

CALIFORNIA ENERGY COMMISSION1516 Ninth Street
Sacramento, California 95814Main website: www.energy.ca.gov**NOTIFICATION OF APPROVAL
OF STANDARD U-FACTOR DATA FOR
METAL FRAMED RAFTER ROOFS**

As part of the adoption of the 2005 Building Energy Efficiency Standards, the California Energy Commission adopted Joint Appendix IV, which contains standard U-factor, C-factor and Thermal Mass data for roof, wall and floor construction assemblies (see page IV-1 of the Joint Appendices at: http://www.energy.ca.gov/title24/2005standards/2004-10-06_400-03-001-JAF.PDF). The data in Joint Appendix IV must be used for all residential and nonresidential compliance approaches, including the mandatory requirements, prescriptive envelope component approach, prescriptive overall envelope approach and performance approach for nonresidential, high-rise residential and hotel/motel buildings, and the mandatory requirements, prescriptive and performance approaches for low-rise residential buildings.

If a construction assembly is not adequately represented in Joint Appendix IV, an applicant may request approval by the Energy Commission's Executive Director for different data for that construction assembly. The approval of the Executive Director is based on the technical justification submitted by the applicant. Approved standard data for the construction assembly will be published as an addendum to Joint Appendix IV for use in all compliance approaches.

This Notice of Approval of Standard U-factor data for Metal Framed Rafter Roofs in Low-Rise Residential Buildings and for Type V Nonresidential Buildings authorizes the use of the data shown in the attached Table IV.5a with the limitations in the description following the table. Table IV.5a is officially added as an addendum to Joint Appendix IV.

Approved by:

A handwritten signature in black ink, appearing to read "B. B. Blevins", written over a horizontal line.

B. B. BLEVINS
Executive DirectorDated: 12/12/05

Table IV.5a – U-factors of Metal Framed Rafter Roofs

Spacing	R-Value of Insulation Between Framing	Nominal Framing Size		Rated R-value of Continuous Insulation ³							
				R-0	R-2	R-4	R-6	R-7	R-8	R-10	R-14
				A	B	C	D	E	F	G	H
16 in. OC	None	Any	1	0.325	0.197	0.141	0.110	0.099	0.090	0.076	0.059
	R-11	2x4	1a	0.135	0.106	0.088	0.075	0.069	0.065	0.057	0.047
	R-13	2x4	1b	0.127	0.101	0.084	0.072	0.067	0.063	0.056	0.046
	R-15 ²	2x4	1c	0.122	0.098	0.082	0.070	0.066	0.062	0.055	0.045
	R-19	2x4	1d	0.127	0.101	0.084	0.072	0.067	0.063	0.056	0.046
	R-11	2x6	2	0.123	0.099	0.082	0.071	0.066	0.062	0.055	0.045
	R-13	2x6	3	0.115	0.093	0.079	0.068	0.064	0.060	0.053	0.044
	R-15 ²	2x6	3a	0.106	0.087	0.074	0.065	0.061	0.057	0.051	0.043
	R-19	2x6	3b	0.107	0.088	0.075	0.065	0.061	0.058	0.052	0.043
	R-19	2x8	4	0.096	0.081	0.069	0.061	0.057	0.054	0.049	0.041
	R-21	2x8	5	0.093	0.078	0.068	0.060	0.056	0.053	0.048	0.040
	R-25	2x10	6	0.084	0.072	0.063	0.056	0.053	0.050	0.046	0.039
	R-30 ²	2x10	7	0.079	0.068	0.060	0.054	0.051	0.048	0.044	0.038
	R-30	2x12	8	0.076	0.066	0.058	0.052	0.050	0.047	0.043	0.037
	R-38 ²	2x12	9	0.071	0.062	0.055	0.050	0.047	0.045	0.042	0.036
R-38	2x14	10	0.068	0.060	0.053	0.048	0.046	0.044	0.040	0.035	
Sprayed Foam or Cellulose Insulation ⁴	2x6	11	0.099	0.083	0.071	0.062	0.058	0.055	0.050	0.041	
	2x8	12	0.087	0.074	0.065	0.057	0.054	0.051	0.047	0.039	
	2x10	13	0.077	0.067	0.059	0.053	0.050	0.048	0.044	0.037	
	2x12	14	0.069	0.061	0.054	0.049	0.047	0.044	0.041	0.035	
	2x14	15	0.064	0.057	0.051	0.046	0.044	0.042	0.039	0.034	
24 in. OC	None	Any	16	0.322	0.196	0.141	0.110	0.099	0.090	0.076	0.058
	R-11	2x4	16a	0.115	0.093	0.079	0.068	0.064	0.060	0.053	0.044
	R-13	2x4	16b	0.107	0.088	0.075	0.065	0.061	0.058	0.052	0.043
	R-15 ²	2x4	16c	0.101	0.084	0.072	0.063	0.059	0.056	0.050	0.042
	R-19	2x4	16d	0.107	0.088	0.075	0.065	0.061	0.058	0.052	0.043
	R-11	2x6	17	0.107	0.088	0.075	0.065	0.061	0.058	0.052	0.043
	R-13	2x6	18	0.099	0.083	0.071	0.062	0.058	0.055	0.050	0.041
	R-15 ²	2x6	18a	0.090	0.076	0.066	0.058	0.055	0.052	0.047	0.040
	R-19	2x6	18b	0.087	0.074	0.065	0.057	0.054	0.051	0.047	0.039
	R-19	2x8	19	0.080	0.069	0.061	0.054	0.051	0.049	0.044	0.038
	R-21	2x8	20	0.076	0.066	0.058	0.052	0.050	0.047	0.043	0.037
	R-25	2x10	21	0.068	0.060	0.053	0.048	0.046	0.044	0.040	0.035
	R-30 ²	2x10	22	0.063	0.056	0.050	0.046	0.044	0.042	0.039	0.033
	R-30	2x12	23	0.061	0.054	0.049	0.045	0.043	0.041	0.038	0.033
	R-38 ²	2x12	24	0.055	0.050	0.045	0.041	0.040	0.038	0.035	0.031
R-38	2x14	25	0.053	0.048	0.044	0.040	0.039	0.037	0.035	0.030	
Sprayed Foam or Cellulose Insulation ⁴	2x6	26	0.081	0.070	0.061	0.055	0.052	0.049	0.045	0.038	
	2x8	27	0.070	0.061	0.055	0.049	0.047	0.045	0.041	0.035	
	2x10	28	0.061	0.054	0.049	0.045	0.043	0.041	0.038	0.033	
	2x12	29	0.054	0.049	0.044	0.041	0.039	0.038	0.035	0.031	
	2x14	30	0.049	0.045	0.041	0.038	0.036	0.035	0.033	0.029	

Notes:

- 1 Rigid foam board used for cavity insulation must fill the entire cavity between the rafters and sealed properly to prevent air gaps, and must be secured properly to prevent any future discrepancies in the construction assembly.
 - 2 A higher density fiberglass batt is needed to provide adequate room for ventilation.
 - 3 Continuous insulation shall be located at the ceiling or at the roof and be uninterrupted by framing.
 - 4 Sprayed foam or cellulose insulation shall fill the entire cavity. Cellulose shall have a binder to prevent sagging. Verify that the building official in your area permits this construction, since there is no ventilation layer.
 - 5 In climate zones 1 and 16 the insulating R-value of continuous insulation materials installed above the roof waterproof membrane shall be multiplied times 0.8 before choosing the table column for determining assembly U-factor.
 - 6 The gray highlights are the values which have been added to the table.
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This table contains pre-calculated U-factors for metal framed rafter roofs where the ceiling is the air barrier. This construction assembly is similar to that covered by Table IV.2 except that metal framing members are substituted for the wood-framing members. The rafters may be either flat or in a sloped application. Insulation is typically installed between the rafters. With this construction, the insulation is in contact with the ceiling and there is typically a one-inch air gap above the insulation so that moisture can be vented. Whether or not there is an air space above the insulation depends on local climate conditions and may not be required in some building permit jurisdictions. The building official will need to waive the air gap requirement in the case of cellulose insulation or sprayed foam.

U-factors are selected from Column A of this table when there is no continuous insulation. When continuous insulation is installed either at the ceiling or at the roof, then U-factors from other columns may be selected. The continuous insulation is typically a rigid polystyrene or polyisocyanurate foam insulation, but can also include mineral wool or other suitable materials.

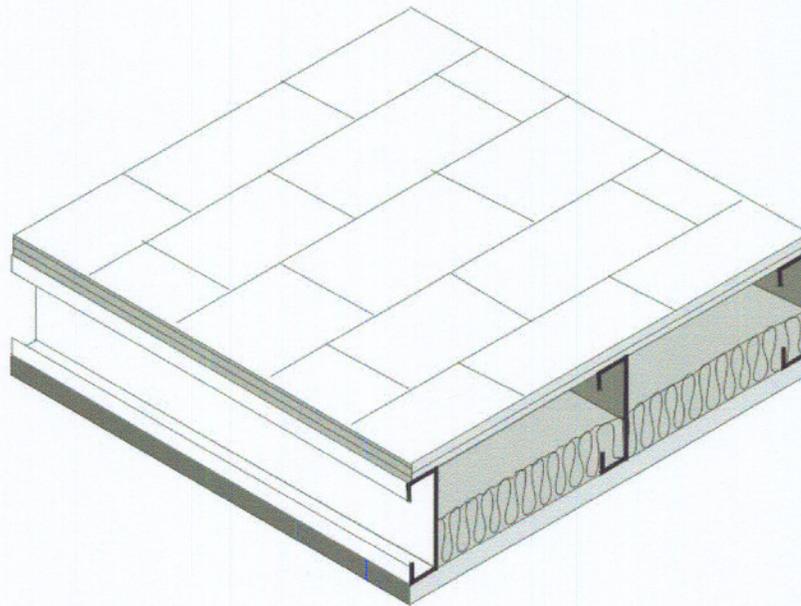


Figure IV.5a – Metal Framed Rafter Roof

When this table is used manually, the R-value of continuous insulation shall be equal to or greater than the R-value published in the continuous insulation columns. For instance if the insulation is R-3, the R-2 column shall be used. No interpolation is permitted when data from the table is used manually. CEC approved software, however, may determine the U-factor for any amount of continuous insulation and/or for unusual construction layers using Equation IV-1 and Equation IV-2.

Assumptions. These data are calculated using the zone calculation method documented in the 2001 ASHRAE Fundamentals. These calculations assume an exterior air film of R-0.17, asphalt shingles of R-0.44 (AR02), building paper of R-0.06 (BP01), ½ inch of plywood of R-0.63 (PW03), the insulation / framing layer, ½ inch gypsum of R-0.45 (GP01), and an interior air film (heat flow up diagonally) of R-0.62. The continuous insulation may either be located at the ceiling or over the structural deck. The thickness of framing members is assumed to be 3.50, 5.50, 7.25, 9.25, and 11.25 inches. for 2x4, 2x6, 2x8, 2x10, and 2x12 nominal sizes. High-density batt insulation is assumed to be 3.5 inch thick for R-15, 5.5 inch thick for R-21, 8.25 inch thick for R-30 and 10.25 inch thick for R-38. The R-value of sprayed foam and cellulose insulation is assumed to be R-3.6 per inch. Framing spacing is 10 percent for 16 inches on center and 7 percent for 24 inches on center. Steel framing has 1.5 inch flange and is 0.075 inch thick steel with no knockouts. U-factors calculated using EZ Frame 2.0B.