

CALIFORNIA ENERGY COMMISSION1516 Ninth Street
Sacramento, California 95814Main website: www.energy.ca.gov**NOTIFICATION OF APPROVAL
OF STANDARD U-FACTOR DATA FOR
WOOD 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 Wood 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.2a with the limitations in the description following the table. Table IV.2a 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 Director

Dated: 12/12/05

Table IV.2a – U-factors of Wood Framed Rafter Roofs

Rafter Spacing	R-value of Cavity Insulation	Nominal Framing Size	Rated R-value of Continuous Insulation ³									
			None	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	0.297	0.184	0.134	0.105	0.095	0.087	0.074	0.057	
	R-11	2x4	1a	0.084	0.072	0.063	0.056	0.053	0.050	0.046	0.039	
	R-13	2x4	1b	0.075	0.065	0.058	0.052	0.049	0.047	0.043	0.037	
	R-15 ²	2x4	1c	0.068	0.060	0.053	0.048	0.046	0.044	0.040	0.035	
	R-19	2x4	1d	0.075	0.065	0.058	0.052	0.049	0.047	0.043	0.037	
	R-19 ¹	2x4	1e	0.062	0.055	0.050	0.045	0.043	0.041	0.038	0.033	
	R-11	2x6	2	0.076	0.066	0.058	0.052	0.049	0.047	0.043	0.037	
	R-13	2x6	3	0.069	0.060	0.053	0.048	0.046	0.044	0.040	0.034	
	R-15 ²	2x6	4	0.062	0.055	0.049	0.045	0.043	0.041	0.038	0.033	
	R-19	2x6	4a	0.056	0.050	0.046	0.042	0.040	0.039	0.036	0.031	
	R-19	2x8	5	0.051	0.046	0.042	0.038	0.037	0.036	0.033	0.029	
	R-21 ²	2x8	6	0.048	0.043	0.039	0.036	0.035	0.034	0.031	0.028	
	R-22	2x10	7	0.044	0.041	0.037	0.035	0.033	0.032	0.030	0.027	
	R-25	2x10	8	0.041	0.037	0.034	0.032	0.031	0.030	0.028	0.025	
	R-30	2x10	9	0.036	0.033	0.031	0.029	0.028	0.027	0.026	0.023	
	R-30	2x12	10	0.035	0.032	0.030	0.028	0.027	0.027	0.025	0.023	
	R-38	2x12	11	0.030	0.028	0.027	0.025	0.025	0.024	0.023	0.021	
R-38	2x14	12	0.028	0.027	0.025	0.024	0.023	0.023	0.022	0.020		
Sprayed Foam or Cellulose Insulation ⁴	2x4	13	0.074	0.064	0.056	0.050	0.047	0.045	0.041	0.035		
	2x6	14	0.052	0.046	0.042	0.038	0.037	0.035	0.033	0.029		
	2x8	15	0.041	0.037	0.034	0.032	0.031	0.030	0.028	0.025		
	2x10	16	0.033	0.031	0.029	0.027	0.026	0.025	0.024	0.022		
	2x12	17	0.028	0.026	0.025	0.023	0.023	0.022	0.021	0.019		
24 in. OC	None	Any	18	0.237	0.160	0.121	0.097	0.089	0.081	0.070	0.055	
	R-11	2x4	18a	0.081	0.070	0.061	0.055	0.052	0.049	0.045	0.038	
	R-13	2x4	18b	0.072	0.063	0.056	0.050	0.048	0.046	0.042	0.036	
	R-15 ²	2x4	18c	0.065	0.058	0.052	0.047	0.045	0.043	0.039	0.034	
	R-19	2x4	18d	0.072	0.063	0.056	0.050	0.048	0.046	0.042	0.036	
	R-19 ¹	2x4	18e	0.059	0.053	0.048	0.044	0.042	0.040	0.037	0.032	
	R-11	2x6	19	0.075	0.065	0.057	0.051	0.049	0.046	0.042	0.036	
	R-13	2x6	20	0.067	0.058	0.052	0.047	0.045	0.043	0.040	0.034	
	R-15 ²	2x6	21	0.060	0.053	0.048	0.044	0.042	0.040	0.037	0.032	
	R-19	2x6	21a	0.054	0.049	0.044	0.041	0.039	0.038	0.035	0.031	
	R-19	2x8	22	0.049	0.045	0.041	0.038	0.036	0.035	0.033	0.029	
	R-21 ²	2x8	23	0.046	0.042	0.038	0.035	0.034	0.033	0.031	0.027	
	R-22	2x10	24	0.043	0.039	0.036	0.034	0.033	0.032	0.030	0.026	
	R-25	2x10	25	0.039	0.036	0.033	0.031	0.030	0.029	0.028	0.025	
	R-30	2x10	26	0.034	0.032	0.030	0.028	0.027	0.026	0.025	0.022	
	R-30	2x12	27	0.033	0.031	0.029	0.027	0.027	0.026	0.025	0.022	
	R-38	2x12	28	0.028	0.026	0.025	0.023	0.023	0.022	0.021	0.019	
R-38	2x14	29	0.027	0.026	0.024	0.023	0.022	0.022	0.021	0.019		
Sprayed Foam or Cellulose Insulation ⁴	2x4	30	0.071	0.061	0.054	0.049	0.046	0.044	0.042	0.035		
	2x6	31	0.050	0.044	0.040	0.037	0.036	0.034	0.033	0.028		
	2x8	32	0.039	0.036	0.033	0.031	0.030	0.029	0.028	0.024		
	2x10	33	0.032	0.029	0.028	0.026	0.025	0.025	0.024	0.021		
	2x12	34	0.026	0.025	0.024	0.022	0.022	0.021	0.021	0.019		

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 thermal performance data (U-factors) for wood framed rafter roofs. This is a common construction in low-rise residential buildings and in Type V nonresidential buildings. 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 there is a space above the insulation depends on local climate conditions and may not be required in some building permit jurisdictions. The ventilation space requirement would have to be waived by the building official for the case of cellulose insulation or foamed plastic, since the entire cavity would be filled.

For the majority of cases, U-factors will be selected from Column A of this table; this case covers insulation placed only in the cavity. 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.

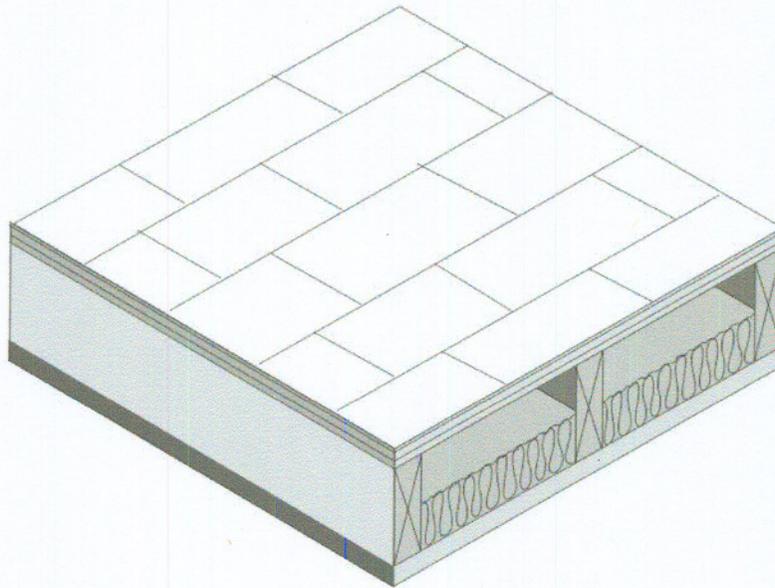


Figure IV.2 – Wood Frame Rafter Roof

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 continuous 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 parallel path 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), continuous insulation (optional), the insulation / framing layer with an air space of R-0.76 or R-0.80 (except for cellulose and foamed plastic), 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 also be located at the ceiling, between the drywall and the framing. The framing percentage is assumed to be 10% for 16 inch OC and 7% for 24 inch OC. The thickness of framing members is assumed to be the actual size of 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.