNCONDITIONED SPACE

CA105.1 General. Tables CA105.1(1) and CA105.1(2) ~~and CA105.1(3)~~ list heat loss coefficients for floors over unconditioned spaces in units of Btu/h × ft^2 × °F.

They are derived from procedures listed in the ASHRAE Fundamentals Handbook, assuming an average outdoor temperature of 45°F, an average indoor temperature of 65°F and a crawlspace area of 1350 ft^2 and 100 feet of perimeter. The crawlspace is assumed to be 2.5 feet high, with 24 inches below grade and 6 inches above grade.

ASHRAE 90.1 Normative Appendix A Tables A5.2.3.1 – A5.4.3.1 list heal loss coefficients for other exposed floors.

TABLE CA105.1(1)
DEFAULT U-FACTORS FOR WOOD-FRAMED FLOORS OVER VENTED CRAWLSPACE OR UNHEATED BASEMENT

Nominal R-Value		U-Factor	
Floor	Perimeter	Post & Beam	Joists
0	0	0.112	0.134
	11	0.100	0.116
	19	0.098	0.114
	30	0.093	0.107
11	0	0.052	0.056
	11	0.048	0.052
19	0	0.038	0.041
	11	0.036	0.038
22	0	0.034	0.037
	11	0.033	0.035
25	0	0.032	0.034
	11	0.031	0.033
30	0	0.028	0.029
	11	0.027	0.028
38	0	0.024	0.025
	11	0.024	0.024

TABLE CA105.1(2)
DEFAULT U-FACTORS FOR WOOD-FRAMED FLOORS OVER HEATED PLENUM CRAWLSPACES

Nominal R-Value Perimeter	U-Factor
11	0.085
19	0.075
30	0.069

Note: Crawlspaces used as heated plenums have approximately 30% higher heat loss rate than unvented crawlspaces with the same assumed ACH. Default U-factors in Table CA105.1(2) reflect this higher rate of heat loss.

~~**TABLE CA105.1(3)**~~
~~**DEFAULT U-FACTORS FOR EXPOSED FLOORS**~~

~~U-Factor~~			
~~Nominal R-Value~~	~~Concrete~~	~~Wood Joist~~	~~Metal Joist~~
~~R-11~~	~~0.077~~	~~0.088~~	~~0.14~~
~~R-15~~	~~0.059~~	~~0.076~~	~~0.12~~
~~R-19~~	~~0.048~~	~~0.062~~	~~0.11~~
~~R-21~~	~~0.043~~	~~0.057~~	~~0.11~~
~~R-25~~	~~0.037~~	~~0.051~~	~~0.10~~
~~R-30~~	~~0.031~~	~~0.040~~	~~0.09~~
~~R-38~~	~~0.025~~	~~0.034~~	~~0.08~~

CA105.2 Crawlspace description. Four configurations are considered: Naturally ventilated crawlspace, mechanically vented crawlspace, heated plenum crawlspace and exposed floor.

CA105.2.1 Naturally ventilated crawlspaces. Assumed to have 3.0 air changes per hour, with at least 1.0 ft^2 of net-free ventilation in the foundation for every 300 ft^2 of crawlspace floor area. The crawlspace is not actively heated. Floors over unheated areas, such as garages, may only use those values which have R-0 perimeter insulation.

CA105.2.2 Mechanically ventilated crawlspaces. Assume to have 1.5 air changes per hour, with less than 1.0 ft^2 of net-free ventilation in the foundation for every 300 ft^2 of crawlspace floor area. The crawlspace is not actively heated. Floors over unheated basements may only use those values which have R-0 perimeter insulation.

CA105.2.3 Heated plenum crawlspaces. Assumed to have 0.25 air changes per hour, with no foundation vents. Heated supply air from central furnace is blown into a crawlspace and allowed to enter the living space unducted via holes cut into the floor.

CA105.2.4 Exposed floors. Assumes no buffer space, and a covering of 1/2 inch T1-11 on the exterior of the cavity exposed to the outside air or rigid insulation below a concrete floor, such as over parking garages.

CA105.3 Construction description. Floors are assumed to be either joisted floors framed on 16 inch centers, or post and beam on 4 foot by 8 foot squares. Insulation is assumed to be installed under the subflooring between the joists or beams with no space between the insulation and the subfloor. Insulation is assumed to be uncompressed. Exposed floors also include concrete with continuous rigid insulation assumed.

Perimeter insulation is assumed to extend from the top of the rim joist to the crawlspace floor and then inward along the ground (on top of the ground cover) for at least 24 inches.

Floor coverings are assumed to be light carpet with rubber pad.

SECTION CA106
ON-GRADE SLAB FLOORS

A106.1 General. ASHRAE 90.1 Normative Appendix A Tables A6.3.1-1 and A6.3.1-2 ~~Table CA106.1 lists~~ list heat loss coefficients for heated on-grade slab floors, in units of Btu/h × °F per lineal foot of perimeter.

~~**TABLE CA106.1**~~
~~**DEFAULT F-FACTORS FOR ON-GRADE SLABS**~~

~~Insulation type~~	~~R-0~~	~~R-5~~	~~R-10~~	~~R-15~~
		~~Unheated Slab~~		
~~Uninsulated slab~~	~~0.73~~	~~—~~	~~—~~	~~—~~
~~2 ft Horizontal (No thermal break)~~	~~—~~	~~0.70~~	~~0.70~~	~~0.69~~
~~4 ft Horizontal (No thermal break)~~	~~—~~	~~0.67~~	~~0.64~~	~~0.63~~
~~2 ft Vertical~~	~~—~~	~~0.58~~	~~0.54~~	~~0.52~~
~~4 ft Vertical~~	~~—~~	~~0.54~~	~~0.48~~	~~0.45~~
~~Fully insulated slab~~	~~—~~	~~—~~	~~0.36~~	~~—~~
		~~Heated Slab~~		
~~Uninsulated slab~~	~~0.84~~	~~—~~	~~—~~	~~—~~
~~Fully insulated slab~~	~~—~~	~~0.74~~	~~0.55~~	~~0.44~~
~~R-5 Center (With perimeter insulation)~~	~~—~~	~~—~~	~~0.66~~	~~0.62~~
~~R-10 Center (With perimeter insulation)~~	~~—~~	~~—~~	~~—~~	~~0.51~~
~~3 ft Vertical~~	~~—~~	~~—~~	~~0.78~~	~~—~~

CA106.2 Component description. All on-grade slab floors are assumed to be 6 inch concrete poured directly onto the earth. The bottom of the slab is assumed to be at grade line. Monolithic and floating slabs are not differentiated.

Soil is assumed to have a conductivity of 0.75 Btu/h × ft^2 × °F. Slabs 2 feet or more below grade should use basement coefficients.

CA106.3 Insulation description. Coefficients are provided for the following three configurations:

1. **Two foot (or four foot) vertical:** Insulation is applied directly to the slab exterior, extending downward from the top of the slab to a depth of 2 feet (or 4 feet) below grade.
2. **Two foot (or four foot) horizontal:** Insulation is applied directly to the underside of the slab, and run horizontally from the perimeter inward for 2 feet (or 4 feet). The slab edge is exposed in this configuration.

   Note: A horizontal installation with a thermal break of at least R-5 at the slab edge should use the vertical-case F-factors.

3. **Fully insulated slab:** Insulation extends from the top of the slab, along the entire perimeter, and completely covers the area under the slab. Thicker perimeter insulation covers the slab edge and extends 2 feet under the slab.

SECTION CA107
DEFAULT U-FACTORS FOR DOORS

CA107.1 Doors without NFRC certification. Doors that do not have NFRC certification shall be assigned the appropriate U-factor from Tables CA107.1(1) through CA107.1(4).

TABLE CA107.1(1)
DEFAULT U-FACTORS FOR DOORS

Door Type	No Glazed Fenestration	Single Glazing	Double Glazing with ¼ in. Airspace	Double Glazing with ½ in. Airspace	Double Glazing with e=0.10, ½ in. Argon
SWINGING DOORS (Rough opening – 38 in. x 82 in.)					
Slab Doors					
Wood slab in wood frame[a]	0.46				
6% glazed fenestration (22 in. x 8 in. lite)	–	0.48	0.47	0.46	0.44
25% glazed fenestration (22 in.x36 in. lite)	–	0.58	0.48	0.46	0.42
45% glazed fenestration (22 in.x64 in. lite)	–	0.69	0.49	0.46	0.39
More than 50% glazed fenestration	Use Table C303.1.3(1)/R303.1.3(1) as appropriate				
Insulated steel slab with wood edge in wood frame[a]	0.16				
6% glazed fenestration (22 in. x 8 in. lite)	–	0.21	0.20	0.19	0.18
25% glazed fenestration (22 in.x36 in. lite)	–	0.39	0.28	0.26	0.23
45% glazed fenestration (22 in.x64 in. lite)	–	0.58	0.38	0.35	0.26
More than 50% g glazed fenestration	Use Table C303.1.3(1)/R303.1.3(1) as appropriate				
Foam insulated steel slab with metal edge in steel frame[b]	0.37				
6% glazed fenestration (22 in. x 8 in. lite)	–	0.44	0.42	0.41	0.39
25% glazed fenestration (22 in.x36 in. lite)	–	0.55	0.50	0.48	0.44
45% glazed fenestration (22 in.x64 in. lite)	–	0.71	0.59	0.56	0.48
More than 50% glazed fenestration	Use Table C303.1.3(1)/R303.1.3(1) as appropriate				
Cardboard honeycomb slab with metal edge in steel frame[b]	0.61				
Style and Rail Doors					
Sliding glass doors/French doors	Use Table C303.1.3(1)/R303.1.3(1) as appropriate				
Site-Assembled Style and Rail Doors					
Aluminum in aluminum frame	–	1.32	0.99	0.93	0.79
Aluminum in aluminum frame with thermal break	–	1.13	0.80	0.74	0.63

a. Thermally broken sill (add 0.03 for non-thermally broken sill)
b. Non-thermally broken sill
c. Nominal U-factors are through the center of the insulated panel before consideration of thermal bridges around the edges of the door section and due to the frame.

TABLE CA107.1(2)
DEFAULT U-FACTORS FOR REVOLVING DOORS

Revolving Doors	
Size (W x H)	**U-Factor**
3-wing	
8 ft x 7 ft	0.79
10 ft x 8 ft	0.80
4-wing	
7 ft x 6.5 ft	0.63
7 ft x 7.5 ft	0.64
Open	
82 in x 84 in	1.32

TABLE CA107.1(3)
DEFAULT U-FACTORS FOR STEEL EMERGENCY DOORS

Double-Skin Steel Emergency Exit Doors		
Core Insulation	**3 ft x 6 ft 8 in**	**6 ft x 6 ft 8 in**
1-3/8 in. thickness		
Honeycomb kraft paper	0.57	0.52
Mineral wool, steel ribs	0.44	0.36
Polyurethane foam	0.34	0.28
1-3/4 in. thickness		
Honeycomb kraft paper	0.57	0.54
Mineral wool, steel ribs	0.41	0.33
Polyurethane foam	0.31	0.26
1-3/8 in. thickness		
Honeycomb kraft paper	0.60	0.55
Mineral wool, steel ribs	0.47	0.39
Polyurethane foam	0.37	0.31
1-3/4 in. thickness		
Honeycomb kraft paper	0.60	0.57
Mineral wool, steel ribs	0.44	0.37
Polyurethane foam	0.34	0.30

TABLE CA107.1(4)
DEFAULT U-FACTORS FOR STEEL GARAGE AND HANGAR DOORS

Double-Skin Steel Garage and Aircraft Hangar Doors					
Insulation[e]	**One-piece tilt-up[a]**		**Sectional tilt-up[b]**	**Aircraft hangar**	
	8 ft. x 7 ft.	**16 ft. x 7 ft.**	**9 ft. x 7 ft.**	**72 ft. x 12 ft.[c]**	**240 ft. x 50 ft.[d]**
1-3/8 in. thickness					
EPS, steel ribs	0.36	0.33	0.34-0.39		
XPS, steel ribs	0.33	0.31	0.31-0.36		
2 in. thickness					
EPS, steel ribs	0.31	0.28	0.29-0.33		
XPS, steel ribs	0.29	0.26	0.27-0.31		
3 in. thickness					
EPS, steel ribs	0.26	0.23	0.25-0.28		
XPS, steel ribs	0.24	0.21	0.24-0.27		
4 in. thickness					
EPS, steel ribs	0.23	0.20	0.23-0.25		
XPS, steel ribs	0.21	0.19	0.21-0.24		
6 in. thickness					
EPS, steel ribs	0.20	0.16	0.20-0.21		
XPS, steel ribs	0.19	0.15	0.19-0.21		
4 in. thickness					
Non-insulated				1.10	1.23
Expanded polystyrene				0.25	0.16
Mineral wool, steel ribs				0.25	0.16
Extruded polystyrene				0.23	0.15
6 in. thickness					
Non-insulated				1.10	1.23
Expanded polystyrene				0.21	0.13
Mineral wool, steel ribs				0.23	0.13
Extruded polystyrene				0.20	0.12
Uninsulated					
All products	1.15				

a. Values are for thermally broken or thermally unbroken doors.
b. Lower values are for thermally broken doors; upper values are for doors with no thermal break.
c. Typical size for a small private airplane (single-engine or twin).
d. Typical hangar door for a midsize commercial jet airliner.
e. EPS is extruded polystyrene, XPS is expanded polystyrene.

SECTION CA108
AIR INFILTRATION

CA108.1 General. Tables CA108.1(1) and CA108.1(2) list effective air change rates and heat capacities for heat loss due to infiltration for Single-Family Residential.

The estimated seasonal average infiltration rate in air changes per hour (ACH) is given for standard air-leakage control (see Section R402.4 for air leakage requirements for Single-Family Residential). The effective air change rate shall be used in calculations for compliance under either the Component Performance or Systems Analysis approaches.

Heat loss due to infiltration shall be computed using the following equation:

$Q_{infil} = ACH_{eff} * HCP$

Where:

Q_{infil} = Heat loss due to air infiltration.

ACH_{eff} = The effective air infiltration rate in Table CA108.1(1)

HCP = The Heat Capacity Density Product for the appropriate elevation or climate zone as given below.

TABLE CA108.1(1)
ASSUMED EFFECTIVE AIR CHANGES PER HOUR

Air-Leakage Control Package	Air Changes per Hour	
	Natural	Effective
Standard	0.35	0.35

TABLE CA108.1(2)
DEFAULT HEAT CAPACITY/DENSITY PRODUCT FOR AIR

Zone	Average Elevation	Heat Capacity/ Density
1	Mean Sea Level	0.0180 Btu/h•°F
2	2000	0.0168 Btu/h•°F
3	3000	0.0162 Btu/h•°F