APPENDIX

CHAPTER ILHR 20

State of Wisconsin
Department of Industry, Labor & Human Relations
Division of Safety & Buildings
Box 7969
Madison, WI 53707
Wisconsin Statutes 101.63, 101.73

WISCONSIN UNIFORM BUILDING PERMIT APPLICATION
(See instructions on back of pink copy)

APPLICATION NO. _____
PARCEL NO. _____

PERMIT REQUESTED ☐ STRUCTURE ☐ HVAC ☐ ELEC ☐ PLUMBING

Owner's Name | Mailing Address | Telephone

Contractor's Name | Mailing Address | Telephone

PROJECT LOCATION _____ ¼, _____ ¼, SECTION _____, T _____ N, R _____ ☐ E or ☐ W

Building Address | Subdivision Name | Lot No. | Block No

Zoning District | Lot Area Sq. ft.

Setbacks: Front ft. | Rear ft. | Left ft. | Right ft.

1a. PROJECT
☐ New ☐ Addition ☐ Raze
☐ Alteration ☐ Repair ☐ Move
☐ Other _____

1b. GARAGE
☐ Attached ☐ Detached

2. AREA
Basements _____ Sq. ft.
Living Area _____ Sq. ft.
Garage _____ Sq. ft.

3. TYPE
☐ Single Family
☐ Two family
☐ Other _____

4. CONST. TYPE
☐ Site constructed
☐ Manufactured

5. STORIES
☐ 1-Story
☐ 2-Story
☐ Other _____

6. ELECTRICAL
Entrance Panel
Size: _____ amp
Service:
☐ Underground
☐ Overhead

7. FOUNDATION
☐ Concrete
☐ Masonry
☐ Treated Wood
☐ Other _____

8. USE
☐ Seasonal
☐ Permanent
☐ Other _____

9. HVAC EQUIPMENT
☐ Forced Air Furnace
☐ Radiant Baseboard or Panel
☐ Heat Pump
☐ Boiler
☐ Central Air Conditioning
☐ Other _____

10. PLUMBING
Sewer
☐ Municipal
☐ Septic
Permit No. _____

11. WATER
☐ Municipal Utility
☐ Private on-site Well

12. ENERGY SOURCE

Fuel	Nat. Gas	L.P.	Oil	Elec. *	Solid	Solar
Space Htg	☐	☐	☐	☐	☐	☐
Water Htg	☐	☐	☐	☐	☐	☐

* ☐ Dwelling unit will have 3 kilowatts or more installed electric space heating equip.
Infiltration control option is ☐ Full sealing of joints ☐ Blower door test ☐ Exterior air infiltration barrier

13. HEAT LOSS (Calculated)
Envelope _____ BTU/HR
Infiltration _____ BTU/HR

14. ESTIMATED COST
$ _____

The applicant agrees to comply with the Wisconsin Uniform Dwelling Code and other Municipal Ordinances and with the conditions of this permit, understands that the issuance of the permit creates no legal liability, express or implied, on the Department or Municipality, and certifies that all the above information is accurate.

SIGNATURE OF APPLICANT _____ DATE _____

CONDITIONS OF APPROVAL This permit is issued pursuant to the following conditions. Failure to comply may result in suspension or revocation of this permit or other penalty.

ISSUING JURISDICTION ☐ TOWN ☐ VILLAGE ☐ CITY ☐ COUNTY ☐ STATE ☐ INDEPENDENT OF: _____

Municipality Number of Inspection Authority _____ - _____ - _____

Municipality Number of Dwelling Location, if different _____ - _____ - _____

FEES:
Plan Review . . . $ _____
Inspection . . . . $ _____
Wis. Permit Seal(s) $ _____
Other . . . . . $ _____
TOTAL . . . $ _____

PERMIT(S) ISSUED
☐ Construction
☐ HVAC
☐ Electrical
☐ Plumbing
☐ Other

WIS. UNIFORM PERMIT SEAL NO. _____

PERMIT ISSUED BY:
NAME _____
DATE _____
CERT. NO. _____

SBD 9823 (R. 04-87) WHITE – Issuing Jurisdiction YELLOW – DILHR GREEN – Inspector PINK – Owner/Agent

Site Info

SUBDIVISION _____
LOT NO._____ BLOCK NO.___
ZONING DISTRICT_____
__¼, __¼, SEC__, T__N, R__ E or W
PARCEL NO._____
SETBACKS:
FRONT YARD _____ feet
REAR YARD _____ feet
LEFT YARD _____ feet
RIGHT YARD _____ feet

Inspection

PHASE	RGH	FNL
FOOTING		
FOUNDATION		
CONSTRUCTION		
INSULATION		
PLUMBING		
HEAT/VENT/AC		
ELECTRICAL		
OCCUPANCY		

NOTICE OF NONCOMPLIANCE
This issuing jurisdiction shall notify the applicant in writing of any violations to be corrected. All cited violations shall be corrected within 30 days after notification, unless extension of time is granted.

SBD-9024(R. 08/97)

Keep this card posted until final inspection has been made. Inspections shall be arranged 48 hrs. in advance. Work shall not proceed until the inspector has approved the various stages of construction or the 48 hr. period since notification has elapsed. This permit will expire 24 months after the date of issuance if construction has not commenced.

WISCONSIN UNIFORM BUILDING PERMIT#

☐ const; ☐ hvac; ☐ elec; ☐ plumb;

Project:

Issued to	OWNER (AGENT)
	BUILDING SITE ADDRESS
	CITY, VILLAGE TOWN, COUNTY

Issued by	PERSON ISSUING	CERT. NO.	affix uniform permit seal here (when applicable) Seal No:
	DATE ISSUED	TELEPHONE NUMBER	

COMMENTS:

WIS. STATS. 101.63

Wisconsin Department of Industry, Labor and Human Relations

MUNICIPAL RECOMMENDATION FOR A VARIANCE APPLICATION

Safety and Buildings Division
Local Program Services
P.O. Box 7969
Madison, Wisconsin 53707

Owner Name	Owner Street Address		
City/Town	State	Zip Code	Owner Telephone No.
Dwelling Location	Dwelling Street Address		
City/Town	County		
Agent (Arch - Engr - Contr)	Agent Street Address		
City/Town	State	Zip Code	Agent Telephone No.

1. I have read the application for variance of rule ILHR _____

2. I recommend (check appropriate box): ☐ Denial ☐ Approval ☐ Cond. Appr. ☐ No Comment

3. Explanation for recommendation:

4. ☐ I find no conflict with local rules and regulations.
   ☐ I find that the variance is in conflict with local rules and regulations.
   Explanation:

5. Inspections completed: ☐ None ☐ Footings ☐ Rough ☐ Final ☐ Foundation
   ☐ Bldg. Const ☐ Energy ☐ HVAC ☐ Electrical ☐ Plumbing

6. Correction orders issued:

Municipality exercising jurisdiction:

Signature of municipal enforcement official:	Date signed:

Please submit this completed form along with original Application for Variance, Form SBD-6070, and $100.00 state review fee to Department of Industry, Labor and Human Relations at the address shown in the upper right corner.

SBD - 6071 (R. 07/87)

State of Wisconsin
Department of Industry,
Labor & Human Relations

RULE VARIANCE APPLICATION UNDER WISCONSIN UNIFORM DWELLING CODE

Safety & Buildings Division
Local Program Services
P.O. Box 7969
Madison, Wisconsin 53707
(UV)

Owner Name	Owner Street Address	
City	State & Zip Code	Owner Telephone No.
Dwelling Location	Dwelling Street Address	
City/Village/Town	County	
Agent (Arch - Engr - Contr)	Agent Street Address	
City	State & Zip Code	Agent Telephone No.
Municipality Having Jurisdiction		Telephone No.

$100 STATE FEE required (ILHR 69.15(2)). Application can only be made by owner. Submit to the address shown in the upper right corner. Additional **MUNICIPAL FEE**, if any: _____

1. Rule ILHR _____ of the Uniform Dwelling Code cannot be entirely satisfied because:

2. In lieu of complying exactly with the rule, the following alternative is proposed as a means of providing an equivalent degree of health, welfare and safety (submit building plans, calculations and specifications to help explain your proposal):

3. Supporting arguments are:

VERIFICATION BY APPLICANT:

_____, verifies that (s)he is the applicant and that all information provided on this application is true to the best of his/her knowledge and belief.

Applicant's Signature _____ Date Signed _____

Subscribed and sworn to before me
this date _____

_____
Notary Public

My commission expires _____

FOR OFFICE USE ONLY	
Application No.	Date Received
☐ Approved ☐ Denied	Date Approved/Denied
Official's Name	Title

APPLICATION IS VALID ONLY IF NOTARIZED AND ACCOMPANIED BY REVIEW FEE.

SBD-6970 (R 07/87)

APPENDIX

CHAPTER ILHR 21

FASTENER SCHEDULE TABLE

Description of Building Materials/Connection	Number and Type of Fastener [1 2 3 4]
Joist to sill or girder, toe nail	2-16d, 3-8d
Bridging to joist, toe nail each end	2-8d
1" x 6" subfloor or less to each joist, face nail	2-8d or 2 staples, 1¾"
Wider than 1" x 6" subfloor to each joist, face nail	3-8d or 4 staples, 1¾"
2" subfloor to joist or girder, blind and face nail	2-16d
Sole plate to joist or blocking, face nail	16d at 16" o.c.
Top or sole plate to stud, end nail	2-16d
Stud to sole plate, toe nail	4-8d or 3-16d
Doubled studs, face nail	16d at 24" o.c.
Doubled top plates, face nail	16d at 16" o.c.
Top plates, laps and intersections, face nail	2-16d
Continuous header, two pieces	16d at 16" o.c. along each edge
Ceiling joists to plate, toe nail	2-16d, 3-8d
Continuous header to stud, toe nail	4-8d
Ceiling joist, laps over partitions, face nail	3-16d
Ceiling joist to parallel rafters, face nail	3-16d
Rafter to plate, toe nail	2-16d, 3-8d
1" brace to each stud and plate, face nail	2-8d or 2 staples, 1¾"
1" x 6" sheathing to each bearing, face nail	2-8d or 2 staples, 1¾"
1" x 8" sheathing to each bearing, face nail	2-8d or 3 staples, 1¾"
Wider than 1" x 8" sheathing to each bearing, face nail	3-8d or 4 staples, 1¾"
Built-up corner studs	16d at 30" o.c., 16d at 24" o.c.
Built-up girder and beams	20d at 32" o.c. at top and bottom and staggered 2-20d at ends and at each splice
2-inch planks	2-16d at each bearing
Roof rafters to ridge, valley or hip rafters, toe nail	4-16d
Roof rafters to ridge, valley or hip rafters, face nail	3-16d
Collar ties to rafters, face nail	3-8d
Plywood subfloor, roof and wall sheathing (to framing)[6]	
½-inch to 5/16-inch	6d[5] or staple
5/8-inch to ¾-inch	8d smooth or common, 6d deformed, or staple
⅞-inch to 1-inch	8d[5]
1⅛-inch to 1¼-inch	10d smooth or common, or 8d deformed
Fiberboard sheathing[7]	
½-inch	6d common or staple, 1½" long or roofing nail[11]
25/32-inch	8d common or staple, 1½" long or roofing nail[11]
Gypsum sheathing, ½"[8]	1½" galvanized roofing nail, or 6d common, or staple
Particleboard wall sheathing (to framing)[6]	
⅜-inch to ½-inch	6d common
5/8-inch to ¾-inch	8d common or staple
Insulated sheathing	11-gauge roofing nails, 6d, 8d, or staple
Combination subfloor underlayment (to framing)[6]	
¾-inch and less	6d deformed
⅞-inch to 1-inch	8d deformed
1⅛-inch to 1¼-inch	10d smooth[9] or common or 8d deformed[9]
Panel siding (to framing)[10]	
½-inch or less	6d
5/8-inch	8d

[1]All nails are smooth-common, box or deformed shank except where otherwise stated.

[2]Nail is a general description and may be T-head, modified round head or round head.

[3]Staples are 16-gauge wire and have a minimum 7/16-inch o.d. crown width.

[4]Common or box nails may be used except where otherwise stated.

[5]Common or deformed shank.

[6]Nails spaced at 6 inches on center at edges, 12 inches at intermediate supports (10 inches at intermediate supports for floors), except 6 inches at all supports where spans are 48 inches or more.

[7]Nails spaced at 3 inches on center at edges, 6 inches at intermediate supports.

[8]Nails spaced at 4 inches on center at edges, 8 inches at intermediate supports.

[9]Nails spaced at 6 inches on center at edges and at intermediate supports.

[10]Corrosion-resistant siding and casing nails.

[11]Galvanized roofing nails with 7/16-inch diameter head and 1½-inch length for ½-inch sheathing and 1¾-inch for 25/32-inch sheathing.

INDEX OF
SPAN TABLES FOR JOISTS AND RAFTERS
(Recommended by National Forest Products Association)

SPAN TABLES FOR JOISTS AND RAFTERS
(Recommended by National Forest Products Association)

EXPLANATION OF TABLES

These span tables for joists and rafters are calculated on the basis of a series of modulus of elasticity (E) and fiber bending stress (F_b) values. The range of values in the tables provides allowable spans for all species and grades of nominal 2-inch framing lumber customarily used in construction.

Tables J-1 through J-6 list spans for floor and ceiling joists used over a single span with calculations based on E and the required F_b values shown.

Tables R-2 through R-15 list spans for rafters used over a single span with calculations based on F_b and the required E values shown.

Tables TSJ-1 and TSJ-2 list spans for floor joists continuous over two equal spans with calculations based on E and the required F_b values shown.

Applicable design criteria for each condition of use appear at the top of each table. While these criteria are directed principally to residential construction, they are suitable for other occupancies having similar conditions of loading. Tabulated spans for rafters also apply to other types of occupancy, since the occupancy has little bearing on roof loading.

LUMBER SIZES

Tabulated spans apply to surfaced (S4S) lumber having dimensions which conform to the American Softwood Lumber Standard, PS 20-70. These sizes are as follows:

	Dressed Size (inches)	
Reference	Surfaced Dry	Surfaced Green
2 x 4	1½ x 3½	1-9/16 x 3-9/16
2 x 6	1½ x 5½	1-9/16 x 5⅝
2 x 8	1½ x 7¼	1-9/16 x 7½
2 x 10	1½ x 9¼	1-9/16 x 9½
2 x 12	1½ x 11¼	1-9/16 x 11½

MOISTURE CONTENT

The listed dry and green sizes are related at 19% maximum moisture content. Tabulated spans are calculated on the basis of the dry sizes and are also applicable to the corresponding green sizes. The spans in these tables are intended for use in covered structures or where moisture content in use does not exceed 19%.

SPAN MEASUREMENT

Tabulated spans are the clear distance between supports. For sloping rafters, the span is measured along the horizontal projection.

LUMBER DESIGN VALUES

Use of these span tables requires reference to the applicable design values for the various species and grades of lumber. "Design Values for Joists and Rafters", a supplement to these span tables, provide such values in convenient-to-use form. Modulus of elasticity (E) and fiber bending stress (F_b) values therein are based on the National Design Specification for Wood Construction (formerly National Design Specification for Stress Grade Lumber and Its Fastenings) and incorporate adjustments appropriate for repetitive-member use under various durations of load.

Repetitive-member use is that condition where framing members such as joists, rafters, studs, planks, decking or similar members are spaced not more than 24 inches, are not less than 3 in number and are joined by floor, roof or other load-distributing elements adequate to support the design load. Design values in bending (F_b) for such use are 15% greater than for single-member use.

The "Joists" column in the design value tables provide values for bending for repetitive-member use under normal conditions. The "Raft-

ers" column of the design value tables provide values for bending for repetitive-member use adjusted for snow-loading.

ROOF LOADS

Rafter spans are tabulated for the most common roof loads. For roof loads intermediate between those tabulated, straight line interpolation may be used.

Light roof coverings are defined as those with a weight of 7 psf or less and typically include asphalt and wood shingles. Heavy roof coverings are those which are more than 7 psf, up to 15 psf, and typically include tile and slate roofs.

LUMBER IDENTIFICATION

When used with the tabulated spans in these tables, lumber should be identified by the grademark of an agency recognized as being competent by the Board of Review of the American Lumber Standards Committee or the Canadian Lumber Standards Administrative Board.

USE OF THE SPAN TABLES

Spans for floor and ceiling joists are calculated on the basis of the modulus of elasticity (E) with the required fiber bending stress (F_b) listed below each span. Spans for rafters are calculated on the basis of fiber bending stress (F_b) with the required modulus of elasticity (E) listed below each span. Use of the tables is illustrated in the examples which follow.

Example 1. Floor joists. Assume a required span of 12'-9", a live load of 40 psf and joists spaced 16 inches on centers. Table J-1 shows that a grade of 2 x 8 having an E value of 1,600,000 psi and an F_b value of 1250 psi would have a span of 12 '-10", which satisfies the condition.

Example 2. Rafters. Assume a horizontal projection span of 13'-0", a live load of 30 psf, dead load of 15 psf and rafters spaced 16 inches on centers. Table R-2 shows that a 2x8 having an F_b value of 1300 psi and an E value of 1,000,000 psi would have a span of 13'-3" of horizontal projection.

Since many combinations of size, spacing, E and F_b values are possible, it is recommended that the users examine the tables to determine which combination fits their particular case most effectively.

DESIGN CRITERIA:
Deflection - For 40 lbs. per sq. ft. live load. Limited to span in inches divided by 360.
Strength - Live Load of 40 lbs. per sq. ft. plus dead load of 10 lbs. per sq. ft. determines the required fiber stress value.

TABLE J-1
FLOOR JOISTS
40 Lbs. Per Sq. Ft. Live Load
(All floors except attic floors.)

JOIST SIZE	SPACING (IN)	Modulus of Elasticity, "E", in 1,000,000 psi																		
(IN)	(IN)	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.2	2.4
2x6	12.0	6-9 450	7-3 520	7-9 590	8-2 660	8-6 720	8-10 780	9-2 830	9-6 890	9-9 940	10-0 990	10-3 1040	10-6 1090	10-9 1140	10-11 1190	11-2 1230	11-4 1280	11-7 1320	11-11 1410	12-3 1490
	13.7	6-6 470	7-0 550	7-5 620	7-9 690	8-2 750	8-6 810	8-9 870	9-1 930	9-4 980	9-7 1040	9-10 1090	10-0 1140	10-3 1190	10-6 1240	10-8 1290	10-10 1340	11-1 1380	11-5 1470	11-9 1560
	16.0	6-2 500	6-7 580	7-0 650	7-5 720	7-9 790	8-0 860	8-4 920	8-7 980	8-10 1040	9-1 1090	9-4 1150	9-6 1200	9-9 1250	9-11 1310	10-2 1360	10-4 1410	10-6 1460	10-10 1550	11-2 1640
	19.2	5-9 530	6-3 610	6-7 690	7-0 770	7-3 840	7-7 910	7-10 970	8-1 1040	8-4 1100	8-7 1160	8-9 1220	9-0 1280	9-2 1330	9-4 1390	9-6 1440	9-8 1500	9-10 1550	10-2 1650	10-6 1750
	24.0	5-4 570	5-9 660	6-2 750	6-6 830	6-9 900	7-0 980	7-3 1050	7-6 1120	7-9 1190	7-11 1250	8-2 1310	8-4 1380	8-6 1440	8-8 1500	8-10 1550	9-0 1610	9-2 1670	9-6 1780	9-9 1880
	32.0					6-2 1010	6-5 1090	6-7 1150	6-10 1230	7-0 1300	7-3 1390	7-5 1450	7-7 1520	7-9 1590	7-11 1660	8-0 1690	8-2 1760	8-4 1840	8-7 1950	8-10 2060
2x8	12.0	8-11 450	9-7 520	10-2 590	10-9 660	11-3 720	11-8 780	12-1 830	12-6 890	12-10 940	13-2 990	13-6 1040	13-10 1090	14-2 1140	14-5 1190	14-8 1230	15-0 1280	15-3 1320	15-9 1410	16-2 1490
	13.7	8-6 470	9-2 550	9-9 620	10-3 690	10-9 750	11-2 810	11-7 870	11-11 930	12-3 980	12-7 1040	12-11 1090	13-3 1140	13-6 1190	13-10 1240	14-1 1290	14-4 1340	14-7 1380	15-0 1470	15-6 1560
	16.0	8-1 500	8-9 580	9-3 650	9-9 720	10-2 790	10-7 850	11-0 920	11-4 980	11-8 1040	12-0 1090	12-3 1150	12-7 1200	12-10 1250	13-1 1310	13-4 1360	13-7 1410	13-10 1460	14-3 1550	14-8 1640
	19.2	7-7 530	8-2 610	8-9 690	9-2 770	9-7 840	10-0 910	10-4 970	10-8 1040	11-0 1100	11-3 1160	11-7 1220	11-10 1280	12-1 1330	12-4 1390	12-7 1440	12-10 1500	13-0 1550	13-5 1650	13-10 1750
	24.0	7-1 570	7-7 660	8-1 750	8-6 830	8-11 900	9-3 980	9-7 1050	9-11 1120	10-2 1190	10-6 1250	10-9 1310	11-0 1380	11-3 1440	11-5 1500	11-8 1550	11-11 1610	12-1 1670	12-6 1780	12-10 1880
	32.0					8-1 990	8-5 1080	8-9 1170	9-0 1230	9-3 1300	9-6 1370	9-9 1450	10-0 1520	10-2 1570	10-5 1650	10-7 1700	10-10 1790	11-0 1840	11-4 1950	11-8 2070

2x10	12.0	11-4 450	12-3 520	13-0 590	13-8 660	14-4 720	14-11 780	15-5 830	15-11 890	16-5 940	16-10 990	17-3 1040	17-8 1090	18-0 1140	18-5 1190	18-9 1230	19-1 1280	19-5 1320	20-1 1410	20-8 1490
	13.7	10-10 470	11-8 550	12-5 620	13-1 690	13-8 750	14-3 810	14-9 870	15-3 930	15-8 980	16-1 1040	16-6 1090	16-11 1140	17-3 1190	17-7 1240	17-11 1290	18-3 1340	18-7 1380	19-2 1470	19-9 1560
	16.0	10-4 500	11-1 580	11-10 650	12-5 720	13-0 790	13-6 850	14-0 920	14-6 980	14-11 1040	15-3 1090	15-8 1150	16-0 1200	16-5 1250	16-9 1310	17-0 1360	17-4 1410	17-8 1460	18-3 1550	18-9 1640
	19.2	9-9 530	10-6 610	11-1 690	11-8 770	12-3 840	12-9 910	13-2 970	13-7 1040	14-0 1100	14-5 1160	14-9 1220	15-1 1280	15-5 1330	15-9 1390	16-0 1440	16-4 1500	16-7 1550	17-2 1650	17-8 1750
	24.0	9-0 570	9-9 660	10-4 750	10-10 830	11-4 900	11-10 980	12-3 1050	12-8 1120	13-0 1190	13-4 1250	13-8 1310	14-0 1380	14-4 1440	14-7 1500	14-11 1550	15-2 1610	15-5 1670	15-11 1780	16-5 1880
	32.0					10-4 1000	10-9 1080	11-1 1150	11-6 1240	11-10 1310	12-2 1380	12-5 1440	12-9 1520	13-0 1580	13-3 1640	13-6 1700	13-9 1770	14-0 1830	14-6 1970	14-11 2080
2x12	12.0	13-10 450	14-11 520	15-10 590	16-8 660	17-5 720	18-1 780	18-9 830	19-4 890	19-11 940	20-6 990	21-0 1040	21-6 1090	21-11 1140	22-5 1190	22-10 1230	23-3 1280	23-7 1320	24-5 1410	25-1 1490
	13.7	13-3 470	14-3 550	15-2 620	15-11 690	16-8 750	17-4 810	17-11 870	18-6 930	19-1 980	19-7 1040	20-1 1090	20-6 1140	21-0 1190	21-5 1240	21-10 1290	22-3 1340	22-7 1380	23-4 1470	24-0 1560
	16.0	12-7 500	13-6 580	14-4 650	15-2 720	15-10 790	16-5 860	17-0 920	17-7 980	18-1 1040	18-7 1090	19-1 1150	19-6 1200	19-11 1250	20-4 1310	20-9 1360	21-1 1410	21-6 1460	22-2 1550	22-10 1640
	19.2	11-10 530	12-9 610	13-6 690	14-3 770	14-11 840	15-6 910	16-0 970	16-7 1040	17-0 1100	17-6 1160	17-11 1220	18-4 1280	18-9 1330	19-2 1390	19-6 1440	19-10 1500	20-2 1550	20-10 1650	21-6 1750
	24.0	11-0 570	11-10 660	12-7 750	13-3 830	13-10 900	14-4 980	14-11 1050	15-4 1120	15-10 1190	16-3 1250	16-8 1310	17-0 1380	17-5 1440	17-9 1500	18-1 1550	18-5 1610	18-9 1670	19-4 1780	19-11 1880
	32.0					12-7 1000	13-1 1080	13-6 1150	13-11 1220	14-4 1300	14-9 1380	15-2 1450	15-6 1520	15-10 1580	16-2 1650	16-5 1700	16-9 1770	17-0 1830	17-7 1950	18-1 2070

Note: The required extreme fiber stress in bending, "F_b", in pounds per square inch is shown below each span.

DESIGN CRITERIA:
Deflection - For 30 lbs. per sq. ft. live load. Limited to span in inches divided by 360.
Strength - Live Load of 30 lbs. per sq. ft. plus dead load of 10 lbs. per sq. ft. determines the required fiber stress value.

TABLE J-2
FLOOR JOISTS
30 lbs. Per Sq. Ft. Live Load
(Optional table for attic floors.)

JOIST SIZE	SPACING (IN)	Modulus of Elasticity, "E", in 1,000,000 psi																		
		0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.2	2.4
2x6	12.0	7-5 440	8-0 510	8-6 570	8-11 640	9-4 700	9-9 750	10-1 810	10-5 860	10-9 910	11-0 960	11-3 1010	11-7 1060	11-10 1100	12-0 1150	12-3 1200	12-6 1240	12-9 1280	13-1 1370	13-6 1450
	13.7	7-1 460	7-8 530	8-2 600	8-7 670	8-11 730	9-4 790	9-8 840	10-0 900	10-3 950	10-6 1010	10-10 1060	11-1 1110	11-3 1160	11-6 1200	11-9 1250	11-11 1300	12-2 1340	12-7 1430	12-11 1510
	16.0	6-9 480	7-3 560	7-9 630	8-2 700	8-6 770	8-10 830	9-2 890	9-6 950	9-9 1000	10-0 1060	10-3 1110	10-6 1160	10-9 1220	10-11 1270	11-2 1320	11-4 1360	11-7 1410	11-11 1500	12-3 1590
	19.2	6-4 510	6-10 600	7-3 670	7-8 740	8-0 810	8-4 880	8-8 940	8-11 1010	9-2 1070	9-5 1130	9-8 1180	9-10 1240	10-1 1290	10-4 1350	10-6 1400	10-8 1450	10-10 1500	11-3 1600	11-7 1690
	24.0	5-11 550	6-4 640	6-9 720	7-1 800	7-5 880	7-9 950	8-0 1020	8-3 1080	8-6 1150	8-9 1210	8-11 1270	9-2 1330	9-4 1390	9-7 1450	9-9 1510	9-11 1560	10-1 1620	10-5 1720	10-9 1820
	32.0					6-9 960	7-0 1040	7-3 1110	7-6 1190	7-9 1270	7-11 1330	8-2 1410	8-4 1470	8-6 1530	8-8 1590	8-10 1650	9-0 1710	9-2 1780	9-6 1910	9-9 2010
2x8	12.0	9-10 440	10-7 510	11-3 570	11-10 640	12-4 700	12-10 750	13-4 810	13-9 860	14-2 910	14-6 960	14-11 1010	15-3 1060	15-7 1100	15-10 1150	16-2 1200	16-6 1240	16-9 1280	17-4 1370	17-10 1450
	13.7	9-4 460	10-1 530	10-9 600	11-4 670	11-10 730	12-3 790	12-9 840	13-2 900	13-6 950	13-11 1010	14-3 1060	14-7 1110	14-11 1160	15-2 1200	15-6 1250	15-9 1300	16-0 1340	16-7 1430	17-0 1510
	16.0	8-11 480	9-7 560	10-2 630	10-9 700	11-3 770	11-8 830	12-1 890	12-6 950	12-10 1000	13-2 1060	13-6 1110	13-10 1160	14-2 1220	14-5 1270	14-8 1320	15-0 1360	15-3 1410	15-9 1500	16-2 1590
	19.2	8-5 510	9-0 600	9-7 670	10-1 740	10-7 810	11-0 880	11-4 940	11-9 1010	12-1 1070	12-5 1130	12-9 1180	13-0 1240	13-4 1290	13-7 1350	13-10 1400	14-1 1450	14-4 1500	14-9 1600	15-3 1690
	24.0	7-9 550	8-5 640	8-11 720	9-4 800	9-10 880	10-2 950	10-7 1020	10-11 1080	11-3 1150	11-6 1210	11-10 1270	12-1 1330	12-4 1390	12-7 1450	12-10 1510	13-1 1560	13-4 1620	13-9 1720	14-2 1820
	32.0					8-11 970	9-3 1040	9-7 1120	9-11 1200	10-2 1260	10-6 1340	10-9 1410	11-0 1470	11-3 1540	11-5 1590	11-8 1660	11-11 1730	12-1 1780	12-6 1900	12-10 2010

2x10	12.0	12-6 440	13-6 510	14-4 570	15-1 640	15-9 700	16-5 750	17-0 810	17-6 860	18-0 910	18-6 960	19-0 1010	19-5 1060	19-10 1100	20-3 1150	20-8 1200	21-0 1240	21-6 1280	22-1 1370	22-9 1450
	13.7	11-11 460	12-11 530	13-8 600	14-6 670	15-1 730	15-8 790	16-3 840	16-9 900	17-3 950	17-9 1010	18-2 1060	18-7 1110	19-0 1160	19-4 1200	19-9 1250	20-1 1300	20-5 1340	21-1 1430	21-9 1510
	16.0	11-4 480	12-3 560	13-0 630	13-8 700	14-4 770	14-11 830	15-5 890	15-11 950	16-6 1000	16-10 1060	17-3 1110	17-8 1160	18-0 1220	18-5 1270	18-9 1320	19-1 1360	19-5 1410	20-1 1500	20-8 1590
	19.2	10-8 510	11-6 600	12-3 670	12-11 740	13-6 810	14-0 880	14-6 940	15-0 1010	15-5 1070	15-10 1130	16-3 1180	16-7 1240	17-0 1290	17-4 1350	17-8 1400	18-0 1450	18-3 1500	18-10 1600	19-5 1690
	24.0	9-11 550	10-8 640	11-4 720	11-11 800	12-6 880	13-0 950	13-6 1020	13-11 1080	14-4 1150	14-8 1210	15-1 1270	15-5 1330	15-9 1390	16-1 1450	16-5 1510	16-8 1560	17-0 1620	17-6 1720	18-0 1820
	32.0					11-4 960	11-10 1050	12-3 1120	12-8 1200	13-0 1260	13-4 1330	13-8 1400	14-0 1470	14-4 1540	14-7 1590	14-11 1660	15-2 1720	15-5 1780	15-11 1890	16-5 2020
2x12	12.0	15-2 440	16-5 510	17-5 570	18-4 640	19-2 700	19-11 750	20-8 810	21-4 860	21-11 910	22-6 960	23-1 1010	23-7 1060	24-2 1100	24-8 1150	25-1 1200	25-7 1240	26-0 1280	26-10 1370	27-8 1450
	13.7	14-7 460	15-8 530	16-8 600	17-6 670	18-4 730	19-1 790	19-9 840	20-5 900	21-0 950	21-7 1010	22-1 1060	22-7 1110	23-1 1160	23-7 1200	24-0 1250	24-5 1300	24-10 1340	25-8 1430	26-5 1510
	16.0	13-10 480	14-11 560	15-10 630	16-8 700	17-5 770	18-1 830	18-9 890	19-4 950	19-11 1000	20-6 1060	21-0 1110	21-6 1160	21-11 1220	22-5 1270	22-10 1320	23-3 1360	23-7 1410	24-5 1500	25-1 1590
	19.2	13-0 510	14-0 600	14-11 670	15-8 740	16-5 810	17-0 880	17-8 940	18-3 1010	18-9 1070	19-3 1130	19-9 1180	20-2 1240	20-8 1290	21-1 1350	21-6 1400	21-10 1450	22-3 1500	22-11 1600	23-7 1690
	24.0	12-1 550	13-0 640	13-10 720	14-7 800	15-2 880	15-10 950	16-5 1020	16-11 1080	17-5 1150	17-11 1210	18-4 1270	18-9 1330	19-2 1390	19-7 1450	19-11 1510	20-3 1560	20-8 1620	21-4 1720	21-11 1820
	32.0					13-10 970	14-4 1040	14-11 1130	15-4 1190	15-10 1270	16-3 1340	16-8 1400	17-0 1460	17-5 1530	17-9 1590	18-1 1650	18-5 1720	18-9 1780	19-4 1890	19-11 2010

Note: The required extreme fiber stress in bending, "F_b", in pounds per square inch is shown below each span.

TABLE J-3
CEILING JOISTS
20 Lbs. Per Sq. Ft. Live Load
(Limited attic storage where development of future rooms is not possible)
(Plaster Ceiling)

DESIGN CRITERIA:
Deflection - For 20 lbs. per sq. ft. live load. Limited to span in inches divided by 360.
Strength - Live load of 20 lbs. per sq. ft. plus dead load of 10 lbs. per sq. ft. determines required fiber stress value.

JOIST SIZE	SPACING (IN)	Modulus of Elasticity, "E", in 1,000,000 psi																		
(IN)		0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.2	2.4
2x4	12.0	5-5 430	5-10 500	6-2 560	6-6 630	6-10 680	7-1 740	7-4 790	7-7 850	7-10 900	8-0 950	8-3 990	8-5 1040	8-7 1090	8-9 1130	8-11 1170	9-1 1220	9-3 1260	9-7 1340	9-10 1420
	13.7	5-2 450	5-7 520	5-11 590	6-3 650	6-6 720	6-9 770	7-0 830	7-3 880	7-6 940	7-8 990	7-10 1040	8-1 1090	8-3 1140	8-5 1180	8-7 1230	8-8 1270	8-10 1320	9-2 1400	9-5 1490
	16.0	4-11 470	5-4 550	5-8 620	5-11 690	6-2 750	6-5 810	6-8 870	6-11 930	7-1 990	7-3 1040	7-6 1090	7-8 1140	7-10 1200	8-0 1240	8-1 1290	8-3 1340	8-5 1390	8-8 1480	8-11 1570
	19.2	4-8 500	5-0 580	5-4 660	5-7 730	5-10 800	6-1 870	6-3 930	6-6 990	6-8 1050	6-10 1110	7-0 1160	7-2 1220	7-4 1270	7-6 1320	7-8 1370	7-9 1420	7-11 1470	8-2 1570	8-5 1660
	24.0	4-4 540	4-8 630	4-11 710	5-2 790	5-5 860	5-8 930	5-10 1000	6-0 1070	6-2 1130	6-4 1190	6-6 1250	6-8 1310	6-10 1370	7-0 1420	7-1 1480	7-3 1530	7-4 1590	7-7 1690	7-10 1790
2x6	12.0	8-6 430	9-2 500	9-9 560	10-3 630	10-9 680	11-2 740	11-7 790	11-11 850	12-3 900	12-7 950	12-11 990	13-3 1040	13-6 1090	13-9 1130	14-1 1170	14-4 1220	14-7 1260	15-0 1340	15-6 1420
	13.7	8-2 450	8-9 520	9-4 590	9-10 650	10-3 720	10-8 770	11-1 830	11-5 880	11-9 940	12-1 990	12-4 1040	12-8 1090	12-11 1140	13-2 1180	13-5 1230	13-8 1270	13-11 1320	14-4 1400	14-9 1490
	16.0	7-9 470	8-4 550	8-10 620	9-4 690	9-9 750	10-2 810	10-6 870	10-10 930	11-2 990	11-5 1040	11-9 1090	12-0 1140	12-3 1200	12-6 1240	12-9 1290	13-0 1340	13-3 1390	13-8 1480	14-1 1570
	19.2	7-3 500	7-10 580	8-4 660	8-9 730	9-2 800	9-6 870	9-10 930	10-2 990	10-6 1050	10-9 1110	11-1 1160	11-4 1220	11-7 1270	11-9 1320	12-0 1370	12-3 1420	12-5 1470	12-10 1570	13-3 1660
	24.0	6-9 540	7-3 630	7-9 710	8-2 790	8-6 860	8-10 930	9-2 1000	9-6 1070	9-9 1130	10-0 1190	10-3 1250	10-6 1310	10-9 1370	10-11 1420	11-2 1480	11-4 1530	11-7 1590	11-11 1690	12-3 1790

2x8	12.0	11-3 430	12-1 500	12-10 560	13-6 630	14-2 680	14-8 740	15-3 790	15-9 850	16-2 900	16-7 950	17-0 990	17-5 1040	17-10 1090	18-2 1130	18-6 1170	18-10 1220	19-2 1260	19-10 1340	20-5 1420
	13.7	10-9 450	11-7 520	12-3 590	12-11 650	13-6 720	14-1 770	14-7 830	15-0 880	15-6 940	15-11 990	16-3 1040	16-8 1090	17-0 1140	17-5 1180	17-9 1230	18-0 1270	18-4 1320	18-11 1400	19-6 1490
	16.0	10-2 470	11-0 550	11-8 620	12-3 690	12-10 750	13-4 810	13-10 870	14-3 930	14-8 990	15-1 1040	15-6 1090	15-10 1140	16-2 1200	16-6 1240	16-10 1290	17-2 1340	17-5 1390	18-0 1480	18-6 1570
	19.2	9-7 500	10-4 580	11-0 660	11-7 730	12-1 800	12-7 870	13-0 930	13-5 990	13-10 1050	14-2 1110	14-7 1160	14-11 1220	15-3 1270	15-6 1320	15-10 1370	16-1 1420	16-5 1470	16-11 1570	17-5 1660
	24.0	8-11 540	9-7 630	10-2 710	10-9 790	11-3 860	11-8 930	12-1 1000	12-6 1070	12-10 1130	13-2 1190	13-6 1250	13-10 1310	14-2 1370	14-5 1420	14-8 1480	15-0 1530	15-3 1590	15-9 1690	16-2 1790
2x10	12.0	14-4 430	15-5 500	16-5 560	17-3 630	18-0 680	18-9 740	19-5 790	20-1 850	20-8 900	21-2 950	21-9 990	22-3 1040	22-9 1090	23-2 1130	23-8 1170	24-1 1220	24-6 1260	25-3 1340	26-0 1420
	13.7	13-8 450	14-9 520	15-8 590	16-6 650	17-3 720	17-11 770	18-7 830	19-2 880	19-9 940	20-3 990	20-9 1040	21-3 1090	21-9 1140	22-2 1180	22-7 1230	23-0 1270	23-5 1320	24-2 1400	24-10 1490
	16.0	13-0 470	14-0 550	14-11 620	15-8 690	16-5 750	17-0 810	17-8 870	18-3 930	18-9 990	19-3 1040	19-9 1090	20-2 1140	20-8 1200	21-1 1240	21-6 1290	21-10 1340	22-3 1390	22-11 1480	23-8 1570
	19.2	12-3 500	13-2 580	14-0 660	14-9 730	15-5 800	16-0 870	16-7 930	17-2 990	17-8 1050	18-1 1110	18-7 1160	19-0 1220	19-5 1270	19-10 1320	20-2 1370	20-7 1420	20-11 1470	21-7 1570	22-3 1660
	24.0	11-4 540	12-3 630	13-0 710	13-8 790	14-4 860	14-11 930	15-5 1000	15-11 1070	16-5 1130	16-10 1190	17-3 1250	17-8 1310	18-0 1370	18-5 1420	18-9 1480	19-1 1530	19-5 1590	20-1 1690	20-8 1790

Note: The required extreme fiber stress in bending, "F_b", in pounds per square inch is shown below each span.

TABLE J-4
CEILING JOISTS

20 Lbs. Per Sq. Ft. Live Load
(Limited attic storage where development of future rooms is not possible)
(Drywall Ceiling)

DESIGN CRITERIA:
Deflection - For 20 lbs. per sq. ft. live load. Limited to span in inches divided by 240.
Strength - live load of 20 lbs. per sq. ft. plus dead load of 10 lbs. per sq. ft. determines required fiber stress value.

JOIST SIZE	SPACING (IN)	Modulus of Elasticity, "E", in 1,000,000 psi																		
(IN)		0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.2	2.4
2x4	12.0	6-2 560	6-8 660	7-1 740	7-6 820	7-10 900	8-1 970	8-5 1040	8-8 1110	8-11 1170	9-2 1240	9-5 1300	9-8 1360	9-10 1420	10-0 1480	10-3 1540	10-5 1600	10-7 1650	10-11 1760	11-3 1860
	13.7	5-11 590	6-5 690	6-9 770	7-2 860	7-6 940	7-9 1010	8-1 1090	8-4 1160	8-7 1230	8-9 1300	9-0 1360	9-3 1420	9-5 1490	9-7 1550	9-9 1610	10-0 1670	10-2 1730	10-6 1840	10-9 1950
	16.0	5-8 620	6-1 720	6-5 810	6-9 900	7-1 990	7-5 1070	7-8 1140	7-11 1220	8-1 1290	8-4 1360	8-7 1430	8-9 1500	8-11 1570	9-1 1630	9-4 1690	9-6 1760	9-8 1820	9-11 1940	10-3 2050
	19.2	5-4 660	5-9 770	6-1 870	6-5 960	6-8 1050	6-11 1130	7-2 1220	7-5 1300	7-8 1370	7-10 1450	8-1 1520	8-3 1590	8-5 1660	8-7 1730	8-9 1800	8-11 1870	9-1 1930	9-4 2060	9-8 2180
	24.0	4-11 710	5-4 830	5-8 930	5-11 1030	6-2 1130	6-5 1220	6-8 1310	6-11 1400	7-1 1480	7-3 1560	7-6 1640	7-8 1720	7-10 1790	8-0 1870	8-1 1940	8-3 2010	8-5 2080	8-8 2220	8-11 2350
2x6	12.0	9-9 560	10-6 660	11-2 740	11-9 820	12-3 900	12-9 970	13-3 1040	13-8 1110	14-1 1170	14-5 1240	14-9 1300	15-2 1360	15-6 1420	15-9 1480	16-1 1540	16-4 1600	16-8 1650	17-2 1760	17-8 1860
	13.7	9-4 590	10-0 690	10-8 770	11-3 860	11-9 940	12-3 1010	12-8 1090	13-1 1160	13-5 1230	13-10 1300	14-2 1360	14-6 1420	14-9 1490	15-1 1550	15-5 1610	15-8 1670	15-11 1730	16-5 1840	16-11 1950
	16.0	8-10 620	9-6 720	10-2 810	10-8 900	11-2 990	11-7 1070	12-0 1140	12-5 1220	12-9 1290	13-1 1360	13-5 1430	13-9 1500	14-1 1570	14-4 1630	14-7 1690	14-11 1760	15-2 1820	15-7 1940	16-1 2050
	19.2	8-4 660	9-0 770	9-6 870	10-0 960	10-6 1050	10-11 1130	11-4 1220	11-8 1300	12-0 1370	12-4 1450	12-8 1520	12-11 1590	13-3 1660	13-6 1730	13-9 1800	14-0 1870	14-3 1930	14-8 2060	15-2 2180
	24.0	7-9 710	8-4 830	8-10 930	9-4 1030	9-9 1130	10-2 1220	10-6 1310	10-10 1400	11-2 1480	11-5 1560	11-9 1640	12-0 1720	12-3 1790	12-6 1870	12-9 1940	13-0 2010	13-3 2080	13-8 2220	14-1 2350

2x8	12.0	12-10 560	13-10 660	14-8 740	15-6 820	16-2 900	16-10 970	17-5 1040	18-0 1110	18-6 1170	19-0 1240	19-6 1300	19-11 1360	20-5 1420	20-10 1480	21-2 1540	21-7 1600	21-11 1650	22-8 1760	23-4 1860
	13.7	12-3 590	13-3 690	14-1 770	14-10 860	15-6 940	16-1 1010	16-8 1090	17-2 1160	17-9 1230	18-2 1300	18-8 1360	19-1 1420	19-6 1490	19-11 1550	20-3 1610	20-8 1670	21-0 1730	21-8 1840	22-4 1950
	16.0	11-8 620	12-7 720	13-4 810	14-1 900	14-8 990	15-3 1070	15-10 1140	16-4 1220	16-10 1290	17-3 1360	17-9 1430	18-2 1500	18-6 1570	18-11 1630	19-3 1690	19-7 1760	19-11 1820	20-7 1940	21-2 2050
	19.2	11-0 660	11-10 770	12-7 870	13-3 960	13-10 1050	14-5 1130	14-11 1220	15-5 1300	15-10 1370	16-3 1450	16-8 1520	17-1 1590	17-5 1660	17-9 1730	18-2 1800	18-5 1870	18-9 1930	19-5 2060	19-11 2180
	24.0	10-2 710	11-0 830	11-8 930	12-3 1030	12-10 1130	13-4 1220	13-10 1310	14-3 1400	14-8 1480	15-1 1560	15-6 1640	15-10 1720	16-2 1790	16-6 1870	16-10 1940	17-2 2010	17-5 2080	18-0 2220	18-6 2350
2x10	12.0	16-5 560	17-8 660	18-9 740	19-9 820	20-8 900	21-6 970	22-3 1040	22-11 1110	23-8 1170	24-3 1240	24-10 1300	25-5 1360	26-0 1420	26-6 1480	27-1 1540	27-6 1600	28-0 1650	28-11 1760	29-9 1860
	13.7	15-8 590	16-11 690	17-11 770	18-11 860	19-9 940	20-6 1010	21-3 1090	21-11 1160	22-7 1230	23-3 1300	23-9 1360	24-4 1420	24-10 1490	25-5 1550	25-10 1610	26-4 1670	26-10 1730	27-8 1840	28-6 1950
	16.0	14-11 620	16-0 720	17-0 810	17-11 900	18-9 990	19-6 1070	20-2 1140	20-10 1220	21-6 1290	22-1 1360	22-7 1430	23-2 1500	23-8 1570	24-1 1630	24-7 1690	25-0 1760	25-5 1820	26-3 1940	27-1 2050
	19.2	14-0 660	15-1 770	16-0 870	16-11 960	17-8 1050	18-4 1130	19-0 1220	19-7 1300	20-2 1370	20-9 1450	21-3 1520	21-9 1590	22-3 1660	22-8 1730	23-2 1800	23-7 1870	23-11 1930	24-9 2060	25-5 2180
	24.0	13-0 710	14-0 830	14-11 930	15-8 1030	16-5 1130	17-0 1220	17-8 1310	18-3 1400	18-9 1480	19-3 1560	19-9 1640	20-2 1720	20-8 1790	21-1 1870	21-6 1940	21-10 2010	22-3 2080	22-11 2220	23-8 2350

Note: The required extreme fiber stress in bending, "F_b", in pounds per square inch is shown below each span.

DESIGN CRITERIA:
Deflection - For 10 lbs. per sq. ft. live load. Limited to span in inches divided by 360.
Strength - live load of 10 lbs. per sq. ft. plus dead load of 5 lbs. per sq. ft. determines required fiber stress value.

TABLE J-5
CEILING JOISTS
10 Lbs. Per Sq. Ft. Live Load
(No attic storage and roof slope not steeper than 3 in 12)
(Plaster Ceiling)

JOIST SIZE	SPACING (IN)	Modulus of Elasticity, "E", in 1,000,000 psi																		
(IN)	(IN)	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.2	2.4
2x4	12.0	6-10 340	7-4 400	7-10 450	8-3 500	8-7 540	8-11 590	9-3 630	9-7 670	9-10 710	10-1 750	10-4 790	10-7 830	10-10 860	11-1 900	11-3 930	11-6 970	11-8 1000	12-1 1070	12-5 1130
	13.7	6-6 360	7-0 410	7-6 470	7-10 520	8-3 570	8-7 610	8-10 660	9-2 700	9-5 740	9-8 780	9-11 820	10-2 860	10-4 900	10-7 940	10-9 970	11-0 1010	11-2 1050	11-6 1110	11-10 1180
	16.0	6-2 380	6-8 440	7-1 490	7-6 550	7-10 600	8-1 650	8-5 690	8-8 740	8-11 780	9-2 830	9-5 870	9-8 910	9-10 950	10-0 990	10-3 1030	10-5 1060	10-7 1100	10-11 1170	11-3 1240
	19.2	5-10 400	6-3 460	6-8 520	7-0 580	7-4 630	7-8 690	7-11 740	8-2 790	8-5 830	8-8 880	8-10 920	9-1 970	9-3 1010	9-5 1050	9-8 1090	9-10 1130	10-0 1170	10-4 1250	10-7 1320
	24.0	5-5 430	5-10 500	6-2 560	6-6 630	6-10 680	7-1 740	7-4 790	7-7 850	7-10 900	8-0 950	8-3 990	8-5 1040	8-7 1090	8-9 1130	8-11 1170	9-1 1220	9-3 1260	9-7 1340	9-10 1420
2x6	12.0	10-9 340	11-7 400	12-3 450	12-11 500	13-6 540	14-1 590	14-7 630	15-0 670	15-6 710	15-11 750	16-3 790	16-8 830	17-0 860	17-4 900	17-8 930	18-0 970	18-4 1000	18-11 1070	19-6 1130
	13.7	10-3 360	11-1 410	11-9 470	12-4 520	12-11 570	13-5 610	13-11 660	14-4 700	14-9 740	15-2 780	15-7 820	15-11 860	16-3 900	16-7 940	16-11 970	17-3 1010	17-6 1050	18-1 1110	18-8 1180
	16.0	9-9 380	10-6 440	11-2 490	11-9 550	12-3 600	12-9 650	13-3 690	13-8 740	14-1 780	14-5 830	14-9 870	15-2 910	15-6 950	15-9 990	16-1 1030	16-4 1060	16-8 1100	17-2 1170	17-8 1240
	19.2	9-2 400	9-10 460	10-6 520	11-1 580	11-7 630	12-0 690	12-5 740	12-10 790	13-3 830	13-7 880	13-11 920	14-3 970	14-7 1010	14-10 1050	15-2 1090	15-5 1130	15-8 1170	16-2 1250	16-8 1320
	24.0	8-6 430	9-2 500	9-9 560	10-3 630	10-9 680	11-2 740	11-7 790	11-11 850	12-3 900	12-7 950	12-11 990	13-3 1040	13-6 1090	13-9 1130	14-1 1170	14-4 1220	14-7 1260	15-0 1340	15-6 1420

2x8	12.0	14-2 340	15-3 400	16-2 450	17-0 500	17-10 540	18-6 590	19-2 630	19-10 670	20-5 710	20-11 750	21-5 790	21-11 830	22-5 860	22-11 900	23-4 930	23-9 970	24-2 1000	24-11 1070	25-8 1130
	13.7	13-6 360	14-7 410	15-6 470	16-3 520	17-0 570	17-9 610	18-4 660	18-11 700	19-6 740	20-0 780	20-6 820	21-0 860	21-5 900	21-11 940	22-4 970	22-9 1010	23-1 1050	23-10 1110	24-7 1180
	16.0	12-10 380	13-10 440	14-8 490	15-6 550	16-2 600	16-10 650	17-5 690	18-0 740	18-6 780	19-0 830	19-6 870	19-11 910	20-5 950	20-10 990	21-2 1030	21-7 1060	21-11 1100	22-8 1170	23-4 1240
	19.2	12-1 400	13-0 460	13-10 520	14-7 580	15-3 630	15-10 690	16-5 740	16-11 790	17-5 830	17-11 880	18-4 920	18-9 970	19-2 1010	19-7 1050	19-11 1090	20-4 1130	20-8 1170	21-4 1250	21-11 1320
	24.0	11-3 430	12-1 500	12-10 560	13-6 630	14-2 680	14-8 740	15-3 790	15-9 850	16-2 900	16-7 950	17-0 990	17-5 1040	17-10 1090	18-2 1130	18-6 1170	18-10 1220	19-2 1260	19-10 1340	20-5 1420
2x10	12.0	18-0 340	19-5 400	20-8 450	21-9 500	22-9 540	23-8 590	24-6 630	25-3 670	26-0 710	26-9 750	27-5 790	28-0 830	28-7 860	29-2 900	29-9 930	30-4 970	30-10 1000	31-10 1070	32-9 1130
	13.7	17-3 360	18-7 410	19-9 470	20-9 520	21-9 570	22-7 610	23-5 660	24-2 700	24-10 740	25-7 780	26-2 820	26-10 860	27-5 900	27-11 940	28-6 970	29-0 1010	29-6 1050	30-5 1110	31-4 1180
	16.0	16-5 380	17-8 440	18-9 490	19-9 550	20-8 600	21-6 650	22-3 690	22-11 740	23-8 780	24-3 830	24-10 870	25-5 910	26-0 950	26-6 990	27-1 1030	27-6 1060	28-0 1100	28-11 1170	29-9 1240
	19.2	15-5 400	16-7 460	17-8 520	18-7 580	19-5 630	20-2 690	20-11 740	21-7 790	22-3 830	22-10 880	23-5 920	23-11 970	24-6 1010	25-0 1050	25-5 1090	25-11 1130	26-4 1170	27-3 1250	28-0 1320
	24.0	14-4 430	15-5 500	16-5 560	17-3 630	18-0 680	18-9 740	19-5 790	20-1 850	20-8 900	21-2 950	21-9 990	22-3 1040	22-9 1090	23-2 1130	23-8 1170	24-1 1220	24-6 1260	25-3 1340	26-0 1420

Note: The required extreme fiber stress in bending, "F_b" in pounds per square inch is shown below each span.

TABLE J-6
CEILING JOISTS
10 Lbs. Per Sq. Ft. Live Load
(No attic storage and roof slope not steeper than 3 in 12)
(Drywall Ceiling)

DESIGN CRITERIA:
Deflection - For 10 lbs. per sq. ft. live load. Limited to span in inches divided by 240.
Strength - live load of 10 lbs. per sq. ft. plus dead load of 5 lbs. per sq. ft. determines required fiber stress value.

JOIST SIZE	SPACING (IN)	Modulus of Elasticity, "E", in 1,000,000 psi																		
(IN)		0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.2	2.4
2x4	12.0	7-10 450	8-5 520	8-11 590	9-5 650	9-10 710	10-3 770	10-7 830	10-11 880	11-3 930	11-7 980	11-10 1030	12-2 1080	12-5 1130	12-8 1180	12-11 1220	13-2 1270	13-4 1310	13-9 1400	14-2 1480
	13.7	7-6 470	8-1 540	8-7 610	9-0 680	9-5 740	9-9 800	10-2 860	10-6 920	10-9 970	11-1 1030	11-4 1080	11-7 1130	11-10 1180	12-1 1230	12-4 1280	12-7 1320	12-9 1370	13-2 1460	13-7 1550
	16.0	7-1 490	7-8 570	8-1 650	8-7 720	8-11 780	9-4 850	9-8 910	9-11 970	10-3 1030	10-6 1080	10-9 1140	11-0 1190	11-3 1240	11-6 1290	11-9 1340	11-11 1390	12-2 1440	12-6 1540	12-11 1630
	19.2	6-8 520	7-2 610	7-8 690	8-1 760	8-5 830	8-9 900	9-1 970	9-4 1030	9-8 1090	9-11 1150	10-2 1210	10-4 1270	10-7 1320	10-10 1380	11-0 1430	11-3 1480	11-5 1530	11-9 1630	12-2 1730
	24.0	6-2 560	6-8 660	7-1 740	7-6 820	7-10 900	8-1 970	8-5 1040	8-8 1110	8-11 1170	9-2 1240	9-5 1300	9-8 1360	9-10 1420	10-0 1480	10-3 1540	10-5 1600	10-7 1650	10-11 1760	11-3 1860
2x6	12.0	12-3 450	13-3 520	14-1 590	14-9 650	15-6 710	16-1 770	16-8 830	17-2 880	17-8 930	18-2 980	18-8 1030	19-1 1080	19-6 1130	19-11 1180	20-3 1220	20-8 1270	21-0 1310	21-8 1400	22-4 1480
	13.7	11-9 470	12-8 540	13-5 610	14-2 680	14-9 740	15-5 800	15-11 860	16-5 920	16-11 970	17-5 1030	17-10 1080	18-3 1130	18-8 1180	19-0 1230	19-5 1280	19-9 1320	20-1 1370	20-9 1460	21-4 1550
	16.0	11-2 490	12-0 570	12-9 650	13-5 720	14-1 780	14-7 850	15-2 910	15-7 970	16-1 1030	16-6 1080	16-11 1140	17-4 1190	17-8 1240	18-1 1290	18-5 1340	18-9 1390	19-1 1440	19-8 1540	20-3 1630
	19.2	10-6 520	11-4 610	12-0 690	12-8 760	13-3 830	13-9 900	14-3 970	14-8 1030	15-2 1090	15-7 1150	15-11 1210	16-4 1270	16-8 1320	17-0 1380	17-4 1430	17-8 1480	17-11 1530	18-6 1630	19-1 1730
	24.0	9-9 560	10-6 660	11-2 740	11-9 820	12-3 900	12-9 970	13-3 1040	13-8 1110	14-1 1170	14-5 1240	14-9 1300	15-2 1360	15-6 1420	15-9 1480	16-1 1540	16-4 1600	16-8 1650	17-2 1760	17-8 1860

2x8	12.0	16-2 450	17-5 520	18-6 590	19-6 650	20-5 710	21-2 770	21-11 830	22-8 880	23-4 930	24-0 980	24-7 1030	25-2 1080	25-8 1130	26-2 1180	26-9 1220	27-2 1270	27-8 1310	28-7 1400	29-5 1480
	13.7	15-6 470	16-8 540	17-9 610	18-8 680	19-6 740	20-3 800	21-0 860	21-8 920	22-4 970	22-11 1030	23-6 1080	24-0 1130	24-7 1180	25-1 1230	25-7 1280	26-0 1320	26-6 1370	27-4 1460	28-1 1550
	16.0	14-8 490	15-10 570	16-10 650	17-9 720	18-6 780	19-3 850	19-11 910	20-7 970	21-2 1030	21-9 1080	22-4 1140	22-10 1190	23-4 1240	23-10 1290	24-3 1340	24-8 1390	25-2 1440	25-11 1540	26-9 1630
	19.2	13-10 520	14-11 610	15-10 690	16-8 760	17-5 830	18-2 900	18-9 970	19-5 1030	19-11 1090	20-6 1150	21-0 1210	21-6 1270	21-11 1320	22-5 1380	22-10 1430	23-3 1480	23-8 1530	24-5 1630	25-2 1730
	24.0	12-10 560	13-10 660	14-8 740	15-6 820	16-2 900	16-10 970	17-5 1040	18-0 1110	18-6 1170	19-0 1240	19-6 1300	19-11 1360	20-5 1420	20-10 1480	21-2 1540	21-7 1600	21-11 1650	22-8 1760	23-4 1860
2x10	12.0	20-8 450	22-3 520	23-8 590	24-10 650	26-0 710	27-1 770	28-0 830	28-11 880	29-9 930	30-7 980	31-4 1030	32-1 1080	32-9 1130	33-5 1180	34-1 1220	34-8 1270	35-4 1310	36-5 1400	37-6 1480
	13.7	19-9 470	21-3 540	22-7 610	23-9 680	24-10 740	25-10 800	26-10 860	27-8 920	28-6 970	29-3 1030	30-0 1080	30-8 1130	31-4 1180	32-0 1230	32-7 1280	33-2 1320	33-9 1370	34-10 1460	35-10 1550
	16.0	18-9 490	20-2 570	21-6 650	22-7 720	23-8 780	24-7 850	25-5 910	26-3 970	27-1 1030	27-9 1080	28-6 1140	29-2 1190	29-9 1240	30-5 1290	31-0 1340	31-6 1390	32-1 1440	33-1 1540	34-1 1630
	19.2	17-8 520	19-0 610	20-2 690	21-3 760	22-3 830	23-2 900	23-11 970	24-9 1030	25-5 1090	26-2 1150	26-10 1210	27-5 1270	28-0 1320	28-7 1380	29-2 1430	29-8 1480	30-2 1530	31-2 1630	32-1 1730
	24.0	16-5 560	17-8 660	18-9 740	19-9 820	20-8 900	21-6 970	22-3 1040	22-11 1110	23-8 1170	24-3 1240	24-10 1300	25-5 1360	26-0 1420	26-6 1480	27-1 1540	27-6 1600	28-0 1650	28-11 1760	29-9 1860

Note: The required extreme fiber stress in bending, "F_b", in pounds per square inch is shown below each span.

TABLE R-2
FLAT OR SLOPED RAFTERS
Supporting Drywall Ceiling
(Flat roof or cathedral ceiling with no attic space)
Live Load - 30 lb. per sq. ft.
Use in Zone 2

DESIGN CRITERIA:
Strength - 15 lbs. per sq. ft. dead load plus 30 lbs. per sq. ft. live load determines required fiber stress.
Deflection - For 30 lbs. per sq. ft. live load. Limited to span in inches divided by 240.

RAFTER SIZE	SPACING (IN)	Extreme Fiber Stress in Bending, "F_b" (psi).										
		300	400	500	600	700	800	900	1000	1100	1200	1300
2x6	12.0	5-10 0.13	6-8 0.19	7-6 0.27	8-2 0.36	8-10 0.45	9-6 0.55	10-0 0.66	10-7 0.77	11-1 0.89	11-7 1.01	12-1 1.14
	13.7	5-5 0.12	6-3 0.18	7-0 0.25	7-8 0.33	8-3 0.42	8-10 0.52	9-5 0.61	9-11 0.72	10-5 0.83	10-10 0.95	11-3 1.07
	16.0	5-0 0.11	5-10 0.17	6-6 0.24	7-1 0.31	7-8 0.39	8-2 0.48	8-8 0.57	9-2 0.67	9-7 0.77	10-0 0.88	10-5 0.99
	19.2	4-7 0.10	5-4 0.15	5-11 0.22	6-6 0.28	7-0 0.36	7-6 0.44	7-11 0.52	8-4 0.61	8-9 0.70	9-2 0.80	9-6 0.90
	24.0	4-1 0.09	4-9 0.14	5-4 0.19	5-10 0.25	6-3 0.32	6-8 0.39	7-1 0.46	7-6 0.54	7-10 0.63	8-2 0.72	8-6 0.81
2x8	12.0	7-8 0.13	8-10 0.19	9-10 0.27	10-10 0.36	11-8 0.45	12-6 0.55	13-3 0.66	13-11 0.77	14-8 0.89	15-3 1.01	15-11 1.14
	13.7	7-2 0.12	8-3 0.18	9-3 0.25	10-1 0.33	10-11 0.42	11-8 0.52	12-5 0.61	13-1 0.72	13-8 0.83	14-4 0.95	14-11 1.07
	16.0	6-7 0.11	7-8 0.17	8-7 0.24	9-4 0.31	10-1 0.39	10-10 0.48	11-6 0.57	12-1 0.67	12-8 0.77	13-3 0.88	13-9 0.99
	19.2	6-1 0.10	7-0 0.15	7-10 0.22	8-7 0.28	9-3 0.36	9-10 0.44	10-6 0.52	11-0 0.61	11-7 0.70	12-1 0.80	12-7 0.90
	24.0	5-5 0.09	6-3 0.14	7-0 0.19	7-8 0.25	8-3 0.32	8-10 0.39	9-4 0.46	9-10 0.54	10-4 0.63	10-10 0.72	11-3 0.81

2x10	12.0	9-9 0.13	11-3 0.19	12-7 0.27	13-9 0.36	14-11 0.45	15-11 0.55	16-11 0.66	17-10 0.77	18-8 0.89	19-6 1.01	20-4 1.14
	13.7	9-1 0.12	10-6 0.18	11-9 0.25	12-11 0.33	13-11 0.42	14-11 0.52	15-10 0.61	16-8 0.72	17-6 0.83	18-3 0.95	19-0 1.07
	16.0	8-5 0.11	9-9 0.17	10-11 0.24	11-11 0.31	12-11 0.39	13-9 0.48	14-8 0.57	15-5 0.67	16-2 0.77	16-11 0.88	17-7 0.99
	19.2	7-8 0.10	8-11 0.15	9-11 0.22	10-11 0.28	11-9 0.36	12-7 0.44	13-4 0.52	14-1 0.61	14-9 0.70	15-5 0.80	16-1 0.90
	24.0	6-11 0.09	8-0 0.14	8-11 0.19	9-9 0.25	10-6 0.32	11-3 0.39	11-11 0.46	12-7 0.54	13-2 0.63	13-9 0.72	14-4 0.81
2x12	12.0	11-10 0.13	13-8 0.19	15-4 0.27	16-9 0.36	18-1 0.45	19-4 0.55	20-6 0.66	21-8 0.77	22-8 0.89	23-9 1.01	24-8 1.14
	13.7	11-1 0.12	12-10 0.18	14-4 0.25	15-8 0.33	16-11 0.42	18-1 0.52	19-3 0.61	20-3 0.72	21-3 0.83	22-2 0.95	23-1 1.07
	16.0	10-3 0.11	11-10 0.17	13-3 0.24	14-6 0.31	15-8 0.39	16-9 0.48	17-9 0.57	18-9 0.67	19-8 0.77	20-6 0.88	21-5 0.99
	19.2	9-5 0.10	10-10 0.15	12-1 0.22	13-3 0.28	14-4 0.36	15-4 0.44	16-3 0.52	17-1 0.61	17-11 0.70	18-9 0.80	19-6 0.90
	24.0	8-5 0.09	9-8 0.14	10-10 0.19	11-10 0.25	12-10 0.32	13-8 0.39	14-6 0.46	15-4 0.54	16-1 0.63	16-9 0.72	17-5 0.81

Note: The required modulus of elasticity, "E", in 1,000,000 pounds per square inch is shown below each span.

TABLE R-2 (cont.)

RAFTERS: Spans are measured along the horizontal projection and loads are considered as applied on the horizontal projection.

Extreme Fiber Stress in Bending, "F_b" (psi).											RAFTER SPACING (IN)	SIZE (IN)
1400	1500	1600	1700	1800	1900	2000	2100	2200	2400	2700		
12-6 1.28	13-0 1.41	13-5 1.56	13-10 1.71	14-2 1.86	14-7 2.02	15-0 2.18	15-4 2.34	15-8 2.51			12.0	
11-9 1.19	12-2 1.32	12-6 1.46	12-11 1.60	13-3 1.74	13-8 1.89	14-0 2.04	14-4 2.19	14-8 2.35			13.7	
10-10 1.10	11-3 1.22	11-7 1.35	11-11 1.48	12-4 1.61	12-8 1.75	13-0 1.89	13-3 2.03	13-7 2.18	14-2 2.48		16.0	2x6
9-11 1.01	10-3 1.12	10-7 1.23	10-11 1.35	11-3 1.47	11-6 1.59	11-10 1.72	12-2 1.85	12-5 1.99	13-0 2.26		19.2	
8-10 0.90	9-2 1.00	9-6 1.10	9-9 1.21	10-0 1.31	10-4 1.43	10-7 1.54	10-10 1.66	11-1 1.78	11-7 2.02	12-4 2.41	24.0	
16-6 1.28	17-1 1.41	17-8 1.56	18-2 1.71	18-9 1.86	19-3 2.02	19-9 2.18	20-3 2.34	20-8 2.51			12.0	
15-5 1.19	16-0 1.32	16-6 1.46	17-0 1.60	17-6 1.74	18-0 1.89	18-5 2.04	18-11 2.19	19-4 2.35			13.7	
14-4 1.10	14-10 1.22	15-3 1.35	15-9 1.48	16-3 1.61	16-8 1.75	17-1 1.89	17-6 2.03	17-11 2.18	18-9 2.48		16.0	2x8
13-1 1.01	13-6 1.12	13-11 1.23	14-5 1.35	14-10 1.47	15-2 1.59	15-7 1.72	16-0 1.85	16-4 1.99	17-1 2.26		19.2	
11-8 0.90	12-1 1.00	12-6 1.10	12-10 1.21	13-3 1.31	13-7 1.43	13-11 1.54	14-4 1.66	14-8 1.78	15-3 2.02	16-3 2.41	24.0	

21-1 1.28	21-10 1.41	22-6 1.56	23-3 1.71	23-11 1.86	24-6 2.02	25-2 2.18	25-10 2.34	26-5 2.51			12.0	2x10
19-8 1.19	20-5 1.32	21-1 1.46	21-9 1.60	22-4 1.74	22-11 1.89	23-7 2.04	24-2 2.19	24-8 2.35			13.7	
18-3 1.10	18-11 1.22	19-6 1.35	20-1 1.48	20-8 1.61	21-3 1.75	21-10 1.89	22-4 2.03	22-10 2.18	23-11 2.48		16.0	
16-8 1.01	17-3 1.12	17-10 1.23	18-4 1.35	18-11 1.47	19-5 1.59	19-11 1.72	20-5 1.85	20-10 1.99	21-10 2.26		19.2	
14-11 0.90	15-5 1.00	15-11 1.10	16-5 1.21	16-11 1.31	17-4 1.43	17-10 1.54	18-3 1.66	18-8 1.78	19-6 2.02	20-8 2.41	24.0	
25-7 1.28	26-6 1.41	27-5 1.56	28-3 1.71	29-1 1.86	29-10 2.02	30-7 2.18	31-4 2.34	32-1 2.51			12.0	2x12
24-0 1.19	24-10 1.32	25-7 1.46	26-5 1.60	27-2 1.74	27-11 1.89	28-8 2.04	29-4 2.19	30-0 2.35			13.7	
22-2 1.10	23-0 1.22	23-9 1.35	24-5 1.48	25-2 1.61	25-10 1.75	26-6 1.89	27-2 2.03	27-10 2.18	29-1 2.48		16.0	
20-3 1.01	21-0 1.12	21-8 1.23	22-4 1.35	23-0 1.47	23-7 1.59	24-2 1.72	24-10 1.85	25-5 1.99	26-6 2.26		19.2	
18-1 0.90	18-9 1.00	19-4 1.10	20-0 1.21	20-6 1.31	21-1 1.43	21-8 1.54	22-2 1.66	22-8 1.78	23-9 2.02	25-2 2.41	24.0	

Note: The required modulus of elasticity, "E", in 1,000,000 pounds per square inch is shown below each span.

TABLE R-3
FLAT OR SLOPED RAFTERS
Supporting Drywall Ceiling
(Flat roof or cathedral ceiling with no attic space)
Live Load - 40 lb. per sq. ft.
Use in Zone 1

DESIGN CRITERIA:
Strength - 15 lbs. per sq. ft. dead load plus 40 lbs. per sq. ft. live load determines required fiber stress.
Deflection - For 40 lbs. per sq. ft. live load, Limited to span in inches divided by 240.

RAFTER SIZE (IN)	SPACING (IN)	Extreme Fiber Stress in Bending, "F_b" (psi).										
		300	400	500	600	700	800	900	1000	1100	1200	1300
2x6	12.0	5-3 0.12	6-1 0.19	6-9 0.27	7-5 0.35	8-0 0.44	8-7 0.54	9-1 0.65	9-7 0.76	10-0 0.88	10-6 1.00	10-11 1.13
	13.7	4-11 0.12	5-8 0.18	6-4 0.25	6-11 0.33	7-6 0.42	8-0 0.51	8-6 0.61	8-11 0.71	9-5 0.82	9-10 0.93	10-3 1.05
	16.0	4-6 0.11	5-3 0.17	5-10 0.23	6-5 0.31	6-11 0.39	7-5 0.47	7-10 0.56	8-3 0.66	8-8 0.76	9-1 0.86	9-5 0.98
	19.2	4-2 0.10	4-9 0.15	5-4 0.21	5-10 0.28	6-4 0.35	6-9 0.43	7-2 0.51	7-7 0.60	7-11 0.69	8-3 0.79	8-8 0.89
	24.0	3-8 0.09	4-3 0.14	4-9 0.19	5-3 0.25	5-8 0.31	6-1 0.38	6-5 0.46	6-9 0.54	7-1 0.62	7-5 0.71	7-9 0.80
2x8	12.0	6-11 0.12	8-0 0.19	8-11 0.27	9-9 0.35	10-7 0.44	11-3 0.54	12-0 0.65	12-7 0.76	13-3 0.88	13-10 1.00	14-5 1.13
	13.7	6-6 0.12	7-6 0.18	8-4 0.25	9-2 0.33	9-11 0.42	10-7 0.51	11-2 0.61	11-10 0.71	12-5 0.82	12-11 0.93	13-6 1.05
	16.0	6-0 0.11	6-11 0.17	7-9 0.23	8-6 0.31	9-2 0.39	9-9 0.47	10-4 0.56	10-11 0.66	11-6 0.76	12-0 0.86	12-6 0.98
	19.2	5-6 0.10	6-4 0.15	7-1 0.21	7-9 0.28	8-4 0.35	8-11 0.43	9-6 0.51	10-0 0.60	10-6 0.69	10-11 0.79	11-5 0.89
	24.0	4-11 0.09	5-8 0.14	6-4 0.19	6-11 0.25	7-6 0.31	8-0 0.38	8-6 0.46	8-11 0.54	9-4 0.62	9-9 0.71	10-2 0.80

2x10	12.0	8-10 0.12	10-2 0.19	11-5 0.27	12-6 0.35	13-6 0.44	14-5 0.54	15-3 0.65	16-1 0.76	16-11 0.88	17-8 1.00	18-4 1.13
	13.7	8-3 0.12	9-6 0.18	10-8 0.25	11-8 0.33	12-7 0.42	13-6 0.51	14-3 0.61	15-1 0.71	15-10 0.82	16-6 0.93	17-2 1.05
	16.0	7-8 0.11	8-10 0.17	9-10 0.23	10-10 0.31	11-8 0.39	12-6 0.47	13-3 0.56	13-11 0.66	14-8 0.76	15-3 0.86	15-11 0.98
	19.2	7-0 0.10	8-1 0.15	9-0 0.21	9-10 0.28	10-8 0.35	11-5 0.43	12-1 0.51	12-9 0.60	13-4 0.69	13-11 0.79	14-6 0.89
	24.0	6-3 0.09	7-2 0.14	8-1 0.19	8-10 0.25	9-6 0.31	10-2 0.38	10-10 0.46	11-5 0.54	11-11 0.62	12-6 0.71	13-0 0.80
2x12	12.0	10-9 0.12	12-5 0.19	13-10 0.27	15-2 0.35	16-5 0.44	17-6 0.54	18-7 0.65	19-7 0.76	20-6 0.88	21-5 1.00	22-4 1.13
	13.7	10-0 0.12	11-7 0.18	12-11 0.25	14-2 0.33	15-4 0.42	16-5 0.51	17-5 0.61	18-4 0.71	19-3 0.82	20-1 0.93	20-11 1.05
	16.0	9-3 0.11	10-9 0.17	12-0 0.23	13-2 0.31	14-2 0.39	15-2 0.47	16-1 0.56	17-0 0.66	17-9 0.76	18-7 0.86	19-4 0.98
	19.2	8-6 0.10	9-10 0.15	10-11 0.21	12-0 0.28	12-11 0.35	13-10 0.43	14-8 0.51	15-6 0.60	16-3 0.69	17-0 0.79	17-8 0.89
	24.0	7-7 0.09	8-9 0.14	9-10 0.19	10-9 0.25	11-7 0.31	12-5 0.38	13-2 0.46	13-10 0.54	14-6 0.62	15-2 0.71	15-9 0.80

Note: The required modulus of elasticity, "E", in 1,000,000 pounds per square inch is shown below each span.

TABLE R-3 (cont.)

RAFTERS: Spans are measured along the horizontal projection and loads are considered as applied on the horizontal projection.

Extreme Fiber Stress in Bending, "F_b" (psi).											RAFTER SPACING (IN)	SIZE (IN)
1400	1500	1600	1700	1800	1900	2000	2100	2200	2400	2700		
11-4 1.26	11-9 1.40	12-1 1.54	12-6 1.68	12-10 1.83	13-2 1.99	13-6 2.15	13-10 2.31	14-2 2.48			12.0	2x6
10-7 1.18	11-0 1.31	11-4 1.44	11-8 1.57	12-0 1.72	12-4 1.86	12-8 2.01	13-0 2.16	13-3 2.32			13.7	
9-10 1.09	10-2 1.21	10-6 1.33	10-10 1.46	11-1 1.59	11-5 1.72	11-9 1.86	12-0 2.00	12-4 2.15	12-10 2.45		16.0	
8-11 0.99	9-3 1.10	9-7 1.22	9-10 1.33	10-2 1.45	10-5 1.57	10-8 1.70	11-0 1.83	11-3 1.96	11-9 2.23		19.2	
8-0 0.89	8-3 0.99	8-7 1.09	8-10 1.19	9-1 1.30	9-4 1.41	9-7 1.52	9-10 1.63	10-0 1.75	10-6 2.00	11-1 2.38	24.0	
14-11 1.26	15-5 1.40	16-0 1.54	16-5 1.68	16-11 1.83	17-5 1.99	17-10 2.15	18-3 2.31	18-9 2.48			12.0	2x8
14-0 1.18	14-6 1.31	14-11 1.44	15-5 1.57	15-10 1.72	16-3 1.86	16-8 2.01	17-1 2.16	17-6 2.32			13.7	
12-11 1.09	13-5 1.21	13-10 1.33	14-3 1.46	14-8 1.59	15-1 1.72	15-5 1.86	15-10 2.00	16-3 2.15	16-11 2.45		16.0	
11-10 0.99	12-3 1.10	12-7 1.22	13-0 1.33	13-5 1.45	13-9 1.57	14-1 1.70	14-6 1.83	14-10 1.96	15-5 2.23		19.2	
10-7 0.89	10-11 0.99	11-3 1.09	11-8 1.19	12-0 1.30	12-4 1.41	12-7 1.52	12-11 1.63	13-3 1.75	13-10 2.00	14-8 2.38	24.0	

19-1 1.26	19-9 1.40	20-4 1.54	21-0 1.68	21-7 1.83	22-2 1.99	22-9 2.15	23-4 2.31	23-11 2.48			12.0	2x10
17-10 1.18	18-5 1.31	19-1 1.44	19-8 1.57	20-2 1.72	20-9 1.86	21-4 2.01	21-10 2.16	22-4 2.32			13.7	
16-6 1.09	17-1 1.21	17-8 1.33	18-2 1.46	18-9 1.59	19-3 1.72	19-9 1.86	20-2 2.00	20-8 2.15	21-7 2.45		16.0	
15-1 0.99	15-7 1.10	16-1 1.22	16-7 1.33	17-1 1.45	17-7 1.57	18-0 1.70	18-5 1.83	18-11 1.96	19-9 2.23		19.2	
13-6 0.89	13-11 0.99	14-5 1.09	14-10 1.19	15-3 1.30	15-8 1.41	16-1 1.52	16-6 1.63	16-11 1.75	17-8 2.00	18-9 2.38	24.0	
23-2 1.26	24-0 1.40	24-9 1.54	25-6 1.68	26-3 1.83	27-0 1.99	27-8 2.15	28-5 2.31	29-1 2.48			12.0	2x12
21-8 1.18	22-5 1.31	23-2 1.44	23-11 1.57	24-7 1.72	25-3 1.86	25-11 2.01	26-7 2.16	27-2 2.32			13.7	
20-1 1.09	20-9 1.21	21-5 1.33	22-1 1.46	22-9 1.59	23-5 1.72	24-0 1.86	24-7 2.00	25-2 2.15	26-3 2.45		16.0	
18-4 0.99	19-0 1.10	19-7 1.22	20-2 1.33	20-9 1.45	21-4 1.57	21-11 1.70	22-5 1.83	23-0 1.96	24-0 2.23		19.2	
16-5 0.89	17-0 0.99	17-6 1.09	18-1 1.19	18-7 1.30	19-1 1.41	19-7 1.52	20-1 1.63	20-6 1.75	21-5 2.00	22-9 2.38	24.0	

Note: The required modulus of elasticity, "E", in 1,000,000 pounds per square inch is shown below each span.

TABLE R-5
FLAT OR SLOPED RAFTERS
Supporting Plaster Ceiling
(Flat roof or cathedral ceiling with no attic space)
Live Load - 30 lb. per sq. ft.
Use in Zone 2

DESIGN CRITERIA:
Strength - 15 lbs. per sq. ft. dead load plus 30 lbs. per sq. ft. live load determines required fiber stress.
Deflection - For 30 lbs. per sq. ft. live load. Limited to Span in inches divided by 360.

RAFTER SIZE (IN)	SPACING (IN)	Extreme Fiber Stress in Bending, "F_b" (psi).									
		300	400	500	600	700	890	900	1000	1100	1200
2x6	12.0	5-10 0.19	6-8 0.29	7-6 0.41	8-2 0.54	8-10 0.68	9-6 0.83	10-0 0.99	10-7 1.15	11-1 1.33	11-7 1.52
	13.7	5-5 0.18	6-3 0.27	7-0 0.38	7-8 0.50	8-3 0.63	8-10 0.77	9-5 0.92	9-11 1.08	10-5 1.25	10-10 1.42
	16.0	5-0 0.16	5-10 0.25	6-6 0.35	7-1 0.46	7-8 0.59	8-2 0.72	8-8 0.85	9-2 1.00	9-7 1.15	10-0 1.31
	19.2	4-7 0.15	5-4 0.23	5-11 0.32	6-6 0.42	7-0 0.53	7-6 0.65	7-11 0.78	8-4 0.91	8-9 1.05	9-2 1.20
	24.0	4-1 0.13	4-9 0.21	5-4 0.29	5-10 0.38	6-3 0.48	6-8 0.58	7-1 0.70	7-6 0.82	7-10 0.94	8-2 1.07
2x8	12.0	7-8 0.19	8-10 0.29	9-10 0.41	10-10 0.54	11-8 0.68	12-6 0.83	13-3 0.99	13-11 1.15	14-8 1.33	15-3 1.52
	13.7	7-2 0.18	8-3 0.27	9-3 0.38	10-1 0.50	10-11 0.63	11-8 0.77	12-5 0.92	13-1 1.08	13-8 1.25	14-4 1.42
	16.0	6-7 0.16	7-8 0.25	8-7 0.35	9-4 0.46	10-1 0.59	10-10 0.72	11-6 0.85	12-1 1.00	12-8 1.15	13-3 1.31
	19.2	6-1 0.15	7-0 0.23	7-10 0.32	8-7 0.42	9-3 0.53	9-10 0.65	10-6 0.78	11-0 0.91	11-7 1.05	12-1 1.20
	24.0	5-5 0.13	6-3 0.21	7-0 0.29	7-8 0.38	8-3 0.48	8-10 0.58	9-4 0.70	9-10 0.82	10-4 0.94	10-10 1.07

2x10	12.0	9-9 0.19	11-3 0.29	12-7 0.41	13-9 0.54	14-11 0.68	15-11 0.83	16-11 0.99	17-10 1.15	18-8 1.33	19-6 1.52
	13.7	9-1 0.18	10-6 0.27	11-9 0.38	12-11 0.50	13-11 0.63	14-11 0.77	15-10 0.92	16-8 1.08	17-6 1.25	18-3 1.42
	16.0	8-5 0.16	9-9 0.25	10-11 0.35	11-11 0.46	12-11 0.59	13-9 0.72	14-8 0.85	15-5 1.00	16-2 1.15	16-11 1.31
	19.2	7-8 0.15	8-11 0.23	9-11 0.32	10-11 0.42	11-9 0.53	12-7 0.65	13-4 0.78	14-1 0.91	14-9 1.05	15-5 1.20
	24.0	6-11 0.13	8-0 0.21	8-11 0.29	9-9 0.38	10-6 0.48	11-3 0.58	11-11 0.70	12-7 0.82	13-2 0.94	13-9 1.07
2x12	12.0	11-10 0.19	13-8 0.29	15-4 0.41	16-9 0.54	18-1 0.68	19-4 0.83	20-6 0.99	21-8 1.15	22-8 1.33	23-9 1.52
	13.7	11-1 0.18	12-10 0.27	14-4 0.38	15-8 0.50	16-11 0.63	18-1 0.77	19-3 0.92	20-3 1.08	21-3 1.25	22-2 1.42
	16.0	10-3 0.16	11-10 0.25	13-3 0.35	14-6 0.46	15-8 0.59	16-9 0.72	17-9 0.85	18-9 1.00	19-8 1.15	20-6 1.31
	19.2	9-5 0.15	10-10 0.23	12-1 0.32	13-3 0.42	14-4 0.53	15-4 0.65	16-3 0.78	17-1 0.91	17-11 1.05	18-9 1.20
	24.0	8-5 0.13	9-8 0.21	10-10 0.29	11-10 0.38	12-10 0.48	13-8 0.58	14-6 0.70	15-4 0.82	16-1 0.94	16-9 1.07

Note: The required modulus of elasticity, "E", in 1,000,000 pounds per square inch is shown below each span.

TABLE R-5 (cont.)

RAFTERS: Spans are measured along the horizontal projection and loads are considered as applied on the horizontal projection.

Extreme Fiber Stress in Bending, "F_b" (psi).									RAFTER SPACING (IN)	SIZE (IN)
1300	1400	1500	1600	1700	1800	1900	2000	2100		
12-1 1.71	12-6 1.91	13-0 2.12	13-5 2.34	13-10 2.56					12.0	2x6
11-3 1.60	11-9 1.79	12-2 1.98	12-6 2.19	12-11 2.39					13.7	
10-5 1.48	10-10 1.66	11-3 1.84	11-7 2.02	11-11 2.22	12-4 2.41				16.0	
9-6 1.35	9-11 1.51	10-3 1.68	10-7 1.85	10-11 2.02	11-3 2.20	11-6 2.39	11-10 2.58		19.2	
8-6 1.21	8-10 1.35	9-2 1.50	9-6 1.65	9-9 1.81	10-0 1.97	10-4 2.14	10-7 2.31	10-10 2.48	24.0	
15-11 1.71	16-6 1.91	17-1 2.12	17-8 2.34	18-2 2.56					12.0	2x8
14-11 1.60	15-5 1.79	16-0 1.98	16-6 2.19	17-0 2.39					13.7	
13-9 1.48	14-4 1.66	14-10 1.84	15-3 2.02	15-9 2.22	16-3 2.41				16.0	
12-7 1.35	13-1 1.51	13-6 1.68	13-11 1.85	14-5 2.02	14-10 2.20	15-2 2.39	15-7 2.58		19.2	
11-3 1.21	11-8 1.35	12-1 1.50	12-6 1.65	12-10 1.81	13-3 1.97	13-7 2.14	13-11 2.31	14-4 2.48	24.0	

20-4 1.71	21-1 1.91	21-10 2.12	22-6 2.34	23-3 2.56					12.0	
19-0 1.60	19-8 1.79	20-5 1.98	21-1 2.19	21-9 2.39					13.7	
17-7 1.48	18-3 1.66	18-11 1.84	19-6 2.02	20-1 2.22	20-8 2.41				16.0	2x10
16-1 1.35	16-8 1.51	17-3 1.68	17-10 1.85	18-4 2.02	18-11 2.20	19-5 2.39	19-11 2.58		19.2	
14-4 1.21	14-11 1.35	15-5 1.50	15-11 1.65	16-5 1.81	16-11 1.97	17-4 2.14	17-10 2.31	18-3 2.48	24.0	
24-8 1.71	25-7 1.91	26-6 2.12	27-5 2.34	28-3 2.56					12.0	
23-1 1.60	24-0 1.79	24-10 1.98	25-7 2.19	26-5 2.39					13.7	
21-5 1.48	22-2 1.66	23-0 1.84	23-9 2.02	24-5 2.22	25-2 2.41				16.0	2x12
19-6 1.35	20-3 1.51	21-0 1.68	21-8 1.85	22-4 2.02	23-0 2.20	23-7 2.39	24-2 2.58		19.2	
17-5 1.21	18-1 1.35	18-9 1.50	19-4 1.65	20-0 1.81	20-6 1.97	21-1 2.14	21-8 2.31	22-2 2.48	24.0	

Note: The required modulus of elasticity, "E", in 1,000,000 pounds per square inch is shown below each span.

TABLE R-6
FLAT OR SLOPED RAFTERS
Supporting Plaster Ceiling
(Flat roof or cathedral ceiling with no attic space)
Live Load - 40 lb. per sq. ft.
Use in Zone 1

DESIGN CRITERIA::
Strength - 15 lbs. per sq. ft. dead load plus 40 lbs. per sq. ft. live load determines required fiber stress.
Deflection - For 40 lbs. per sq. ft. live load. Limited to span in inches divided by 360.

RAFTER SIZE (IN)	SPACING (IN)	Extreme Fiber Stress in Bending, "F_b" (psi).									
		300	400	500	600	700	800	900	1000	1100	1200
2x6	12.0	5-3 0.19	6-1 0.29	6-9 0.40	7-5 0.53	8-0 0.67	8-7 0.82	9-1 0.97	9-7 1.14	10-0 1.31	10-6 1.50
	13.7	4-11 0.18	5-8 0.27	6-4 0.38	6-11 0.50	7-6 0.62	8-0 0.76	8-6 0.91	8-11 1.07	9-5 1.23	9-10 1.40
	16.0	4-6 0.16	5-3 0.25	5-10 0.35	6-5 0.46	6-11 0.58	7-5 0.71	7-10 0.84	8-3 0.99	8-8 1.14	9-1 1.30
	19.2	4-2 0.15	4-9 0.23	5-4 0.32	5-10 0.42	6-4 0.53	6-9 0.64	7-2 0.77	7-7 0.90	7-11 1.04	8-3 1.18
	24.0	3-8 0.13	4-3 0.20	4-9 0.28	5-3 0.37	5-8 0.47	6-1 0.58	6-5 0.69	6-9 0.81	7-1 0.93	7-5 1.06
2x8	12.0	6-11 0.19	8-0 0.29	8-11 0.40	9-9 0.53	10-7 0.67	11-3 0.82	12-0 0.97	12-7 1.14	13-3 1.31	13-10 1.50
	13.7	6-6 0.18	7-6 0.27	8-4 0.38	9-2 0.50	9-11 0.62	10-7 0.76	11-2 0.91	11-10 1.07	12-5 1.23	12-11 1.40
	16.0	6-0 0.16	6-11 0.25	7-9 0.35	8-6 0.46	9-2 0.58	9-9 0.71	10-4 0.84	10-11 0.99	11-6 1.14	12-0 1.30
	19.2	5-6 0.15	6-4 0.23	7-1 0.32	7-9 0.42	8-4 0.53	8-11 0.64	9-6 0.77	10-0 0.90	10-6 1.04	10-11 1.18
	24.0	4-11 0.13	5-8 0.20	6-4 0.28	6-11 0.37	7-6 0.47	8-0 0.58	8-6 0.69	8-11 0.81	9-4 0.93	9-9 1.06

2x10	12.0	8-10 0.19	10-2 0.29	11-5 0.40	12-6 0.53	13-6 0.67	14-5 0.82	15-3 0.97	16-1 1.14	16-11 1.31	17-8 1.50
	13.7	8-3 0.18	9-6 0.27	10-8 0.38	11-8 0.50	12-7 0.62	13-6 0.76	14-3 0.91	15-1 1.07	15-10 1.23	16-6 1.40
	16.0	7-8 0.16	8-10 0.25	9-10 0.35	10-10 0.46	11-8 0.58	12-6 0.71	13-3 0.84	13-11 0.99	14-8 1.14	15-3 1.30
	19.2	7-0 0.15	8-1 0.23	9-0 0.32	9-10 0.42	10-8 0.53	11-5 0.64	12-1 0.77	12-9 0.90	13-4 1.04	13-11 1.18
	24.0	6-3 0.13	7-2 0.20	8-1 0.28	8-10 0.37	9-6 0.47	10-2 0.58	10-10 0.69	11-5 0.81	11-11 0.93	12-6 1.06
2x12	12.0	10-9 0.19	12-5 0.29	13-10 0.40	15-2 0.53	16-5 0.67	17-6 0.82	18-7 0.97	19-7 1.14	20-6 1.31	21-5 1.50
	13.7	10-0 0.18	11-7 0.27	12-11 0.38	14-2 0.50	15-4 0.62	16-5 0.76	17-5 0.91	18-4 1.07	19-3 1.23	20-1 1.40
	16.0	9-3 0.16	10-9 0.25	12-0 0.35	13-2 0.46	14-2 0.58	15-2 0.71	16-1 0.84	17-0 0.99	17-9 1.14	18-7 1.30
	19.2	8-6 0.15	9-10 0.23	10-11 0.32	12-0 0.42	12-11 0.53	13-10 0.64	14-8 0.77	15-6 0.90	16-3 1.04	17-0 1.18
	24.0	7-7 0.13	8-9 0.20	9-10 0.28	10-9 0.37	11-7 0.47	12-5 0.58	13-2 0.69	13-10 0.81	14-6 0.93	15-2 1.06

Note: The required modulus of elasticity, "E", in 1,000,000 pounds per square inch is shown below each span.

TABLE R-6 (cont.)

RAFTERS: Spans are measured along the horizontal projection and loads are considered as applied on the horizontal projection.

Extreme Fiber Stress in Bending, "F_b" (psi).									RAFTER SPACING (IN)	SIZE (IN)
1300	1400	1500	1600	1700	1800	1900	2000	2100		
10-11 1.69	11-4 1.89	11-9 2.09	12-1 2.31	12-6 2.53					12.0	
10-3 1.58	10-7 1.77	11-0 1.96	11-4 2.16	11-8 2.36	12-0 2.57				13.7	
9-5 1.46	9-10 1.63	10-2 1.81	10-6 2.00	10-10 2.19	11-1 2.38	11-5 2.58			16.0	2x6
8-8 1.34	8-11 1.49	9-3 1.65	9-7 1.82	9-10 2.00	10-2 2.18	10-5 2.36	10-8 2.55		19.2	
7-9 1.19	8-0 1.33	8-3 1.48	8-7 1.63	8-10 1.79	9-1 1.95	9-4 2.11	9-7 2.28	9-10 2.45	24.0	
14-5 1.69	14-11 1.89	15-5 2.09	16-0 2.31	16-5 2.53					12.0	
13-6 1.58	14-0 1.77	14-6 1.96	14-11 2.16	15-5 2.36	15-10 2.57				13.7	
12-6 1.46	12-11 1.63	13-5 1.81	13-10 2.00	14-3 2.19	14-8 2.38	15-1 2.58			16.0	2x8
11-5 1.34	11-10 1.49	12-3 1.65	12-7 1.82	13-0 2.00	13-5 2.18	13-9 2.36	14-1 2.55		19.2	
10-2 1.19	10-7 1.33	10-11 1.48	11-3 1.63	11-8 1.79	12-0 1.95	12-4 2.11	12-7 2.28	12-11 2.45	24.0	

18-4 1.69	19-1 1.89	19-9 2.09	20-4 2.31	21-0 2.53					12.0	2x10
17-2 1.58	17-10 1.77	18-5 1.96	19-1 2.16	19-8 2.36	20-2 2.57				13.7	
15-11 1.46	16-6 1.63	17-1 1.81	17-8 2.00	18-2 2.19	18-9 2.38	19-3 2.58			16.0	
14-6 1.34	15-1 1.49	15-7 1.65	16-1 1.82	16-7 2.00	17-1 2.18	17-7 2.36	18-0 2.55		19.2	
13-0 1.19	13-6 1.33	13-11 1.48	14-5 1.63	14-10 1.79	15-3 1.95	15-8 2.11	16-1 2.28	16-6 2.45	24.0	
22-4 1.69	23-2 1.89	24-0 2.09	24-9 2.31	25-6 2.53					12.0	2x12
20-11 1.58	21-8 1.77	22-6 1.96	23-2 2.16	23-11 2.36	24-7 2.57				13.7	
19-4 1.46	20-1 1.63	20-9 1.81	21-5 2.00	22-1 2.19	22-9 2.38	23-5 2.58			16.0	
17-8 1.34	18-4 1.49	19-0 1.65	19-7 1.82	20-2 2.00	20-9 2.18	21-4 2.36	21-11 2.55		19.2	
15-9 1.19	16-5 1.33	17-0 1.48	17-6 1.63	18-1 1.79	18-7 1.95	19-1 2.11	19-7 2.28	20-1 2.45	24.0	

Note: The required modulus of elasticity, "E", in 1,000,000 pounds per square inch is shown below each span.

TABLE R-8
FLAT OR LOW SLOPE RAFTERS
No Ceiling Load
Slope 3 in 12 or less
Live Load - 30 lb. per. sq. ft.
Use in Zone 2

DESIGN CRITERIA:
Strength - 10 lbs. per sq. ft. dead load plus 30 lbs. per sq. ft. live load determines required fiber stress.
Deflection - For 30 lbs. per sq. ft. live load. Limited to span in inches divided by 240.

RAFTER SIZE (IN)	SPACING (IN)	Extreme Fiber Stress In Bending, "F_b" (psi).										
		300	400	500	600	700	800	900	1000	1100	1200	1300
2x6	12.0	6-2 0.15	7-1 0.23	7-11 0.32	8-8 0.43	9-5 0.54	10-0 0.66	10-8 0.78	11-3 0.92	11-9 1.06	12-4 1.21	12-10 1.36
	13.7	5-9 0.14	6-8 0.22	7-5 0.30	8-2 0.40	8-9 0.50	9-5 0.61	10-0 0.73	10-6 0.86	11-0 0.99	11-6 1.13	12-0 1.27
	16.0	5-4 0.13	6-2 0.20	6-11 0.28	7-6 0.37	8-2 0.47	8-8 0.57	9-3 0.68	9-9 0.80	10-2 0.92	10-8 1.05	11-1 1.18
	19.2	4-10 0.12	5-7 0.18	6-3 0.26	6-11 0.34	7-5 0.43	7-11 0.52	8-5 0.62	8-11 0.73	9-4 0.84	9-9 0.95	10-1 1.08
	24.0	4-4 0.11	5-0 0.16	5-7 0.23	6-2 0.30	6-8 0.38	7-1 0.46	7-6 0.55	7-11 0.65	8-4 0.75	8-8 0.85	9-1 0.96
2x8	12.0	8-1 0.15	9-4 0.23	10-6 0.32	11-6 0.43	12-5 0.54	13-3 0.66	14-0 0.78	14-10 0.92	15-6 1.06	16-3 1.21	16-10 1.36
	13.7	7-7 0.14	8-9 0.22	9-9 0.30	10-9 0.40	11-7 0.50	12-5 0.61	13-2 0.73	13-10 0.86	14-6 0.99	15-2 1.13	15-9 1.27
	16.0	7-0 0.13	8-1 0.20	9-1 0.28	9-11 0.37	10-9 0.47	11-6 0.57	12-2 0.68	12-10 0.80	13-5 0.92	14-0 1.05	14-7 1.18
	19.2	6-5 0.12	7-5 0.18	8-3 0.26	9-1 0.34	9-9 0.43	10-6 0.52	11-1 0.62	11-8 0.73	12-3 0.84	12-10 0.95	13-4 1.08
	24.0	5-9 0.11	6-7 0.16	7-5 0.23	8-1 0.30	8-9 0.38	9-4 0.46	9-11 0.55	10-6 0.65	11-0 0.75	11-6 0.85	11-11 0.96

2x10	12.0	10-4 0.15	11-11 0.23	13-4 0.32	14-8 0.43	15-10 0.54	16-11 0.66	17-11 0.78	18-11 0.92	19-10 1.06	20-8 1.21	21-6 1.36
	13.7	9-8 0.14	11-2 0.22	12-6 0.30	13-8 0.40	14-9 0.50	15-10 0.61	16-9 0.73	17-8 0.86	18-6 0.99	19-4 1.13	20-2 1.27
	16.0	8-11 0.13	10-4 0.20	11-7 0.28	12-8 0.37	13-8 0.47	14-8 0.57	15-6 0.68	16-4 0.80	17-2 0.92	17-11 1.05	18-8 1.18
	19.2	8-2 0.12	9-5 0.18	10-7 0.26	11-7 0.34	12-6 0.43	13-4 0.52	14-2 0.62	14-11 0.73	15-8 0.84	16-4 0.95	17-0 1.08
	24.0	7-4 0.11	8-5 0.16	9-5 0.23	10-4 0.30	11-2 0.38	11-11 0.46	12-8 0.55	13-4 0.65	14-0 0.75	14-8 0.85	15-3 0.96
2x12	12.0	12-7 0.15	14-6 0.23	16-3 0.32	17-9 0.43	19-3 0.54	20-6 0.66	21-9 0.78	23-0 0.92	24-1 1.06	25-2 1.21	26-2 1.36
	13.7	11-9 0.14	13-7 0.22	15-2 0.30	16-8 0.40	18-0 0.50	19-3 0.61	20-5 0.73	21-6 0.86	22-6 0.99	23-6 1.13	24-6 1.27
	16.0	10-11 0.13	12-7 0.20	14-1 0.28	15-5 0.37	16-8 0.47	17-9 0.57	18-10 0.68	19-11 0.80	20-10 0.92	21-9 1.05	22-8 1.18
	19.2	9-11 0.12	11-6 0.18	12-10 0.26	14-1 0.34	15-2 0.43	16-3 0.52	17-3 0.62	18-2 0.73	19-0 0.84	19-11 0.95	20-8 1.08
	24.0	8-11 0.11	10-3 0.16	11-6 0.23	12-7 0.30	13-7 0.38	14-6 0.46	15-5 0.55	16-3 0.65	17-0 0.75	17-9 0.85	18-6 0.96

Note: The required modulus of elasticity, "E", in 1,000,000 pounds per square inch is shown below each span.

TABLE R-8 (cont.)

RAFTERS: Spans are measured along the horizontal projection and loads are considered as applied on the horizontal projection.

Extreme Fiber Stress in Bending, "F_b" (psi).										RAFTER SPACING (IN)	SIZE (IN)
1400	1500	1600	1700	1800	1900	2000	2100	2200	2400		
13-3 1.52	13-9 1 69	14-2 1.86	14-8 2.04	15-1 2.22	15-6 2.41	15-11 2.60				12.0	
12-5 1.42	12-10 1.58	13-3 1.74	13-8 1.90	14-1 2.08	14-6 2.25	14-10 2.43				13.7	
11-6 1.32	11-11 1.46	12-4 1.61	12-8 1.76	13-1 1.92	13-5 2.08	13-9 2.25	14-1 2.42	14-5 2.60		16.0	2x6
10-6 1.20	10-10 1.33	11-3 1.47	11-7 1.61	11-11 1.75	12-3 1.90	12-7 2.05	12-10 2.21	13-2 2.37		19.2	
9-5 1.08	9-9 1.19	10-0 1.31	10-4 1.44	10-8 1.57	10-11 1.70	11-3 1.84	11-6 1.98	11-9 2.12	12-4 2.41	24.0	
17-6 1.52	18-2 1.69	18-9 1.86	19-4 2.04	19-10 2.22	20-5 2.41	20-11 2.60				12.0	
16-5 1.42	16-11 1.58	17-6 1.74	18-1 1.90	18-7 2.08	19-1 2.25	19-7 2.43				13.7	
15-2 1.32	15-8 1.46	16-3 1.61	16-9 1.76	17-2 1.92	17-8 2.08	18-2 2.25	18-7 2.42	19-0 2.60		16.0	2x8
13-10 1.20	14-4 1.33	14-10 1.47	15-3 1.61	15-8 1.75	16-2 1.90	16-7 2.05	16-11 2.21	17-4 2.37		19.2	
12-5 1.08	12-10 1.19	13-3 1.31	13-8 1.44	14-0 1.57	14-5 1.70	14-10 1.84	15-2 1.98	15-6 2.12	16-3 2.41	24.0	

22-4 1.52	23-2 1.69	23-11 1.86	24-7 2.04	25-4 2.22	26-0 2.41	26-8 2.60				12.0	
20-11 1.42	21-8 1.58	22-4 1.74	23-0 1.90	23-8 2.08	24-4 2.25	25-0 2.43				13.7	
19-4 1.32	20-0 1.46	20-8 1.61	21-4 1.76	21-11 1.92	22-6 2.08	23-2 2.25	23-8 2.42	24-3 2.60		16.0	2x10
17-8 1.20	18-3 1.33	18-11 1.47	19-6 1.61	20-0 1.75	20-7 1.90	21-1 2.05	21-8 2.21	22-2 2.37		19.2	
15-10 1.08	16-4 1.19	16-11 1.31	17-5 1.44	17-11 1.57	18-5 1.70	18-11 1.84	19-4 1.98	19-10 2.12	20-8 2.41	24.0	
27-2 1.52	28-2 1.69	29-1 1.86	29-11 2.04	30-10 2.22	31-8 2.41	32-6 2.60				12.0	
25-5 1.42	26-4 1.58	27-2 1.74	28-0 1.90	28-10 2.08	29-7 2.25	30-5 2.43				13.7	
23-6 1.32	24-4 1.46	25-2 1.61	25-11 1.76	26-8 1.92	27-5 2.08	28-2 2.25	28-10 2.42	29-6 2.60		16.0	2x12
21-6 1.20	22-3 1.33	23-0 1.47	23-8 1.61	24-4 1.75	25-0 1.90	25-8 2.05	26-4 2.21	26-11 2.37		19.2	
19-3 1.08	19-11 1.19	20-6 1.31	21-2 1.44	21-9 1.57	22-5 1.70	23-0 1.84	23-6 1.98	24-1 2.12	25-2 2.41	24.0	

Note: The required modulus of elasticity, "E", in 1,000,000 pounds per square inch is shown below each span.

TABLE R-9
FLAT OR LOW SLOPE RAFTERS
No Ceiling Load
Slope 3 in 12 or less
Live Load - 40 lb. per. sq. ft.
Use in Zone 1

DESIGN CRITERIA:
Strength - 10 lbs. per sq. ft. dead load plus 40 lbs. per sq. ft. live load determines required fiber stress.
Deflection - For 40 lbs. per sq. ft. live load. Limited to span in inches divided by 240.

RAFTER SIZE	SPACING (IN)	Extreme Fiber Stress in Bending, "F_b" (psi).										
		300	400	500	600	700	800	900	1000	1100	1200	1300
2x6	12.0	5-6 0.14	6-4 0.22	7-1 0.31	7-9 0.41	8-5 0.51	9-0 0.63	9-6 0.75	10-0 0.88	10-6 1.01	11-0 1.15	11-5 1.30
	13.7	5-2 0.13	5-11 0.21	6-8 0.29	7-3 0.38	7-10 0.48	8-5 0.59	8-11 0.70	9-5 0.82	9-10 0.95	10-3 1.08	10-9 1.22
	16.0	4-9 0.12	5-6 0.19	6-2 0.27	6-9 0.35	7-3 0.44	7-9 0.54	8-3 0.65	8-8 0.76	9-1 0.88	9-6 1.00	9-11 1.12
	19.2	4-4 0.11	5-0 0.18	5-7 0.24	6-2 0.32	6-8 0.41	7-1 0.50	7-6 0.59	7-11 0.69	8-4 0.80	8-8 0.91	9-1 1.03
	24.0	3-11 0.10	4-6 0.16	5-0 0.22	5-6 0.29	5-11 0.36	6-4 0.44	6-9 0.53	7-1 0.62	7-5 0.71	7-9 0.81	8-1 0.92
2x8	12.0	7-3 0.14	8-4 0.22	9-4 0.31	10-3 0.41	11-1 0.51	11-10 0.63	12-7 0.75	13-3 0.88	13-11 1.01	14-6 1.15	15-1 1.30
	13.7	6-9 0.13	7-10 0.21	8-9 0.29	9-7 0.38	10-4 0.48	11-1 0.59	11-9 0.70	12-5 0.82	13-0 0.95	13-7 1.08	14-1 1.22
	16.0	6-3 0.12	7-3 0.19	8-1 0.27	8-11 0.35	9-7 0.44	10-3 0.54	10-11 0.65	11-6 0.76	12-0 0.88	12-7 1.00	13-1 1.12
	19.2	5-9 0.11	6-7 0.18	7-5 0.24	8-1 0.32	8-9 0.41	9-4 0.50	9-11 0.59	10-6 0.69	11-0 0.80	11-6 0.91	11-11 1.03
	24.0	5-2 0.10	5-11 0.16	6-7 0.22	7-3 0.29	7-10 0.36	8-4 0.44	8-11 0.53	9-4 0.62	9-10 0.71	10-3 0.81	10-8 0.92

2x10	12.0	9-3 0.14	10-8 0.22	11-11 0.31	13-1 0.41	14-2 0.51	15-1 0.63	16-0 0.75	16-11 0.88	17-9 1.01	18-6 1.15	19-3 1.30
	13.7	8-8 0.13	10-0 0.21	11-2 0.29	12-3 0.38	13-3 0.48	14-2 0.59	15-0 0.70	15-10 0.82	16-7 0.95	17-4 1.08	18-0 1.22
	16.0	8-0 0.12	9-3 0.19	10-4 0.27	11-4 0.35	12-3 0.44	13-1 0.54	13-11 0.65	14-8 0.76	15-4 0.88	16-0 1.00	16-8 1.12
	19.2	7-4 0.11	8-5 0.18	9-5 0.24	10-4 0.32	11-2 0.41	11-11 0.50	12-8 0.59	13-4 0.69	14-0 0.80	14-8 0.91	15-3 1.03
	24.0	6-6 0.10	7-7 0.16	8-5 0.22	9-3 0.29	10-0 0.36	10-8 0.44	11-4 0.53	11-11 0.62	12-6 0.71	13-1 0.81	13-7 0.92
2x12	12.0	11-3 0.14	13-0 0.22	14-6 0.31	15-11 0.41	17-2 0.51	18-4 0.63	19-6 0.75	20-6 0.88	21-7 1.01	22-6 1.15	23-5 1.30
	13.7	10-6 0.13	12-2 0.21	13-7 0.29	14-11 0.38	16-1 0.48	17-2 0.59	18-3 0.70	19-3 0.82	20-2 0.95	21-1 1.08	21-11 1.22
	16.0	9-9 0.12	11-3 0.19	12-7 0.27	13-9 0.35	14-11 0.44	15-11 0.54	16-11 0.65	17-9 0.76	18-8 0.88	19-6 1.00	20-3 1.12
	19.2	8-11 0.11	10-3 0.18	11-6 0.24	12-7 0.32	13-7 0.41	14-6 0.50	15-5 0.59	16-3 0.69	17-0 0.80	17-9 0.91	18-6 1.03
	24.0	7-11 0.10	9-2 0.16	10-3 0.22	11-3 0.29	12-2 0.36	13-0 0.44	13-9 0.53	14-6 0.62	15-3 0.71	15-11 0.81	16-7 0.92

Note: The required modulus of elasticity, "E", in 1,000,000 pounds per square inch is shown below each span.

TABLE R-9 (cont.)

RAFTERS: Spans are measured along the horizontal projection and loads are considered as applied on the horizontal projection.

Extreme Fiber Stress in Bending, "F_b" (psi).										RAFTER SPACING (IN)	SIZE (IN)
1400	1500	1600	1700	1800	1900	2000	2100	2200	2400		
11-11 1.45	12-4 1.61	12-8 1.77	13-1 1.94	13-6 2.12	13-10 2.30	14-2 2.48				12.0	
11-1 1.36	11-6 1.51	11-11 1.66	12-3 1.82	12-7 1.98	12-11 2.15	13-3 2.32	13-7 2.49			13.7	
10-3 1.26	10-8 1.39	11-0 1.54	11-4 1.68	11-8 1.83	12-0 1.99	12-4 2.15	12-7 2.31	12-11 2.48		16.0	2x6
9-5 1.15	9-9 1.27	10-0 1.40	10-4 1.54	10-8 1.67	10-11 1.81	11-3 1.96	11-6 2.11	11-9 2.26	12-4 2.58	19.2	
8-5 1.03	8-8 1.14	9-0 1.25	9-3 1.37	9-6 1.50	9-9 1.62	10-0 1.75	10-3 1.89	10-6 2.02	11-0 2.30	24.0	
15-8 1.45	16-3 1.61	16-9 1.77	17-3 1.94	17-9 2.12	18-3 2.30	18-9 2.48				12.0	
14-8 1.36	15-2 1.51	15-8 1.66	16-2 1.82	16-7 1.98	17-1 2.15	17-6 2.32	17-11 2.49			13.7	
13-7 1.26	14-0 1.39	14-6 1.54	14-11 1.68	15-5 1.83	15-10 1.99	16-3 2.15	16-7 2.31	17-0 2.48		16.0	2x8
12-5 1.15	12-10 1.27	13-3 1.40	13-8 1.54	14-0 1.67	14-5 1.81	14-10 1.96	15-2 2.11	15-6 2.26	16-3 2.58	19.2	
11-1 1.03	11-6 1.14	11-10 1.25	12-2 1.37	12-7 1.50	12-11 1.62	13-3 1.75	13-7 1.89	13-11 2.02	14-6 2.30	24.0	

20-0 1.45	20-8 1.61	21-4 1.77	22-0 1.94	22-8 2.12	23-3 2.30	23-11 2.48				12.0	2x10
18-8 1.36	19-4 1.51	20-0 1.66	20-7 1.82	21-2 1.98	21-9 2.15	22-4 2.32	22-11 2.49			13.7	
17-4 1.26	17-11 1.39	18-6 1.54	19-1 1.68	19-7 1.83	20-2 1.99	20-8 2.15	21-2 2.31	21-8 2.48		16.0	
15-10 1.15	16-4 1.27	16-11 1.40	17-5 1.54	17-11 1.67	18-5 1.81	18-11 1.96	19-4 2.11	19-10 2.26	20-8 2.58	19.2	
14-2 1.03	14-8 1.14	15-1 1.25	15-7 1.37	16-0 1.50	16-6 1.62	16-11 1.75	17-4 1.89	17-9 2.02	18-6 2.30	24.0	
24-4 1.45	25-2 1.61	26-0 1.77	26-9 1.94	27-7 2.12	28-4 2.30	29-1 2.48				12.0	2x12
22-9 1.36	23-6 1.51	24-4 1.66	25-1 1.82	25-9 1.98	26-6 2.15	27-2 2.32	27-10 2.49			13.7	
21-1 1.26	21-9 1.39	22-6 1.54	23-2 1.68	23-10 1.83	24-6 1.99	25-2 2.15	25-9 2.31	26-5 2.48		16.0	
19-3 1.15	19-11 1.27	20-6 1.40	21-2 1.54	21-9 1.67	22-5 1.81	23-0 1.96	23-6 2.11	24-1 2.26	25-2 2.58	19.2	
17-2 1.03	17-9 1.14	18-4 1.25	18-11 1.37	19-6 1.50	20-0 1.62	20-6 1.75	21-1 1.89	21-7 2.02	22-6 2.30	24.0	

Note: The required modulus of elasticity, "E", in 1,000,000 pounds per inch is shown below each span.

TABLE R-11
MEDIUM OR HIGH SLOPE RAFTERS
No Ceiling Load
Slope over 3 in 12
Live Load - 30 lb. per. sq. ft.
(Heavy roof covering)
Use in Zone 2

DESIGN CRITERIA:
Strength - 15 lbs. per sq. ft. dead load plus 30 lbs. per sq. ft. live load determines required fiber stress.
Deflection - For 30 lbs. per sq. ft. live load. Limited to span in inches divided by 180.

RAFTER SIZE	SPACING (IN)	Extreme Fiber Stress in Bending, "F_b" (psi).											
		200	300	400	500	600	700	800	900	1000	1100	1200	1300
2x4	12.0	3-0 0.05	3-8 0.09	4-3 0.15	4-9 0.20	5-3 0.27	5-8 0.34	6-0 0.41	6-5 0.49	6-9 0.58	7-1 0.67	7-5 0.76	7-8 0.86
	13.7	2-10 0.05	3-5 0.09	4-0 0.14	4-5 0.19	4-11 0.25	5-3 0.32	5-8 0.39	6-0 0.46	6-4 0.54	6-7 0.62	6-11 0.71	7-2 0.80
	16.0	2-7 0.04	3-2 0.08	3-8 0.13	4-1 0.18	4-6 0.23	4-11 0.29	5-3 0.36	5-6 0.43	5-10 0.50	6-1 0.58	6-5 0.66	6-8 0.74
	19.2	2-5 0.04	2-11 0.08	3-4 0.12	3-9 0.16	4-1 0.21	4-5 0.27	4-9 0.33	5-1 0.39	5-4 0.46	5-7 0.53	5-10 0.60	6-1 0.68
	24.0	2-2 0.04	2-7 0.07	3-0 0.10	3-4 0.14	3-8 0.19	4-0 0.24	4-3 0.29	4-6 0.35	4-9 0.41	5-0 0.47	5-3 0.54	5-5 0.61
2x6	12.0	4-9 0.05	5-10 0.09	6-8 0.15	7-6 0.20	8-2 0.27	8-10 0.34	9-6 0.41	10-0 0.49	10-7 0.58	11-1 0.67	11-7 0.76	12-1 0.86
	13.7	4-5 0.05	5-5 0.09	6-3 0.14	7-0 0.19	7-8 0.25	8-3 0.32	8-10 0.39	9-5 0.46	9-11 0.54	10-5 0.62	10-10 0.71	11-3 0.80
	16.0	4-1 0.04	5-0 0.08	5-10 0.13	6-6 0.18	7-1 0.23	7-8 0.29	8-2 0.36	8-8 0.43	9-2 0.50	9-7 0.58	10-0 0.66	10-5 0.74
	19.2	3-9 0.04	4-7 0.08	5-4 0.12	5-11 0.16	6-6 0.21	7-0 0.27	7-6 0.33	7-11 0.39	8-4 0.46	8-9 0.53	9-2 0.60	9-6 0.68
	24.0	3-4 0.04	4-1 0.07	4-9 0.10	5-4 0.14	5-10 0.19	6-3 0.24	6-8 0.29	7-1 0.35	7-6 0.41	7-10 0.47	8-2 0.54	8-6 0.61

2x8	12.0	6-3 0.05	7-8 0.09	8-10 0.15	9-10 0.20	10-10 0.27	11-8 0.34	12-6 0.41	13-3 0.49	13-11 0.58	14-8 0.67	15-3 0.76	15-11 0.86
	13.7	5-10 0.05	7-2 0.09	8-3 0.14	9-3 0.19	10-1 0.25	10-11 0.32	11-8 0.39	12-5 0.46	13-1 0.54	13-8 0.62	14-4 0.71	14-11 0.80
	16.0	5-5 0.04	6-7 0.08	7-8 0.13	8-7 0.18	9-4 0.23	10-1 0.29	10-10 0.36	11-6 0.43	12-1 0.50	12-8 0.58	13-3 0.66	13-9 0.74
	19.2	4-11 0.04	6-1 0.08	7-0 0.12	7-10 0.16	8-7 0.21	9-3 0.27	9-10 0.33	10-6 0.39	11-0 0.46	11-7 0.53	12-1 0.60	12-7 0.68
	24.0	4-5 0.04	5-5 0.07	6-3 0.10	7-0 0.14	7-8 0.19	8-3 0.24	8-10 0.29	9-4 0.35	9-10 0.41	10-4 0.47	10-10 0.54	11-3 0.61
2x10	12.0	8-0 0.05	9-9 0.09	11-3 0.15	12-7 0.20	13-9 0.27	14-11 0.34	15-11 0.41	16-11 0.49	17-10 0.58	18-8 0.67	19-6 0.76	20-4 0.86
	13.7	7-5 0.05	9-1 0.09	10-6 0.14	11-9 0.19	12-11 0.25	13-11 0.32	14-11 0.39	15-10 0.46	16-8 0.54	17-6 0.62	18-3 0.71	19-0 0.80
	16.0	6-11 0.04	8-5 0.08	9-9 0.13	10-11 0.18	11-11 0.23	12-11 0.29	13-9 0.36	14-8 0.43	15-5 0.50	16-2 0.58	16-11 0.66	17-7 0.74
	19.2	6-4 0.04	7-8 0.08	8-11 0.12	9-11 0.16	10-11 0.21	11-9 0.27	12-7 0.33	13-4 0.39	14-1 0.46	14-9 0.53	15-5 0.60	16-1 0.68
	24.0	5-8 0.04	6-11 0.07	8-0 0.10	8-11 0.14	9-9 0.19	10-6 0.24	11-3 0.29	11-11 0.35	12-7 0.41	13-2 0.47	13-9 0.54	14-4 0.61

Note: The required modulus of elasticity, "E", in 1,000,000 pounds per inch is shown below each span.

TABLE R-11 (cont.)

RAFTERS: Spans are measured along the horizontal projection and loads are considered as applied on the horizontal projection.

Extreme Fiber Stress in Bending, "F_b" (psi).												RAFTER SPACING (IN)	SIZE (IN)
1400	1500	1600	1700	1800	1900	2000	2100	2200	2400	2700	3000		
8-0 0.96	8-3 1.06	8-6 1.17	8-9 1.28	9-0 1.39	9-3 1.51	9-6 1.63	9-9 1.76	10-0 1.88	10-5 2.15	11-1 2.56		12.0	2x4
7-5 0.89	7-9 0.99	8-0 1.09	8-3 1.20	8-5 1.30	8-8 1.41	8-11 1.53	9-2 1.64	9-4 1.76	9-9 2.01	10-4 2.40		13.7	
6-11 0.83	7-2 0.92	7-5 1.01	7-7 1.11	7-10 1.21	8-0 1.31	8-3 1.41	8-5 1.52	8-8 1.63	9-0 1.86	9-7 2.22	10-1 2.60	16.0	
6-4 0.76	6-6 0.84	6-9 0.92	6-11 1.01	7-2 1.10	7-4 1.20	7-6 1.29	7-9 1.39	7-11 1.49	8-3 1.70	8-9 2.03	9-3 2.37	19.2	
5-8 0.68	5-10 0.75	6-0 0.83	6-3 0.90	6-5 0.99	6-7 1.07	6-9 1.15	6-11 1.24	7-1 1.33	7-5 1.52	7-10 1.81	8-3 2.12	24.0	
12-6 0.96	13-0 1.06	13-5 1.17	13-10 1.28	14-2 1.39	14-7 1.51	15-0 1.63	15-4 1.76	15-8 1.88	16-5 2.15	17-5 2.56		12.0	2x6
11-9 0.89	12-2 0.99	12-6 1.09	12-11 1.20	13-3 1.30	13-8 1.41	14-0 1.53	14-4 1.64	14-8 1.76	15-4 2.01	16-3 2.40		13.7	
10-10 0.83	11-3 0.92	11-7 1.01	11-11 1.11	12-4 1.21	12-8 1.31	13-0 1.41	13-3 1.52	13-7 1.63	14-2 1.86	15-1 2.22	15-11 2.60	16.0	
9-11 0.76	10-3 0.84	10-7 0.92	10-11 1.01	11-3 1.10	11-6 1.20	11-10 1.29	12-2 1.39	12-5 1.49	13-0 1.70	13-9 2.03	14-6 2.37	19.2	
8-10 0.68	9-2 0.75	9-6 0.83	9-9 0.90	10-0 0.99	10-4 1.07	10-7 1.15	10-10 1.24	11-1 1.33	11-7 1.52	12-4 1.81	13-0 2.12	24.0	

16-6 0.96	17-1 1.06	17-8 1.17	18-2 1.28	18-9 1.39	19-3 1.51	19-9 1.63	20-3 1.76	20-8 1.88	21-7 2.15	22-11 2.56		12.0	2x8
15-5 0.89	16-0 0.99	16-6 1.09	17-0 1.20	17-6 1.30	18-0 1.41	18-5 1.53	18-11 1.64	19-4 1.76	20-3 2.01	21-5 2.40		13.7	
14-4 0.83	14-10 0.92	15-3 1.01	15-9 1.11	16-3 1.21	16-8 1.31	17-1 1.41	17-6 1.52	17-11 1.63	18-9 1.86	19-10 2.22	20-11 2.60	16.0	
13-1 0.76	13-6 0.84	13-11 0.92	14-5 1.01	14-10 1.10	15-2 1.20	15-7 1.29	16-0 1.39	16-4 1.49	17-1 1.70	18-2 2.03	19-1 2.37	19.2	
11-8 0.68	12-1 0.75	12-6 0.83	12-10 0.90	13-3 0.99	13-7 1.07	13-11 1.15	14-4 1.24	14-8 1.33	15-3 1.52	16-3 1.81	17-1 2.12	24.0	
21-1 0.96	21-10 1.06	22-6 1.17	23-3 1.28	23-11 1.39	24-6 1.51	25-2 1.63	25-10 1.76	26-5 1.88	27-7 2.15	29-3 2.56		12.0	2x10
19-8 0.89	20-5 0.99	21-1 1.09	21-9 1.20	22-4 1.30	22-11 1.41	23-7 1.53	24-2 1.64	24-8 1.76	25-10 2.01	27-4 2.40		13.7	
18-3 0.83	18-11 0.92	19-6 1.01	20-1 1.11	20-8 1.21	21-3 1.31	21-10 1.41	22-4 1.52	22-10 1.63	23-11 1.86	25-4 2.22	26-8 2.60	16.0	
16-8 0.76	17-3 0.84	17-10 0.92	18-4 1.01	18-11 1.10	19-5 1.20	19-11 1.29	20-5 1.39	20-10 1.49	21-10 1.70	23-2 2.03	24-5 2.37	19.2	
14-11 0.68	15-5 0.75	15-11 0.83	16-5 0.90	16-11 0.99	17-4 1.07	17-10 1.15	18-3 1.24	18-8 1.33	19-6 1.52	20-8 1.81	21-10 2.12	24.0	

Note: The required modulus of elasticity, "E", in 1,000,000 pounds per square inch is shown below each span.

TABLE R-12
MEDIUM OR HIGH SLOPE RAFTERS
No Ceiling Load
Slope over 3 in 12
Live Load - 40 lb. per. sq. ft.
(Heavy roof covering)
Use in Zone 1

DESIGN CRITERIA:
Strength - 15 lbs. per sq. ft. dead load plus 40 lbs. per sq. ft. live load determines required fiber stress.
Deflection - For 40 lbs. per sq. ft. live load. Limited to span in inches divided by 180.

RAFTER SIZE (IN)	SPACING (IN)	Extreme Fiber Stress in Bending, "F_b" (psi).											
		200	300	400	500	600	700	800	900	1000	1100	1200	1300
2x4	12.0	2-9 0.05	3-4 0.09	3-10 0.14	4-4 0.20	4-9 0.26	5-1 0.33	5-5 0.41	5-9 0.49	6-1 0.57	6-5 0.66	6-8 0.75	6-11 0.84
	13.7	2-7 0.05	3-1 0.09	3-7 0.13	4-0 0.19	4-5 0.25	4-9 0.31	5-1 0.38	5-5 0.46	5-8 0.53	6-0 0.61	6-3 0.70	6-6 0.79
	16.0	2-4 0.04	2-11 0.08	3-4 0.12	3-9 0.17	4-1 0.23	4-5 0.29	4-9 0.35	5-0 0.42	5-3 0.49	5-6 0.57	5-9 0.65	6-0 0.73
	19.2	2-2 0.04	2-8 0.07	3-1 0.11	3-5 0.16	3-9 0.21	4-0 0.26	4-4 0.32	4-7 0.38	4-10 0.45	5-1 0.52	5-3 0.59	5-6 0.67
	24.0	1-11 0.04	2-4 0.07	2-9 0.10	3-1 0.14	3-4 0.19	3-7 0.24	3-10 0.29	4-1 0.34	4-4 0.40	4-6 0.46	4-9 0.53	4-11 0.60
2x6	12.0	4-3 0.05	5-3 0.09	6-1 0.14	6-9 0.20	7-5 0.26	8-0 0.33	8-7 0.41	9-1 0.49	9-7 0.57	10-0 0.66	10-6 0.75	10-11 0.84
	13.7	4-0 0.05	4-11 0.09	5-8 0.13	6-4 0.19	6-11 0.25	7-6 0.31	8-0 0.38	8-6 0.46	8-11 0.53	9-5 0.61	9-10 0.70	10-3 0.79
	16.0	3-8 0.04	4-6 0.08	5-3 0.12	5-10 0.17	6-5 0.23	6-11 0.29	7-5 0.35	7-10 0.42	8-3 0.49	8-8 0.57	9-1 0.65	9-5 0.73
	19.2	3-5 0.04	4-2 0.07	4-9 0.11	5-4 0.16	5-10 0.21	6-4 0.26	6-9 0.32	7-2 0.38	7-7 0.45	7-11 0.52	8-3 0.59	8-8 0.67
	24.0	3-0 0.04	3-8 0.07	4-3 0.10	4-9 0.14	5-3 0.19	5-8 0.24	6-1 0.29	6-5 0.34	6-9 0.40	7-1 0.46	7-5 0.53	7-9 0.60

2x8	12.0	5-8 0.05	6-11 0.09	8-0 0.14	8-11 0.20	9-9 0.26	10-7 0.33	11-3 0.41	12-0 0.49	12-7 0.57	13-3 0.66	13-10 0.75	14-5 0.84
	13.7	5-3 0.05	6-6 0.09	7-6 0.13	8-4 0.19	9-2 0.25	9-11 0.31	10-7 0.28	11-2 0.46	11-10 0.53	12-5 0.61	12-11 0.70	13-6 0.79
	16.0	4-11 0.04	6-0 0.08	6-11 0.12	7-9 0.17	8-6 0.23	9-2 0.29	9-9 0.35	10-4 0.42	10-11 0.49	11-6 0.57	12-0 0.65	12-6 0.73
	19.2	4-6 0.04	5-6 0.07	6-4 0.11	7-1 0.16	7-9 0.21	8-4 0.26	8-11 0.32	9-6 0.38	10-0 0.45	10-6 0.52	10-11 0.59	11-5 0.67
	24.0	4-0 0.04	4-11 0.07	5-8 0.10	6-4 0.14	6-11 0.19	7-6 0.24	8-0 0.29	8-6 0.34	8-11 0.40	9-4 0.46	9-9 0.53	10-2 0.60
2x10	12.0	7-2 0.05	8-10 0.09	10-2 0.14	11-5 0.20	12-6 0.26	13-6 0.33	14-5 0.41	15-3 0.49	16-1 0.57	16-11 0.66	17-8 0.75	18-4 0.84
	13.7	6-9 0.05	8-3 0.09	9-6 0.13	10-8 0.19	11-8 0.25	12-7 0.31	13-6 0.38	14-3 0.46	15-1 0.53	15-10 0.61	16-6 0.70	17-2 0.79
	16.0	6-3 0.04	7-8 0.08	8-10 0.12	9-10 0.17	10-10 0.23	11-8 0.29	12-6 0.35	13-3 0.42	13-11 0.49	14-8 0.57	15-3 0.65	15-11 0.73
	19.2	5-8 0.04	7-0 0.07	8-1 0.11	9-0 0.16	9-10 0.21	10-8 0.26	11-5 0.32	12-1 0.38	12-9 0.45	13-4 0.52	13-11 0.59	14-6 0.67
	24.0	5-1 0.04	6-3 0.07	7-2 0.10	8-1 0.14	8-10 0.19	9-6 0.24	10-2 0.29	10-10 0.34	11-5 0.40	11-11 0.46	12-6 0.53	13-0 0.60

Note: The required modulus of elasticity, "E", in 1,000,000 pounds per square inch is shown below each span.

TABLE R-12 (cont.)

RAFTERS: Spans are measured along the horizontal projection and loads are considered as applied on the horizontal projection.

Extreme Fiber Stress in Bending, "F_b" (psi).												RAFTER SPACING (IN)	SIZE (IN)
1400	1500	1600	1700	1800	1900	2000	2100	2200	2400	2700	3000		
7-3 0.94	7-6 1.05	7-8 1.15	7-11 1.26	8-2 1.38	8-5 1.49	8-7 1.61	8-10 1.73	9-0 1.86	9-5 2.12	10-0 2.53		12.0	2x4
6-9 0.88	7-0 0.98	7-3 1.08	7-5 1.18	7-8 1.29	7-10 1.40	8-1 1.51	8-3 1.62	8-5 1.74	8-10 1.98	9-4 2.36		13.7	
6-3 0.82	6-6 0.91	6-8 1.00	6-11 1.09	7-1 1.19	7-3 1.29	7-6 1.40	7-8 1.50	7-10 1.61	8-2 1.83	8-8 2.19	9-2 2.56	16.0	
5-8 0.75	5-11 0.83	6-1 0.91	6-3 1.00	6-6 1.09	6-8 1.18	6-10 1.27	7-0 1.37	7-2 1.47	7-6 1.67	7-11 2.00	8-4 2.34	19.2	
5-1 0.67	5-3 0.74	5-5 0.82	5-7 0.89	5-9 0.97	5-11 1.06	6-1 1.14	6-3 1.23	6-5 1.31	6-8 1.50	7-1 1.79	7-6 2.09	24.0	
11-4 0.94	11-9 1.05	12-1 1.15	12-6 1.26	12-10 1.38	13-2 1.49	13-6 1.61	13-10 1.73	14-2 1.86	14-10 2.12	15-9 2.53		12.0	2x6
10-7 0.88	11-0 0.98	11-4 1.08	11-8 1.18	12-0 1.29	12-4 1.40	12-8 1.51	13-0 1.62	13-3 1.74	13-10 1.98	14-9 2.36		13.7	
9-10 0.82	10-2 0.91	10-6 1.00	10-10 1.09	11-1 1.19	11-5 1.29	11-9 1.40	12-0 1.50	12-4 1.61	12-10 1.83	13-7 2.19	14-4 2.56	16.0	
8-11 0.75	9-3 0.83	9-7 0.91	9-10 1.00	10-2 1.09	10-5 1.18	10-8 1.27	11-0 1.37	11-3 1.47	11-9 1.67	12-5 2.00	13-1 2.34	19.2	
8-0 0.67	8-3 0.74	8-7 0.82	8-10 0.89	9-1 0.97	9-4 1.06	9-7 1.14	9-10 1.23	10-0 1.31	10-6 1.50	11-1 1.79	11-9 2.09	24.0	

14-11 0.94	15-5 1.05	16-0 1.15	16-5 1.26	16-11 1.38	17-5 1.49	17-10 1.61	18-3 1.73	18-9 1.86	19-7 2.12	20-9 2.53		12.0	2x8
14-0 0.88	14-6 0.98	14-11 1.08	15-5 1.18	15-10 1.29	16-3 1.40	16-8 1.51	17-1 1.62	17-6 1.74	18-3 1.98	19-5 2.36		13.7	
12-11 0.82	13-5 0.91	13-10 1.00	14-3 1.09	14-8 1.19	15-1 1.29	15-5 1.40	15-10 1.50	16-3 1.61	16-11 1.83	18-0 2.19	18-11 2.56	16.0	
11-10 0.75	12-3 0.83	12-7 0.91	13-0 1.00	13-5 1.09	13-9 1.18	14-1 1.27	14-6 1.37	14-10 1.47	15-5 1.67	16-5 2.00	17-3 2.34	19.2	
10-7 0.67	10-11 0.74	11-3 0.82	11-8 0.89	12-0 0.97	12-4 1.06	12-7 1.14	12-11 1.23	13-3 1.31	13-10 1.50	14-8 1.79	15-5 2.09	24.0	
19-1 0.94	19-9 1.05	20-4 1.15	21-0 1.26	21-7 1.38	22-2 1.49	22-9 1.61	23-4 1.73	23-11 1.86	24-11 2.12	26-6 2.53		12.0	2x10
17-10 0.88	18-5 0.98	19-1 1.08	19-8 1.18	20-2 1.29	20-9 1.40	21-4 1.51	21-10 1.62	22-4 1.74	23-4 1.98	24-9 2.36		13.7	
16-6 0.82	17-1 0.91	17-8 1.00	18-2 1.09	18-9 1.19	19-3 1.29	19-9 1.40	20-2 1.50	20-8 1.61	21-7 1.83	22-11 2.19	24.2 2.56	16.0	
15-1 0.75	15-7 0.83	16-1 0.91	16-7 1.00	17-1 1.09	17-7 1.18	18-0 1.27	18-5 1.37	18-11 1.47	19-9 1.67	20-11 2.00	22-1 2.34	19.2	
13-6 0.67	13-11 0.74	14-5 0.82	14-10 0.89	15-3 0.97	15-8 1.06	16-1 1.14	16-6 1.23	16-11 1.31	17-8 1.50	18-9 1.79	19-9 2.09	24.0	

Note: The required modulus of elasticity, "E" in 1,000,000 pounds per square inch is shown below each span.

TABLE R-14
MEDIUM OR HIGH SLOPE RAFTERS
No Ceiling Load
Slope over 3 in 12
Live Load - 30 lb. per. sq. ft.
(Light roof covering)
Use in Zone 2

DESIGN CRITERIA:
Strength - 7 lbs. per sq. ft. dead load plus 30 lbs. per sq. ft. live load determines required fiber stress.
Deflection - For 30 lbs. per sq. ft. live load. Limited to span in inches divided by 180.

RAFTER SIZE (IN)	SPACING (IN)	Extreme Fiber Stress in Bending, "F_b" (psi).											
		200	300	400	500	600	700	800	900	1000	1100	1200	1300
2x4	12.0	3-4 0.07	4-1 0.13	4-8 0.20	5-3 0.27	5-9 0.36	6-3 0.45	6-8 0.55	7-1 0.68	7-5 0.77	7-9 0.89	8-2 1.02	8-6 1.15
	13.7	3-1 0.06	3-10 0.12	4-5 0.18	4-11 0.26	5-5 0.34	5-10 0.42	6-3 0.52	6-7 0.62	6-11 0.72	7-3 0.84	7-7 0.95	7-11 1.07
	16.0	2-11 0.06	3-6 0.11	4-1 0.17	4-7 0.24	5-0 0.31	5-5 0.39	5-9 0.48	6-1 0.57	6-5 0.67	6-9 0.77	7-1 0.88	7-4 0.99
	19.2	2-8 0.05	3-3 0.10	3-9 0.15	4-2 0.22	4-7 0.28	4-11 0.36	5-3 0.44	5-7 0.52	5-10 0.61	6-2 0.71	6-5 0.80	6-8 0.91
	24.0	2-4 0.05	2-11 0.09	3-4 0.14	3-9 0.19	4-1 0.25	4-5 0.32	4-8 0.39	5-0 0.47	5-3 0.55	5-6 0.63	5-9 0.72	6-0 0.81
2x6	12.0	5-3 0.07	6-5 0.13	7-5 0.20	8-3 0.27	9-1 0.36	9-9 0.45	10-5 0.55	11-1 0.66	11-8 0.77	12-3 0.89	12-9 1.02	13-4 1.15
	13.7	4-11 0.06	6-0 0.12	6-11 0.18	7-9 0.26	8-5 0.34	9-2 0.42	9-9 0.52	10-4 0.62	10-11 0.72	11-5 0.84	12-0 0.95	12-5 1.07
	16.0	4-6 0.06	5-6 0.11	6-5 0.17	7-2 0.24	7-10 0.31	8-5 0.39	9-1 0.48	9-7 0.57	10-1 0.67	10-7 0.77	11-1 0.88	11-6 0.99
	19.2	4-2 0.05	5-1 0.10	5-10 0.15	6-6 0.22	7-2 0.28	7-9 0.36	8-3 0.44	8-9 0.52	9-3 0.61	9-8 0.71	10-1 0.80	10-6 0.91
	24.0	3-8 0.05	4-6 0.09	5-3 0.14	5-10 0.19	6-5 0.25	6-11 0.32	7-5 0.39	7-10 0.47	8-3 0.55	8-8 0.63	9-1 0.72	9-5 0.81

2x8	12.0	6-11 0.07	8-5 0.13	9-9 0.20	10-11 0.27	11-11 0.36	12-10 0.45	13-9 0.55	14-7 0.66	15-5 0.77	16-2 0.89	16-10 1.02	17-7 1.15
	13.7	6-5 0.06	7-11 0.12	9-1 0.18	10-2 0.26	11-2 0.34	12-1 0.42	12-10 0.52	13-8 0.62	14-5 0.72	15-1 0.84	15-9 0.95	16-5 1.07
	16.0	6-0 0.06	7-4 0.11	8-5 0.17	9-5 0.24	10-4 0.31	11-2 0.39	11-11 0.48	12-8 0.57	13-4 0.67	14-0 0.77	14-7 0.88	15-2 0.99
	19.2	5-5 0.05	6-8 0.10	7-8 0.15	8-7 0.22	9-5 0.28	10-2 0.36	10-11 0.44	11-6 0.52	12-2 0.61	12-9 0.71	13-4 0.80	13-10 0.91
	24.0	4-10 0.05	6-0 0.09	6-11 0.14	7-8 0.19	8-5 0.25	9-1 0.32	9-9 0.39	10-4 0.47	10-11 0.55	11-5 0.63	11-11 0.72	12-5 0.81
2x10	12.0	8-9 0.07	10-9 0.13	12-5 0.20	13-11 0.27	15-2 0.36	16-5 0.45	17-7 0.55	18-7 0.66	19-8 0.77	20-7 0.89	21-6 1.02	22-5 1.15
	13.7	8-3 0.06	10-1 0.12	11-7 0.18	13-0 0.26	14-3 0.34	15-4 0.42	16-5 0.52	17-5 0.62	18-4 0.72	19-3 0.84	20-1 0.95	20-11 1.07
	16.0	7-7 0.07	9-4 0.12	10-9 0.19	12-0 0.26	13-2 0.34	14-3 0.43	15-2 0.53	16-2 0.63	17-0 0.74	17-10 0.85	18-7 0.97	19-5 1.09
	19.2	6-11 0.05	8-6 0.10	9-10 0.15	11-0 0.22	12-0 0.28	13-0 0.36	13-11 0.44	14-9 0.52	15-6 0.61	16-3 0.71	17-0 0.80	17-8 0.91
	24.0	6-2 0.05	7-7 0.09	8-9 0.14	9-10 0.19	10-9 0.25	11-7 0.32	12-5 0.39	13-2 0.47	13-11 0.55	14-7 0.63	15-2 0.72	15-10 0.81

Note: The required modulus of elasticity, "E", in 1,000,000 pounds per square inch is shown below each span.

TABLE R-14 (cont.)

RAFTERS: Spans are measured along the horizontal projection and loads are considered as applied on the horizontal projection.

Extreme Fiber Stress in Bending, "F_b" (psi).											RAFTER SPACING (IN)	SIZE (IN)
1400	1500	1600	1700	1800	1900	2000	2100	2200	2400	2700		
8-9 1.28	9-1 1.42	9-5 1.57	9-8 1.72	10-0 1.87	10-3 2.03	10-6 2.19	10-9 2.36	11-0 2.53			12.0	
8-3 1.20	8-6 1.33	8-9 1.47	9-1 1.61	9-4 1.75	9-7 1.90	9-10 2.05	10-1 2.20	10-4 2.36			13.7	
7-7 1.11	7-11 1.23	8-2 1.36	8-5 1.49	8-8 1.62	8-10 1.76	9-1 1.90	9-4 2.04	9-7 2.19	10-0 2.49		16.0	2x4
6-11 1.01	7-2 1.12	7-5 1.24	7-8 1.36	7-11 1.48	8-1 1.60	8-4 1.73	8-6 1.86	8-9 2.00	9-1 2.28		19.2	
6-3 0.91	6-5 1.01	6-8 1.11	6-10 1.21	7-1 1.32	7-3 1.43	7-5 1.55	7-7 1.67	7-9 1.79	8-2 2.04	8-8 2.43	24.0	
13-10 1.28	14-4 1.42	14-9 1.57	15-3 1.72	15-8 1.87	16-1 2.03	16-6 2.19	16-11 2.36	17-4 2.53			12.0	
12-11 1.20	13-4 1.33	13-10 1.47	14-3 1.61	14-8 1.75	15-1 1.90	15-5 2.05	15-10 2.20	16-2 2.36			13.7	
12-0 1.11	12-5 1.23	12-9 1.36	13-2 1.49	13-7 1.62	13-11 1.76	14-4 1.90	14-8 2.04	15-0 2.19	15-8 2.49		16.0	2x6
10-11 1.01	11-4 1.12	11-8 1.24	12-0 1.36	12-5 1.48	12-9 1.60	13-1 1.73	13-4 1.86	13-8 2.00	14-4 2.28		19.2	
9-9 0.91	10-1 1.01	10-5 1.11	10-9 1.21	11-1 1.32	11-5 1.43	11-8 1.55	12-0 1.67	12-3 1.79	12-9 2.04	13-7 2.43	24.0	

18-2 1.28	18-10 1.42	19-6 1.57	20-1 1.72	20-8 1.87	21-3 2.03	21-9 2.19	22-4 2.36	22-10 2.53			12.0	2x8
17-0 1.20	17-8 1.33	18-2 1.47	18-9 1.61	19-4 1.75	19-10 1.90	20-4 2.05	20-10 2.20	21-4 2.36			13.7	
15-9 1.11	16-4 1.23	16-10 1.36	17-4 1.49	17-11 1.62	18-4 1.76	18-10 1.90	19-4 2.04	19-9 2.19	20-8 2.49		16.0	
14-5 1.01	14-11 1.12	15-5 1.24	15-10 1.36	16-4 1.48	16-9 1.60	17-2 1.73	17-8 1.86	18-1 2.00	18-10 2.28		19.2	
12-10 0.91	13-4 1.01	13-9 1.11	14-2 1.21	14-7 1.32	15-0 1.43	15-5 1.55	15-9 1.67	16-2 1.79	16-10 2.04	17-11 2.43	24.0	
23-3 1.28	24-1 1.42	24-10 1.57	25-7 1.72	26-4 1.87	27-1 2.03	27-9 2.19	28-5 2.36	29-1 2.53			12.0	2x10
21-9 1.20	22-6 1.33	23-3 1.47	23-11 1.61	24-8 1.75	25-4 1.90	26-0 2.05	26-7 2.20	27-3 2.36			13.7	
20-1 1.22	20-10 1.35	21-6 1.49	22-2 1.63	22-10 1.78	23-5 1.93	24-1 2.08	24-8 2.24	25-3 2.40			16.0	
18-4 1.01	19-0 1.12	19-8 1.24	20-3 1.36	20-10 1.48	21-5 1.60	21-11 1.73	22-6 1.86	23-0 2.00	24-1 2.28		19.2	
16-5 0.91	17-0 1.01	17-7 1.11	18-1 1.21	18-7 1.32	19-2 1.43	19-8 1.55	20-1 1.67	20-7 1.79	21-6 2.04	22-10 2.43	24.0	

Note: The required modulus of elasticity, "E", in 1,000,000 pounds per square inch is shown below each span.

TABLE R-15
MEDIUM OR HIGH SLOPE RAFTERS
No Ceiling Load
Slope over 3 in 12
Live Load - 40 lb. per. sq. ft.
(Light roof covering)
Use in Zone 1

DESIGN CRITERIA:
Strength - 7 lbs. per sq. ft. dead load plus 40 lbs. per sq. ft. live load determines required fiber stress.
Deflection - For 40 lbs. per sq. ft. live load. Limited to span in inches divided by 180.

RAFTER SIZE (IN)	SPACING (IN)	Extreme Fiber Stress in Bending, "F_b" (psi).											
		200	300	400	500	600	700	800	900	1000	1100	1200	1300
2x4	12.0	2-11 0.06	3-7 0.12	4-2 0.18	4-8 0.25	5-1 0.34	5-6 0.42	5-11 0.52	6-3 0.62	6-7 0.72	6-11 0.83	7-3 0.95	7-6 1.07
	13.7	2-9 0.06	3-5 0.11	3-11 0.17	4-4 0.24	4-9 0.31	5-2 0.40	5-6 0.48	5-10 0.58	6-2 0.67	6-6 0.78	6-9 0.89	7-0 1.00
	16.0	2-7 0.06	3-2 0.10	3-7 0.16	4-0 0.22	4-5 0.29	4-9 0.37	5-1 0.45	5-5 0.53	5-8 0.62	6-0 0.72	6-3 0.82	6-6 0.93
	19.2	2-4 0.05	2-10 0.09	3-4 0.14	3-8 0.20	4-0 0.26	4-4 0.33	4-8 0.41	4-11 0.49	5-3 0.57	5-6 0.66	5-8 0.75	5-11 0.85
	24.0	2-1 0.05	2-7 0.08	2-11 0.13	3-4 0.18	3-7 0.24	3-11 0.30	4-2 0.36	4-5 0.44	4-8 0.51	4-11 0.59	5-1 0.67	5-4 0.76
2x6	12.0	4-8 0.06	5-8 0.12	6-7 0.18	7-4 0.25	8-0 0.34	8-8 0.42	9-3 0.52	9-10 0.62	10-4 0.72	10-10 0.83	11-4 0.95	11-10 1.07
	13.7	4-4 0.06	5-4 0.11	6-2 0.17	6-10 0.24	7-6 0.31	8-1 0.40	8-8 0.48	9-2 0.58	9-8 0.67	10-2 0.78	10-7 0.89	11-1 1.00
	16.0	4-0 0.06	4-11 0.10	5-8 0.16	6-4 0.22	6-11 0.29	7-6 0.37	8-0 0.45	8-6 0.53	9-0 0.62	9-5 0.72	9-10 0.82	10-3 0.93
	19.2	3-8 0.05	4-6 0.09	5-2 0.14	5-9 0.20	6-4 0.26	6-10 0.33	7-4 0.41	7-9 0.49	8-2 0.57	8-7 0.66	9-0 0.75	9-4 0.85
	24.0	3-3 0.05	4-0 0.08	4-8 0.13	5-2 0.18	5-8 0.24	6-2 0.30	6-7 0.36	6-11 0.44	7-4 0.51	7-8 0.59	8-0 0.67	8-4 0.76

2x8	12.0	6-1 0.06	7-6 0.12	8-8 0.18	9-8 0.25	10-7 0.34	11-5 0.42	12-3 0.52	12-11 0.62	13-8 0.72	14-4 0.83	14-11 0.95	15-7 1.07
	13.7	5-9 0.06	7-0 0.11	8-1 0.17	9-0 0.24	9-11 0.31	10-8 0.40	11-5 0.48	12-1 0.58	12-9 0.67	13-5 0.78	14-0 0.89	14-7 1.00
	16.0	5-3 0.06	6-6 0.10	7-6 0.16	8-4 0.22	9-2 0.29	9-11 0.37	10-7 0.45	11-3 0.53	11-10 0.62	12-5 0.72	12-11 0.82	13-6 0.93
	19.2	4-10 0.05	5-11 0.09	6-10 0.14	7-8 0.20	8-4 0.26	9-0 0.33	9-8 0.41	10-3 0.49	10-10 0.57	11-4 0.66	11-10 0.75	12-4 0.85
	24.0	4-4 0.05	5-3 0.08	6-1 0.13	6-10 0.18	7-6 0.24	8-1 0.30	8-8 0.36	9-2 0.44	9-8 0.51	10-2 0.59	10-7 0.67	11-0 0.76
2x10	12.0	7-9 0.06	9-6 0.12	11-0 0.18	12-4 0.25	13-6 0.34	14-7 0.42	15-7 0.52	16-6 0.62	17-5 0.72	18-3 0.83	19-1 0.95	19-10 1.07
	13.7	7-3 0.06	8-11 0.11	10-4 0.17	11-6 0.24	12-7 0.31	13-8 0.40	14-7 0.48	15-5 0.58	16-4 0.67	17-1 0.78	17-10 0.89	18-7 1.00
	16.0	6-9 0.06	8-3 0.10	9-6 0.16	10-8 0.22	11-8 0.29	12-7 0.37	13-6 0.45	14-4 0.53	15-1 0.62	15-10 0.72	16-6 0.82	17-2 0.93
	19.2	6-2 0.05	7-7 0.09	8-9 0.14	9-9 0.20	10-8 0.26	11-6 0.33	12-4 0.41	13-1 0.49	13-9 0.57	14-5 0.66	15-1 0.75	15-8 0.85
	24.0	5-6 0.05	6-9 0.08	7-9 0.13	8-9 0.18	9-6 0.24	10-4 0.30	11-0 0.36	11-8 0.44	12-4 0.51	12-11 0.59	13-6 0.67	14-1 0.76

Note: The required modulus of elasticity, "E", in 1,000,000 pounds per square inch is shown below each span.

TABLE R-15 (cont.)

RAFTERS: Spans are measured along the horizontal projection and loads are considered as applied on the horizontal projection.

Extreme Fiber Stress in Bending, "F_b" (psi).											RAFTER SPACING (IN)	SIZE (IN)
1400	1500	1600	1700	1800	1900	2000	2100	2200	2400	2700		
7-10 1.19	8-1 1.32	8-4 1.46	8-7 1.60	8-10 1.74	9-1 1.89	9-4 2.04	9-7 2.19	9-9 2.35			12.0	2x4
7-4 1.12	7-7 1.24	7-10 1.37	8-0 1.50	8-3 1.63	8-6 1.77	8-9 1.91	8-11 2.05	9-2 2.20	9-7 2.51		13.7	
6-9 1.03	7-0 1.15	7-3 1.26	7-5 1.38	7-8 1.51	7-10 1.64	8-1 1.77	8-3 1.90	8-6 2.04	8-10 2.32		16.0	
6-2 0.94	6-5 1.05	6-7 1.15	6-10 1.26	7-0 1.38	7-2 1.49	7-4 1.61	7-7 1.74	7-9 1.86	8-1 2.12	8-7 2.53	19.2	
5-6 0.84	5-8 0.94	5-11 1.03	6-1 1.13	6-3 1.23	6-5 1.34	6-7 1.44	6-9 1.55	6-11 1.66	7-3 1.90	7-8 2.26	24.0	
12-3 1.19	12-8 1.32	13-1 1.46	13-6 1.60	13-11 1.74	14-3 1.89	14-8 2.04	15-0 2.19	15-4 2.35			12.0	2x6
11-6 1.12	11-10 1.24	12-3 1.37	12-8 1.50	13-0 1.63	13-4 1.77	13-8 1.91	14-0 2.05	14-4 2.20	15-0 2.51		13.7	
10-7 1.03	11-0 1.15	11-4 1.26	11-8 1.38	12-0 1.51	12-4 1.64	12-8 1.77	13-0 1.90	13-4 2.04	13-11 2.32		16.0	
9-8 0.94	10-0 1.05	10-4 1.15	10-8 1.26	11-0 1.38	11-3 1.49	11-7 1.61	11-10 1.74	12-2 1.86	12-8 2.12	13-5 2.53	19.2	
8-8 0.84	9-0 0.94	9-3 1.03	9-7 1.13	9-10 1.23	10-1 1.34	10-4 1.44	10-7 1.55	10-10 1.66	11-4 1.90	12-0 2.26	24.0	

16-2 1.19	16-9 1.32	17-3 1.46	17-10 1.60	18-4 1.74	18-10 1.89	19-4 2.04	19-9 2.19	20-3 2.35			12.0	2x8
15-1 1.12	15-8 1.24	16-2 1.37	16-8 1.50	17-2 1.63	17-7 1.77	18-1 1.91	18-6 2.05	18-11 2.20	19-9 2.51		13.7	
14-0 1.03	14-6 1.15	14-11 1.26	15-5 1.38	15-10 1.51	16-4 1.64	16-9 1.77	17-2 1.90	17-6 2.04	18-4 2.32		16.0	
12-9 0.94	13-3 1.05	13-8 1.15	14-1 1.26	14-6 1.38	14-11 1.49	15-3 1.61	15-8 1.74	16-0 1.86	16-9 2.12	17-9 2.53	19.2	
11-5 0.84	11-10 0.94	12-3 1.03	12-7 1.13	12-11 1.23	13-4 1.34	13-8 1.44	14-0 1.55	14-4 1.66	14-11 1.90	15-10 2.26	24.0	
20-7 1.19	21-4 1.32	22-0 1.46	22-9 1.60	23-4 1.74	24-0 1.89	24-8 2.04	25-3 2.19	25-10 2.35			12.0	2x10
19-3 1.12	19-11 1.24	20-7 1.37	21-3 1.50	21-10 1.63	22-6 1.77	23-1 1.91	23-7 2.05	24-2 2.20	25-3 2.51		13.7	
17-10 1.03	18-6 1.15	19-1 1.26	19-8 1.38	20-3 1.51	20-10 1.64	21-4 1.77	21-10 1.90	22-4 2.04	23-4 2.32		16.0	
16-4 0.94	16-10 1.05	17-5 1.15	17-11 1.26	18-6 1.38	19-0 1.49	19-6 1.61	19-11 1.74	20-5 1.86	21-4 2.12	22-8 2.53	19.2	
14-7 0.84	15-1 0.94	15-7 1.03	16-1 1.13	16-6 1.23	17-0 1.34	17-5 1.44	17-10 1.55	18-3 1.66	19-1 1.90	20-3 2.26	24.0	

Note: The required modulus of elasticity, "E", in 1,000,000 pounds per square inch is shown below each span.

TABLE TSJ-1
TWO-SPAN FLOOR JOISTS
40 Lbs. Per Sq. Ft. Live Load
(All floors except attic floors)

DESIGN CRITERIA:
Deflection - For 40 lbs. per sq. ft. live load on one span and 20 lbs. per sq. ft. on other. Limited to span in inches divided by 360.
Strength - Live load of 40 lbs. per sq. ft. plus dead load of 10 lbs. per sq. ft. on both spans determines the required fiber stress value.

JOIST SIZE	SPACING (IN)	Modulus of Elasticity, "E", in 1,000,000 psi															
		0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.2	2.4	2.6
2x6	12.0	10-3 1060	10-8 1150	11-1 1230	11-5 1310	11-9 1390	12-1 1460	12-5 1540	12-8 1610	13-0 1680	13-3 1750	13-6 1820	13-9 1880	14-0 1950	14-2 2010	14-5 2080	14-8 2140
	13.7	9-10 1110	10-3 1200	10-7 1280	10-11 1370	11-3 1450	11-7 1530	11-10 1610	12-2 1680	12-5 1760	12-8 1830	12-11 1900	13-1 1970	13-4 2040	13-7 2100	13-9 2170	14-0 2240
	16.0	9-4 1170	9-9 1260	10-1 1350	10-5 1440	10-8 1530	11-0 1610	11-3 1690	11-6 1770	11-9 1850	12-0 1920	12-3 2000	12-6 2070	12-8 2140	12-11 2210	13-2 2280	13-4 2350
	19.2	8-9 1240	9-2 1340	9-6 1440	9-9 1530	10-1 1620	10-4 1710	10-7 1800	10-10 1880	11-1 1960	11-4 2040	11-6 2120	11-9 2200	11-11 2280	12-2 2350	12-4 2430	12-6 2500
	24.0	8-2 1330	8-6 1440	8-9 1550	9-1 1650	9-4 1750	9-7 1840	9-10 1940	10-1 2030	10-3 2120	10-6 2200	10-8 2290	10-11 2370	11-1 2450	11-3 2530	11-5 2610	11-7 2690
2x8	12.0	13-7 1060	14-1 1150	14-7 1230	15-1 1310	15-6 1390	15-11 1460	16-4 1540	16-9 1610	17-1 1680	17-5 1750	17-9 1820	18-1 1880	18-5 1950	18-9 2010	19-0 2080	19-4 2140
	13.7	13-0 1110	13-6 1200	14-0 1290	14-5 1370	14-10 1450	15-3 1530	15-8 1610	16-0 1680	16-4 1760	16-8 1830	17-0 1900	17-4 1970	17-7 2040	17-11 2110	18-2 2180	18-6 2240
	16.0	12-4 1170	12-10 1260	13-3 1350	13-8 1440	14-1 1530	14-6 1610	14-10 1690	15-2 1770	15-6 1850	15-10 1930	16-2 2000	16-5 2070	16-9 2150	17-0 2220	17-3 2290	17-6 2360
	19.2	11-7 1240	12-1 1340	12-6 1440	12-11 1530	13-3 1620	13-8 1710	14-0 1800	14-4 1880	14-7 1970	14-11 2050	15-2 2130	15-6 2200	15-9 2280	16-0 2360	16-3 2430	16-6 2500
	24.0	10-9 1340	11-2 1440	11-7 1550	12-0 1650	12-4 1750	12-8 1840	13-0 1940	13-3 2030	13-7 2320	13-10 2200	14-1 2290	14-4 2370	14-7 2460	14-10 2540	15-1 2620	15-4 2700

2x10	12.0	17-4 1060	18-0 1150	18-8 1230	19-3 1310	19-10 1390	20-4 1460	20-10 1540	21-4 1610	21-10 1680	22-3 1750	22-8 1820	23-1 1880	23-6 1950	23-11 2010	24-3 2080	24-8 2140
	13.7	16-7 1110	17-3 1200	17-10 1290	18-5 1370	19-0 1450	19-6 1530	20-0 1610	20-5 1680	20-10 1760	21-4 1830	21-9 1900	22-1 1970	22-6 2040	22-10 2110	23-3 2170	23-7 2240
	16.0	15-9 1170	16-4 1260	16-11 1350	17-6 1440	18-0 1530	18-6 1610	19-0 1690	19-5 1770	19-10 1850	20-3 1930	20-7 2000	21-0 2070	21-4 2150	21-9 2220	22-1 2290	22-5 2360
	19.2	14-10 1240	15-5 1340	15-11 1440	16-6 1530	16-11 1620	17-5 1710	17-10 1800	18-3 1880	18-8 1970	19-0 2050	19-5 2130	19-9 2200	20-1 2280	20-5 2360	20-9 2430	21-1 2500
	24.0	13-9 1340	14-3 1440	14-9 1550	15-3 1650	15-9 1750	16-2 1840	16-7 1940	16-11 2030	17-4 2120	17-8 2200	18-0 2290	18-4 2370	18-8 2460	19-0 2540	19-3 2620	19-7 2700
2x12	12.0	21-1 1060	21-11 1150	22-8 1230	23-5 1310	24-1 1390	24-9 1460	25-5 1540	26-0 1610	26-7 1680	27-1 1750	27-7 1820	28-1 1880	28-7 1950	29-1 2010	29-6 2080	30-0 2140
	13.7	20-2 1110	20-11 1200	21-8 1290	22-5 1370	23-1 1450	23-8 1530	24-2 1610	24-10 1680	25-5 1760	25-11 1830	26-5 1900	26-11 1970	27-4 2040	27-9 2110	28-3 2170	28-8 2240
	16.0	19-2 1170	19-11 1260	20-7 1350	21-3 1440	21-11 1530	22-6 1610	23-1 1690	23-7 1770	24-1 1850	24-7 1930	25-1 2000	25-7 2070	26-0 2150	26-5 2220	26-10 2290	27-3 2360
	19.2	18-0 1240	18-9 1340	19-5 1440	20-0 1530	20-7 1620	21-2 1710	21-8 1800	22-3 1880	22-8 1970	23-2 2050	23-7 2130	24-0 2200	24-5 2280	24-10 2360	25-3 2430	25-7 2500
	24.0	16-9 1340	17-5 1440	18-0 1550	18-7 1650	19-2 1750	19-8 1840	20-2 1940	20-8 2030	21-1 2120	21-6 2200	21-11 2290	22-4 2370	22-8 2460	23-1 2540	23-5 2620	23-9 2700

Note: The required extreme fiber stress in bending, "F_b", in pounds per square inch is shown below each span.

TABLE TSJ-2
TWO-SPAN FLOOR JOISTS
30 Lbs. Per Sq. Ft. Live Load
(Optional table for attic floors)

DESIGN CRITERIA:
Deflection - For 30 lbs. per sq. ft. live load on one span and 15 lbs. per sq. ft. on other
Limited to span in inches divided by 360.
Strength - Live load of 30 lbs. per sq. ft. plus dead load of 10 lbs. per sq. ft. on both spans determines the required fiber stress value.

JOIST SIZE (IN)	SPACING (IN)	Modulus of Elasticity, "E", in 1,000,000 psi															
		0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.2	2.4	2.6
2x6	12.0	11-4 1030	11-9 1110	12-2 1190	12-7 1270	13-0 1340	13-4 1420	13-8 1490	14-0 1560	14-3 1630	14-7 1700	14-10 1760	15-1 1830	15-5 1890	15-8 1950	15-10 2010	16-1 2070
	13.7	10-10 1070	11-3 1160	11-8 1250	12-0 1330	12-5 1410	12-9 1480	13-1 1560	13-4 1630	13-8 1700	13-11 1770	14-2 1840	14-5 1910	14-8 1970	14-11 2040	15-2 2100	15-5 2170
	16.0	10-3 1130	10-8 1220	11-1 1310	11-5 1400	11-9 1480	12-1 1560	12-5 1640	12-8 1720	13-0 1790	13-3 1870	13-6 1940	13-9 2010	14-0 2080	14-2 2150	14-5 2210	14-8 2280
	19.2	9-8 1200	10-1 1300	10-5 1390	10-9 1480	11-1 1570	11-5 1660	11-8 1740	11-11 1820	12-2 1900	12-5 1980	12-8 2060	12-11 2130	13-2 2210	13-4 2280	13-7 2350	13-9 2420
	24.0	9-0 1290	9-4 1400	9-8 1500	10-0 1600	10-3 1690	10-7 1790	10-10 1880	11-1 1960	11-4 2050	11-7 2130	11-9 2220	12-0 2300	12-2 2380	12-5 2460	12-7 2530	12-9 2610
2x8	12.0	14-11 1030	15-6 1110	16-1 1190	16-7 1270	17-1 1350	17-7 1420	18-0 1490	18-5 1560	18-10 1630	19-2 1700	19-7 1760	19-11 1830	20-3 1890	20-7 1950	20-11 2010	21-3 2070
	13.7	14-3 1080	14-10 1160	15-5 1250	15-11 1330	16-4 1410	16-10 1480	17-3 1560	17-7 1630	18-0 1700	18-4 1770	18-9 1840	19-1 1910	19-5 1980	19-9 2040	20-0 2110	20-4 2170
	16.0	13-7 1130	14-1 1220	14-7 1310	15-1 1400	15-6 1480	15-11 1560	16-4 1640	16-9 1720	17-1 1790	17-5 1870	17-9 1940	18-1 2010	18-5 2080	18-9 2150	19-0 2220	19-4 2280
	19.2	21-9 1200	13-3 1300	13-9 1390	14-2 1490	14-7 1570	15-0 1660	15-5 1740	15-9 1830	16-1 1910	16-5 1980	16-9 2060	17-0 2140	17-4 2210	17-7 2280	17-11 2350	18-2 2430
	24.0	11-10 1290	12-4 1400	12-9 1500	13-2 1600	13-7 1690	13-11 1790	14-3 1880	14-7 1970	14-11 2050	15-3 2140	15-6 2220	15-10 2300	16-1 2380	16-4 2460	16-7 2540	16-10 2610

2x10	12.0	19-1 1030	19-10 1110	20-6 1190	21-2 1270	21-10 1350	22-5 1420	23-0 1490	23-6 1560	24-0 1630	24-6 1700	25-0 1760	25-5 1830	25-11 1890	26-4 1950	26-9 2010	27-1 2070
	13.7	18-3 1080	19-0 1160	19-8 1250	20-3 1330	20-11 1410	21-5 1480	22-0 1560	22-6 1630	23-0 1700	23-5 1770	23-11 1840	24-4 1910	24-9 1980	25-2 2040	25-7 2110	25-11 2170
	16.0	17-4 1120	18-0 1220	18-8 1310	19-3 1400	19-10 1480	20-4 1560	20-11 1640	21-4 1720	21-10 1790	22-3 1870	22-8 1940	23-1 2010	23-6 2080	23-11 2150	24-3 2220	24-8 2280
	19.2	16-4 1200	16-11 1300	17-7 1390	18-1 1490	18-8 1570	19-2 1660	19-8 1740	20-1 1830	20-6 1910	20-11 1980	21-4 2060	21-9 2140	22-1 2210	22-6 2280	22-10 2350	23-2 2430
	24.0	15-1 1290	15-9 1400	16-4 1500	16-10 1600	17-4 1690	17-9 1790	18-3 1880	18-8 1970	19-1 2050	19-5 2140	19-10 2220	20-2 2300	20-6 2380	20-11 2460	21-2 2540	21-6 2610
2x12	12.0	23-2 1030	24-1 1110	25-0 1190	25-10 1270	26-7 1350	27-3 1420	27-11 1490	28-7 1560	29-3 1630	29-10 1700	30-5 1760	30-11 1830	31-6 1890	32-0 1950	32-6 2010	33-0 2070
	13.7	22-2 1080	23-1 1160	23-11 1250	24-8 1330	25-5 1410	26-1 1480	26-9 1560	27-4 1630	27-11 1700	28-6 1770	29-1 1840	29-7 1910	30-1 1980	30-7 2040	31-1 2110	31-7 2170
	16.0	21-1 1130	21-11 1220	22-8 1310	23-5 1400	24-1 1480	24-9 1560	25-5 1640	26-0 1720	26-7 1790	27-1 1870	27-7 1940	28-1 2010	28-7 2080	29-1 2150	29-6 2220	30-0 2280
	19.2	19-10 1200	20-7 1300	21-4 1390	22-1 1490	22-8 1570	23-4 1660	23-11 1740	24-5 1830	25-0 1910	25-6 1980	26-0 2060	26-6 2140	26-11 2210	27-4 2280	27-9 2350	28-2 2430
	24.0	18-5 1290	19-2 1400	19-10 1500	20-6 1600	21-1 1690	21-8 1790	22-2 1880	22-8 1970	23-2 2050	23-8 2140	24-2 2220	24-7 2300	25-0 2380	25-5 2460	25-10 2540	26-2 2610

Note: The required extreme fiber stress in bending, "F_b", in pounds per square inch is shown below each span.

DESIGN VALUES FOR JOISTS AND RAFTERS - VISUAL GRADING

These "F_b" values are for use where repetitive members are spaced not more than 24 inches. For wider spacing, the "F_b" values should be reduced 13 percent.

Values for surfaced dry or surfaced green lumber apply at 19 percent maximum moisture content in use.

Species and Grade	Size	Design Value in Bending "F_b"		Modulus of Elasticity "E"	Grading Rules Agency
		Joists	Rafters		
BALSAM FIR (Surfaced dry or surfaced green)					
Select Structural		2000	2100	1,500,000	Northeastern
No. 1	2x4	1700	1790	1,500,000	Lumber
No. 2		1400	1470	1,300,000	Manufacturers
No. 3		775	810	1,200,000	Association
Appearance		1700	1790	1,500,000	
Stud		775	810	1,200,000	Northern Hardwood
Construction		1000	1050	1,200,000	& Pine
Standard	2x4	575	600	1,200,000	Manufacturers
Utility		275	290	1,200,000	Association
Select Structural	2x5	1700	1790	1,500,000	
No. 1 & Appearance	and	1450	1520	1,500,000	(See notes 1
No. 2	wider	1200	1260	1,300,000	and 3)
No. 3		700	740	1,200,000	
Stud		700	740	1,200,000	

DOUGLAS FIR - LARCH (Surfaced dry or surfaced green)					
Dense Select Structural	2x4	2800	2940	1,900,000	Western Wood Products Association (See notes 1 and 3) West Coast Lumber Inspection Bureau
Select Structural		2400	2520	1,800,000	
Dense No. 1		2400	2520	1,900,000	
No. 1 & Appearance		2050	2150	1,800,000	
Dense No. 2		1950	2050	1,700,000	
No. 2		1650	1730	1,700,000	
No. 3		925	970	1,500,000	
Stud		925	970	1,500,000	
Construction	2x4	1200	1260	1,500,000	
Standard		675	710	1,500,000	
Utility		325	340	1,500,000	
Dense Select Structural	2x5 and wider	2400	2520	1,900,000	
Select Structural		2050	2150	1,800,000	
Dense No. 1		2050	2150	1,900,000	
No. 1 & Appearance		1750	1840	1,800,000	
Dense No. 2		1700	1790	1,700,000	
No. 2		1450	1520	1,700,000	
No. 3		850	890	1,500,000	
Stud		850	890	1,500,000	

DESIGN VALUES FOR JOISTS AND RAFTERS - VISUAL GRADING (Cont)

These "F_b" values are for use where repetitive members are spaced not more than 24 inches. For wider spacing, the "F_b" values should be reduced 13 percent.

Values for surfaced dry or surfaced green lumber apply at 19 percent maximum moisture content in use.

Species and Grade	Size	Design Value in Bending "F_b"		Modulus of Elasticity "E"	Grading Rules Agency
		Joists	Rafters		
EASTERN HEMLOCK (Surfaced dry or surfaced green)					
Select Structural	2x4	2050	2150	1,200,000	Northern Hardwood & Pine Manufacturers Association Northeastern Lumber Manufacturers Association (See notes 1 and 3)
No. 1		1750	1840	1,200,000	
No. 2		1450	1520	1,100,000	
No. 3		800	840	1,000,000	
Appearance		1750	1840	1,200,000	
Stud		800	840	1,000,000	
Construction	2x4	1050	1100	1,000,000	
Standard		575	600	1,000,000	
Utility		275	290	1,000,000	
Select Structural	2x5 and wider	1750	1840	1,200,000	
No. 1 & Appearance		1500	1580	1,200,000	
No. 2		1250	1310	1,100,000	
No. 3		700	740	1,000,000	
Stud		700	740	1,000,000	

EASTERN SPRUCE (Surfaced dry or surfaced green)					
Select Structural		1600	1680	1,500,000	Northeastern
No. 1		1350	1420	1,500,000	Lumber
No. 2	2x4	1100	1160	1,400,000	Manufacturers
No. 3		625	660	1,200,000	Association
Appearance		1350	1420	1,500,000	
Stud		625	660	1,200,000	Northern
					Hardwood
Construction		800	840	1,200,000	& Pine
Standard	2x4	450	470	1,200,000	Manufacturers
Utility		225	240	1,200,000	Association
Select Structural		1350	1420	1,500,000	(See notes 1
No. 1 & Appearance	2x5	1150	1210	1,500,000	and 3)
No. 2	and	950	1000	1,400,000	
No. 3	wider	550	580	1,200,000	
Stud		550	580	1,200,000	

DESIGN VALUES FOR JOISTS AND RAFTERS - VISUAL GRADING (Cont)

These "F_b" values are for use where repetitive members are spaced not more than 24 inches. For wider spacing, the "F_b" values should be reduced 13 percent.

Values for surfaced dry or surfaced green lumber apply at 19 percent maximum moisture content in use.

Species and Grade	Size	Design Value in Bending "F_b"		Modulus of Elasticity "E"	Grading Rules Agency
		Joists	Rafters		
EASTERN WHITE PINE (Surfaced dry or surfaced green)					Northeastern
Select Structural	2x4	1550	1630	1,200,000	Lumber
No. 1 & Appearance		1350	1420	1,200,000	Manufacturers
No. 2		1100	1160	1,100,000	Association
No. 3		600	630	1,000,000	
Stud		600	630	1,000,000	
Construction	2x4	800	840	1,000,000	Northern
Standard		450	470	1,000,000	Hardwood & Pine
Utility		200	210	1,000,000	Manufacturers Association
Select Structural	2x5 and wider	1350	1420	1,200,000	
No. 1 & Appearance		1150	1210	1,200,000	
No. 2		950	1000	1,100,000	
No. 3		550	580	1,000,000	(See notes 1
Stud		550	580	1,000,000	and 3)

EASTERN WHITE PINE (NORTH) (Surfaced dry or surfaced green)					
Select Structural	2x4	1550	1630	1,200,000	Nat'l. Lumber Grades Auth. (A Canadian Agency - See notes 1, 2 and 3)
No. 1 & Appearance		1350	1420	1,200,000	
No. 2		1100	1160	1,100,000	
No. 3		600	630	1,000,000	
Stud		600	630	1,000,000	
Construction	2x4	800	840	1,000,000	
Standard		450	470	1,000,000	
Utility		200	210	1,000,000	
Select Structural	2x5 and wider	1350	1420	1,200,000	
No. 1 & Appearance		1150	1210	1,200,000	
No. 2		950	1000	1,100,000	
No. 3		550	580	1,000,000	
Stud		550	580	1,000,000	

DESIGN VALUES FOR JOISTS AND RAFTERS - VISUAL GRADING (Cont)

These "F_b" values are for use where repetitive members are spaced not more than 24 inches. For wider spacing, the "F_b" values should be reduced 13 percent.

Values for surfaced dry or surfaced green lumber apply at 19 percent maximum moisture content in use.

Species and Grade	Size	Design Value in Bending "F_b"		Modulus of Elasticity "E"	Grading Rules Agency
		Joists	Rafters		
HEM - FIR (Surfaced dry or surfaced green)					
Select Structural		1900	2000	1,500,000	
No. 1 & Appearance		1600	1680	1,500,000	
No. 2		1350	1420	1,400,000	Western Wood
No. 3	2x4	725	760	1,200,000	Products
Stud		725	760	1,200,000	Association
					(See notes 1
Construction		975	1020	1,200,000	and 3)
Standard	2x4	550	580	1,200,000	
Utility		250	260	1,200,000	
					West Coast
Select Structural		1650	1730	1,500,000	Lumber
No. 1 & Appearance	2x5	1400	1470	1,500,000	Inspection
No. 2	and	1150	1210	1,400,000	Bureau
No. 3	wider	675	710	1,200,000	
Stud		675	710	1,200,000	

NORTHERN PINE (Surfaced dry or surfaced green)					
Select Structural		1850	1940	1,400,000	Northeastern
No. 1		1600	1680	1,400,000	Lumber
No. 2	2x4	1300	1370	1,300,000	Manufacturers
No. 3		725	760	1,100,000	Association
Appearance		1400	1470	1,400,000	
Stud		725	760	1,100,000	Northern
					Hardwood
Construction		950	1000	1,100,000	& Pine
Standard	2x4	525	550	1,100,000	Manufacturers
Utility		250	260	1,100,000	Association
Select Structural		1600	1680	1,400,000	(See notes 1
No. 1 & Appearance	2x5	1400	1470	1,400,000	and 3)
No. 2	and	1100	1160	1,300,000	
No. 3	wider	650	680	1,100,000	
Stud		650	680	1,100,000	

DESIGN VALUES FOR JOISTS AND RAFTERS - VISUAL GRADING (Cont)

These "F_b" values are for use where repetitive members are spaced not more than 24 inches. For wider spacing, the "F_b" values should be reduced 13 percent.

Values for surfaced dry or surfaced green lumber apply at 19 percent maximum moisture content in use.

Species and Grade	Size	Design Value in Bending "F_b"		Modulus of Elasticity "E"	Grading Rules Agency
		Joists	Rafters		
PONDEROSA PINE - SUGAR PINE (PONDEROSA PINE - LODGEPOLE PINE) (Surfaced dry or surfaced green)					
Select Structural	2x4	1650	1730	1,200,000	Western Wood Products Association
No. 1 & Appearance		1400	1470	1,200,000	
No. 2		1150	1210	1,100,000	
No. 3		625	660	1,000,000	
Stud		625	660	1,000,000	
Construction	2x4	825	870	1,000,000	(See notes 1 and 3)
Standard		450	470	1,000,000	
Utility		225	240	1,000,000	
Select Structural	2x5 and wider	1400	1470	1,200,000	
No. 1 & Appearance		1200	1260	1,200,000	
No. 2		975	1020	1,100,000	
No. 3		575	600	1,000,000	
Stud		575	600	1,000,000	

SOUTHERN PINE (Surfaced dry)					
Select Structural	2x4	2300	2420	1,700,000	Southern Pine Inspection Bureau (See note 3)
Dense Select Structural		2700	2840	1,800,000	
No. 1		1950	2050	1,700,000	
No. 1 Dense		2300	2420	1,800,000	
No. 2		1650	1730	1,600,000	
No. 2 Dense		1900	2000	1,600,000	
No. 3		900	950	1,400,000	
No. 3 Dense		1050	1100	1,500,000	
Stud		900	950	1,400,000	
Construction	2x4	1150	1210	1,400,000	
Standard		675	710	1,400,000	
Utility		300	320	1,400,000	
Select Structural	2x5 and wider	2000	2100	1,700,000	
Dense Select Structural		2350	2470	1,800,000	
No. 1		1700	1790	1,700,000	
No. 1 Dense		2000	2100	1,800,000	
No. 2		1400	1470	1,600,000	
No. 2 Dense		1650	1730	1,600,000	
No. 3		800	840	1,400,000	
No. 3 Dense		925	970	1,500,000	
Stud		850	890	1,400,000	

DESIGN VALUES FOR JOISTS AND RAFTERS - VISUAL GRADING (Cont)

These "F_b" values are for use where repetitive members are spaced not more than 24 inches. For wider spacing, the "F_b" values should be reduced 13 percent.

Values for surfaced dry or surfaced green lumber apply at 19 percent maximum moisture content in use.

Species and Grade	Size	Design Value in Bending "F_b"		Modulus of Elasticity "E"	Grading Rules Agency
		Joists	Rafters		
SOUTHERN PINE (Surfaced at 15 percent maximum moisture content-KD)					
Select Structural		2500	2630	1,800,000	
Dense Select Structural		2900	3050	1,900,000	
No. 1		2100	2210	1,800,000	
No. 1 Dense		2450	2570	1,900,000	
No. 2	2x4	1750	1840	1,600,000	
No. 2 Dense		2050	2150	1,700,000	Southern
No. 3		975	1020	1,500,000	Pine
No. 3 Dense		1150	1210	1,500,000	Inspection
Stud		975	1020	1,500,000	Bureau
Construction		1250	1310	1,500,000	
Standard	2x4	725	760	1,500,000	
Utility		300	320	1,500,000	(See note 3)
Select Structural		2150	2260	1,800,000	
Dense Select Structural		2500	2630	1,900,000	
No. 1		1850	1940	1,800,000	
No. 1 Dense	2x5 and	2150	2260	1,900,000	
No. 2	wider	1500	1580	1,600,000	
No. 2 Dense		1750	1840	1,700,000	
No. 3		875	920	1,500,000	
No. 3 Dense		1000	1050	1,500,000	
Stud		900	950	1,500,000	

SPRUCE – PINE – FIR (Surfaced dry or surfaced green)					
Select Structural		1650	1730	1,500,000	
No. 1 & Appearance		1400	1470	1,500,000	
No. 2	2x4	1150	1210	1,300,000	
No. 3		650	680	1,200,000	Nat'l. Lumber
Stud		650	680	1,200,000	Grades Auth.
					(A Canadian
Construction		850	890	1,200,000	Agency –
Standard	2x4	475	500	1,200,000	
Utility		225	240	1,200,000	(See notes 1, 2 and 3)
Select Structural	2x5	1450	1520	1,500,000	
No. 1 & Appearance	and	1200	1260	1,500,000	
No. 2	wider	1000	1050	1,300,000	
No. 3		575	600	1,200,000	
Stud		575	600	1,200,000	

DESIGN VALUES FOR JOISTS AND RAFTERS - VISUAL GRADING (Cont)

These "F_b" values are for use where repetitive members are spaced not more than 24 inches. For wider spacing, the "F_b" values should be reduced 13 percent.

Values for surfaced dry or surfaced green lumber apply at 19 percent maximum moisture content in use.

Species and Grade	Size	Design Value in Bending "F_b"		Modulus of Elasticity "E"	Grading Rules Agency
		Joists	Rafters		
WESTERN HEMLOCK (Surfaced dry or surfaced green)					
Select Structural		2100	2210	1,600,000	Western Wood
No. 1 & Appearance		1800	1890	1,600,000	Products
No. 2	2x4	1450	1520	1,400,000	Association
No. 3		800	840	1,300,000	(See notes 1
Stud		800	840	1,300,000	and 3)
Construction		1050	1100	1,300,000	West Coast
Standard	2x4	600	630	1,300,000	Lumber
Utility		275	290	1,300,000	Inspection Bureau
Select Structural		1800	1890	1,600,000	
No. 1 & Appearance	2x5	1550	1630	1,600,000	
No. 2	and	1250	1310	1,400,000	
No. 3	wider	750	790	1,300,000	
Stud		750	790	1,300,000	

WHITE WOODS (WESTERN WOODS) (Surfaced dry or surfaced green)					
Select Structural	2x4	1550	1630	1,100,000	Western Wood Products Association
No. 1 & Appearance		1300	1370	1,100,000	
No. 2		1050	1100	1,000,000	
No. 3		600	630	900,000	
Stud		600	630	900,000	
Construction	2x4	775	810	900,000	(See notes 1 and 3)
Standard		425	450	900,000	
Utility		200	210	900,000	
Select Structural	2x5 and wider	1300	1370	1,100,000	
No. 1 & Appearance		1100	1160	1,100,000	
No. 2		925	970	1,000,000	
No. 3		550	580	900,000	
Stud		550	580	900,000	

1. When 2-inch lumber is manufactured at a maximum moisture content of 15% (grade marked MC-15) and used in a condition where the moisture content does not exceed 15%, the design values shown for "surfaced dry or surfaced green" lumber may be increased 8% for design value in bending "F_b", and 5% for modulus of elasticity "E".

2. National Lumber Grades Authority is the Canadian rules writing agency responsible for preparation, maintenance and dissemination of a uniform softwood lumber grading rule for all Canadian species.

3. Design values for stud grade in 2x5 and wider size classifications apply to 5-inch and 6-inch widths only.

APPENDIX A
CHAPTER ILHR 22
DETERMINATION OF REQUIRED LEVELS OF INSULATION USING THE ENERGY WORKSHEET

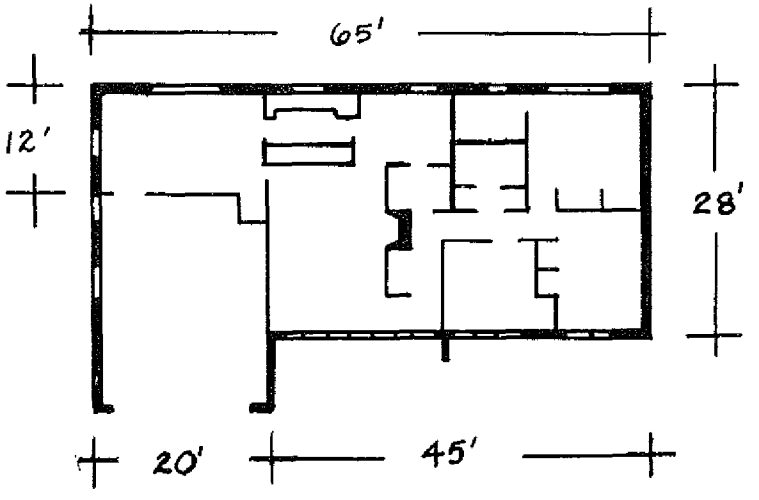
Two methods may be used to determine the level of insulation required by Chapter ILHR 22 for electrically heated and non- electrically heated dwellings. The Component Method (also known as the Accepted Practice Method) can be used with a minimum of calculations and is recommended for standard designs. The System Design Method is more complex and is used for alternate designs. Under the System Design Method, less insulation may be installed in one building component if more insulation is installed in another.

The following illustration demonstrates use of the Energy Worksheet to determine the required levels of insulation. Single copies of the Energy Worksheet are available at no charge upon written request.

Write to:
Department of Industry, Labor and Human Relations
Division of Safety and Buildings
Post Office Box 7969
Madison, Wisconsin 53707

Portions A and H of the Energy Worksheet must be filled out for the Component Method. Portions B, C and D of the Energy Worksheet must be filled out to use the System Design Method. Sections B and F are filled out to size the furnace for either method. Section G must be filled out to size the ventilation system for electrically heated homes. Both the Component Method and the System Method will be shown in the illustration, although completion of only one method is sufficient to show compliance with the insulation requirements of Ch. ILHR 22.

SAMPLE DWELLING



Sample dwelling: 1,500 square feet 186 lineal feet of perimeter building thermal envelope.

Gross wall area = 8.13 feet × 186 lineal feet = 1,512.18 square feet
Wall window area = 172.67 square feet
Box sill area = 0.81 feet × 186 lineal feet = 150.66 square feet
Gross exposed foundation wall area = 124.62 square feet
Basement window area = 15.65 square feet
Door area = 37.82 square feet
Ceiling area = 1,500 square feet

Dane County location - Zone 3

The dwelling will be electrically heated.

The planned construction:

Walls	
Wood bevel ½" × 8" siding	R = 0.81
1" Extruded polystyrene sheathing	R = 5.27
R19 Batt insulation	R = 19
2 × 6 Framing, 24" O.C.	R = 6.875
Drywall ½"	R = 0.45
Ceiling	
2 × 6 Framing, 24" O.C.	R = 6.875
Blown Fiberglass insulation	R/inch = 2.5
Insulation in 5.5" Cavity	R = 13.75
Insulation over both Cavity and Framing, 14.5"	R = 36.25
½-inch drywall finish	R = 0.45
Foundation	
8" Masonry Block	R = 1.72
2" Extruded polystyrene	R = 10.54
Windows	
All triple glazed	R = 2.7
Doors	
Insulated	R = 2.12
Storm door	R = 1.00
Total door R value	R = 3.12

The 1500 square foot basement will be divided into a 575 square foot finished living space and a 925 square foot utility and storage space. The value of all the dead air spaces on both levels (closets, cabinets, interior walls, etc.) equals 2163 cubic feet.

Estimating Design R-values for Building Materials and Components

R-values listed in Table A-4 of the UDC appendix, ASHRAE manual or manufacturer's specifications may be helpful in determining the designed R-values for building components or materials. The designed R-values which are entered in Part C of the Energy Worksheet should be consistent with the end use or installed condition of the insulation and building materials used. The design R-values should take into account possible effects such as:

- Long term aging effects.
- Settling or other density variations that may occur with blown-in fiberglass and cellulose insulation.

- Moisture effect on wet installations such as exterior foundation insulation.
- Effect of compression on insulating materials subject to loads, such as the case of porous, semi-ridged fiberglass applied to foundation exteriors.
- Orientation of installation effects (horizontal or vertical).

In order to use the design R-value given in the manufacturer's specifications, insulation and building materials must be installed in accordance with the manufacturers instructions. For example, most foam panel insulation products are required to be protected from exposure to sunlight (ultraviolet light). An opaque covering is typically installed to provide that protection.

DILHR

Safety and Buildings Division
P.O. Box 7969
Madison, WI 53707

ENERGY WORKSHEET
UNIFORM DWELLING CODE

PROJECT ADDRESS: SAMPLE - ZONE 3

BUILDER: _____ OWNER: _____

WORKSHEET COMPLETED BY: _____ DATE: _____

Does dwelling unit have three kilowatts or more input capacity of permanently installed electrical space heating equipment?

☒ YES (see below) ☐ NO

If yes, then indicate infiltration control option:

_____ Full sealing per s. ILHR 22.13(3)(a)
__x__ Infiltration barrier per s. ILHR 22.13(3)(b)
_____ Blower door test per s. ILHR 22.13(2)(c) & (3)(c)

INSTRUCTIONS: This worksheet is a DILHR-approved method of showing compliance with the energy conservation standards of Chapter ILHR 22 of the Uniform Dwelling Code (UDC) which applies to one- and two-family dwellings built since December 1, 1978. It is recommended that the user purchase a copy of the UDC from State Document Sales, (608) 266-3358.

You have the choice of using the Accepted Practice Method or the System Design Method to show code compliance. For the Accepted Practice Method, which is recommended for standard designs, complete Sections A. and B. and Sections E. through F. and Section H. You will be first calculating component areas, then your dwelling's code-allowed and other heat loss to determine your furnace size, and then comparing your planned insulation levels to the required insulation levels from the Appendix of the UDC.

For the System Design Method, which is recommended for alternative designs, complete Sections A. through F. You will be first calculating component areas, then the code-allowed heat loss, then component U- and R-values and then your calculated heat loss which you will compare to the code-allowed heat loss. You will also be calculating the allowable furnace size.

With either method, you will need to apply the stricter and slightly different standards shown for electrically-heated homes if you answered "YES" to the above question. For electrically heated homes, you must also complete Section G. to determine the required mechanical ventilation capacity.

All "R' and 'U' calculations must be carried to four places after the decimal point, rounded to three places. Linear dimensions must be carried to three places, rounded to two. Area and heat loss calculations may be rounded to the whole number.

Numbers in brackets, [1], refer to the footnotes listed on page 5.

PAGE 2

A. AREA CALCULATIONS

Some calculations will not be necessary depending on home design and heating fuel. These calculated areas are referenced elsewhere on this worksheet, for example, A 1 , A 2....

1. GROSS (INSULATED) ABOVE-FOUNDATION WALL AREA (Including doors, windows and box sills) 1512.18 + 150.66 = 1662.84 sq. ft.		4. GROSS EXPOSED FOUNDATION WALL AREA (Enclosing warm space 50° F or warmer) 124.62 sq. ft.
2. WINDOW & PATIO DOOR AREA (sash/door area) a. In Above-Foundation Walls: 172.67 sq. ft. b. In Foundation Walls: 15.65 sq. ft. Total (a. + b.) = 188.32		5. FOUNDATION WALL AREA BETWEEN GRADE AND THREE FEET BELOW GRADE 186 x 3 = 558.0 sq. ft.
3. DOOR AREA IN ABOVE-FOUNDATION WALLS 37.82 sq. ft.		6. FOUNDATION WALL AREA MORE THAN THREE FEET BELOW GRADE 805.38 sq. ft.
7. OPAQUE [1] ABOVE-FOUNDATION WALL AREA (1.- 2.a.- 3.) 1662.84 - 172.67 - 37.82 = 1452.35 sq. ft.	8. GROSS WALL AREA ABOVE GRADE (1. + 4.) 1662.84 + 124.62 = 1787.46 sq. ft.	9. OPAQUE [1] EXPOSED FOUNDATION WALL AREA (4.- 2 b.) 124.62 - 15.65 = 108.97 sq. ft.
10. WALL AREA BELOW GRADE (5. + 6.) 558.0 + 805.38 = 1363.38 sq. ft.	11. TOTAL FOUNDATION WALL AREA (4. + 5. + 6.) 124.62 + 558.0 + 805.38 = 1488.0 sq. ft.	12. INSULATED ROOF OR CEILING AREA 1500 sq. ft.
13. FLOOR AREA OVER UNHEATED SPACES (LESS THAN 50°) 0 sq. ft.	14. SLAB ON GRADE (slab-on-grade garage will be placed outside the thermal envelope) 0 lineal feet of slab perimeter	15. BASEMENT FLOOR AREA 1500 sq. ft.

B. CODE-ALLOWED HEAT LOSS

PAGE 3

Enter values into table from elsewhere on this worksheet and multiply across by the electric or non-electric code-required U-value. For lines 1 through 5 for walls, complete as follows:

Electrically-heated Homes - Lines 1, 4 & 5.

Non-Electrically Heated Homes - Option A or B.

Option A - Lines 1, 4 & 5 - Suggested if non-foundation and exposed foundation walls are of similar construction.

Option B - Lines 2, 3, 4 and 5.

COMPONENT	AREA FROM SECT. A	X REQUIRED U-VALUE NON-ELECTRIC	ELECTRIC	X TEMP. DIFF. [2]	= HEAT LOSS BTU/HR
1. Gross Wall Above Grade (A.8.)	1787.46	.13	.080	85	12155
2. Gross Above-Foundation Wall (A.1.)		.12	N/A		
3.a. Gross Exposed Foundation Wall (A.4.) Max Area of A.4. = A.11. x .25		.25	N/A		
b. Gross Exposed Foundation Wall in Excess of Line 3.a.		.12	N/A		
4. Foundation Wall Between Grade And 3 Feet Below Grade (A.5.)	558.0	.113 [3]	.072 [3]	60	2411
5. Foundation Wall More Than Three Feet Below Grade (A.6.)	805.38	.094 [3]	.048 [3]	60	2320
6. Floors Over Unheated Spaces (A.13.)	0	.09	.055	85	0
7. Roof or Ceiling (A.12.)	1500	.029	.020	85	2550
8. Slab On Grade (A.14.)	0Un. ft.	.51 'F' [4]	.51 'F' [4]	85	0
9. Basement Floor (A.15.)	1500	.025	.025	60	2250
TOTAL CODE - ALLOWED HEAT LOSS					21686

C. SYSTEM DESIGN METHOD - ACTUAL 'U' VALUES OF YOUR HOME

C.1. ABOVE-GRADE COMPONENTS - Enter 'R-values' from Table A-4 of the UDC Appendix, ASHRAE Manual, or manufacturer's specifications. Total them across and then find the 'U' value by taking the reciprocal (1/R) of the total 'R-value'. For components having the same insulation but different interior or exterior finishes, separate calculations are not necessary if the one with the lowest 'R-value' is used in your calculations.

COMPONENT	CAVITY OR SOLID IF APPLICABLE	EXT. AIR FILM *	EXT. FINISH	SHEATHING	INSULATION OVER FRAMING	FRAMING, OR SOLID	INSULATION IN CAVITY	INTERIOR FINISH	INT. AIR FILM *	TOTAL 'R-VALUE'	'U-Value' (or 1/R)
Above-Foundation Walls	Cavity	.17	.81	5.27	0		19	0.45	.68	26.38	0.038
	Solid	.17	.81	5.27	0	6.88		0.45	.68	14.26	0.070
Exposed Foundation	Cavity	.17							.68		
	Solid	.17		10.54		1.72			.68	13.11	0.076
Roof or Ceiling	Cavity	.61			36.25		13.75	0.45	.61	51.57	0.019
	Solid	.61			36.25	6.88		0.45	.61	44.89	0.022
Floor Over Unheated Space	Cavity	.17							.92		
	Solid	.17							.92		

* Air Film R-Values

LOCATION	HEAT FLOW DIRECTION Upwards	Horizontal	Downwards
EXTERIOR	.17	.17	.17
INTERIOR	.61	.68	.92

C.2. BELOW-GRADE COMPONENTS - Precalculated 'U-values' including air films, wall, insulation and soil. Check appropriate boxes for planned type of construction.

COMPONENT TYPE	GRADE TO THREE FEET BELOW GRADE	MORE THAN THREE FEET BELOW GRADE
☐ Masonry or conc. wall without insulation	.288	.094
☐ Masonry or conc. wall with R-5 insulation board	.113	.063
☐ Masonry or conc. wall with R-10 insulation board or R-11 insulation batt and 2x4's	.072	.048
☐ Basement floor without insulation	.025	.025
☐ Basement floor with R-5 insulation	.022	.022
☐ Slab-on-Grade or within 2 ft of grade without insulation	.81 (F-value) per lineal foot of slab perimeter	
☐ Slab-on-Grade or within 2 ft of grade with R-10 insulation board for 48" total horizontal and vertical application	.51 (F-value) per lineal foot of slab perimeter	
☐ Other (describe)	Claimed U-value:	Claimed U-value:

C.3. WINDOWS AND DOORS - See Tables A-5 and A-6 of UDC Appendix for U-values and wood frame factors.

D. SYSTEM DESIGN METHOD - CALCULATED ENVELOPE HEAT LOSS OF YOUR HOME

Enter values into table from elsewhere on this worksheet and multiply across to find the actual heat loss of each component. Add component heat loss figures to find total envelope heat loss.

COMPONENT	CAVITY OR SOLID IF APPLICABLE	AREA FROM SECT. A.	X	WOOD FRAME FACTOR **	X	ACTUAL 'U' VALUE FROM SECT. C	X	TEMP. DIFF. (D)	=	HEAT LOSS BTU/HR
Opaque Above Foundation Wall (A. 7.)	Cavity	1452.35		.90		0.038		85		4222
	Solid			.10		0.070				864
Opaque Exposed Foundation Wall (A. 9.)		108.97				0.076		85		704
Foundation Between Grade and Three Feet Below Grade (A. 5.)		558.0				0.072		60		2411
Foundation Wall More Than Three Feet Below Grade (A. 6.)		805.38				0.048		60		2319
Windows (A. 2. a. + b.)	--------	188.32		.95		0.370		85		5627
Doors (A 3.)	--------	37.92		--------		0.320		85		1029
Roof or Ceiling (A. 12.)	Cavity	1500.0		.93		0.019		85		2253
	Solid			.07		0.022				196
Floor Over Unheated Spaces (A. 13.)	Cavity									
	Solid									
Basement Floor (A. 15.)	--------	1500.0		--------		0.025		60		2250
Slab On Grade (A. 14.)	--------	Lin. ft		--------		F-Val.				
TOTAL CALCULATED ENVELOPE HEAT LOSS - May not exceed Total Code Allowed Heat Loss in Sect. B. by more than 1%										21875

** Adjustment Factors For Wood-Framed Components

SPACING OF FRAMING MEMBERS	STUDS		JOISTS/RAFTERS	
	CAVITY	SOLID	CAVITY	SOLID
12"	.80	.20	.86	.14
16"	.85	.15	.90	.10
24"	.90	.10	.93	.07

Also see Part C of UDC Appendix Table A-5 for window framing adjustment factors.

E. HEAT LOSS BY AIR INFILTRATION (for furnance sizing)

An air change rate of between 0.25 and 1.00 per hour is recommended depending on tightness of construction.

FLOOR LEVEL	AREA	X	HEIGHT	=	VOLUME	X	CONSTANT	X	TEMPERATURE DIFFERENCE [2]	X	AIR CHANGES PER HOUR	=	HEAT LOSS BTU/HR
Basement	1500		8		12000		.018		85		0.5		9180
Level 1	1500		8		12000		.018		85		0.5		9180
Level 2							.018						
Level 3							.018						
	Total Dwelling Volume				24000				INFILTRATION HEAT LOSS				18360

F. FURNACE SIZING

This section determines the maximum and minimum furnace size in BTU's/HR.

	Minimum	Maximum
System Design Method: Calculated Heat Loss from Sect. D, or Accepted Practice Method: Code-Allowed Heat Loss from Sect. B.	21875	---------
Code-Allowed Heat Loss (from Sect. B)	---------	21686
Infiltration Heat Loss (from Sect. E)	+ 18360	+ 18360
TOTAL DWELLING HEAT LOSS (total of above)	= 40235	= 40046
Allowable Furnace Size Margin Multiplier	X 1.0	X 1.15
ALLOWABLE FURNACE OUTPUT SIZE RANGE	= 40235	= 46053 [5]
Planned Furnace Output	50,000	

G. MECHANICAL VENTILATION SIZING

Required for electrically-heated homes only.

1. Dwelling volume from Sect. E.		24,000
2. Less volume of non-living area; area: (925) X height: (8)	=	- 7,400
3. Less volume of dead air spaces (cabinets, walls, etc) Approx. 20%		- 2,163
4. Net volume of living area (total of above)	=	14,437
5. Cubic feet of air changed per hour (multiply line 4 by 0.5)	=	7,218.5
6. MINIMUM REQUIRED MECHANICAL VENTILATION IN CFM's (multiply line 5 by 0.0167)	=	120.5

Footnotes:

[1] Opaque wall area is wall area minus opening areas of doors and windows.

[2] Temperature Difference = Inside design temperature of 70° minus outside design temperature from Table 22.04-B of the UDC. Basement inside temperature may be taken between 50° and 70°. Temperature difference for transmission heat losses of below-grade spaces of basements is inside temperature minus 10°, disregarding outside temperature.

[3] These below-grade U-values have the insulating value of the soil added to the code-required U-values which apply to the building materials only. See sect. C.2. for typical insulated component U-values.

[4] These slab-on-grade F-values are derived from the code-required U-values and include the heat loss through the edge and body of the slab. See sect. C.2.

[5] If desired manufacturer does not have a furnace of this size, designer may go to manfacturer's next larger size.

H. ACCEPTED PRACTICE METHOD

For completion of the accepted practice method, please refer to the Appendix Tables A-1, 2 and 3 and E-1, 2 and 3 of the Uniform Dwelling Code (UDC). Complete Subsection H.1. if your home is heated with other than electricity. Complete Subsection H.2. if your home is electrically heated. Area figures should be calculated in Section A. and are referenced below.

SUBSECTION H.1. Non-Electrically Heated Homes Only

WALLS ABOVE FOUNDATION WALL INCLUDING BOXSILL, USE TABLE A-1	MINIMUM ☐ Single w/storm MINIMUM ☐ Insulated SIDING: ☐ Wood (R-.77) ABOVE-FDTN ☐ Insulated glass DOORS: ☐ Solid Wood ☐ Alum. (R-1.82) WINDOWS: ☐ Triple pane ☐ Uninsulated w/storm ☐ Other: R-____ PLANNED INSULATION TYPE AND R-VALUE: _____ PERMITTED WINDOW AND DOOR AREA: ____% _____ (Above Foundation Window & Door Area (A.2.a. + A.3.)) ÷ _____ (Gross Above-Foundation Wall Area (A.1.)) X 100% = _____ % (% Planned Window and Door Area)
EXPOSED FOUNDATION WALL, USE TABLE A-2	BASEMENT WINDOWS: ☐ Single-glazed OR ☐ Single w/storm or insulated glass PLANNED INSULATION TYPE AND R-VALUE: _____ _____ (Exposed Foundation Area (A.4)) ÷ _____ (Total Foundation Area (A.11.)) X 100 % = _____ % (% Exposed Foundation) (If over 25% exposed foundation, then exposed foundation area equal to 25% of foundation shall have maximum U-Value of .25 and balance of area shall have maximum U-Value of .12.) Percent Window Area Permitted By Table: _____ % _____ (Basement Window Area (A.2.b)) ÷ _____ (Exposed Fdtn. Wall Area (A.4.)) X 100 % = _____ % (% Planned Window Area)
ROOF OR CEILING, USE TABLE A-3	PLANNED INSULATION TYPE: _____ R-VALUE PER INCH: _____ REQUIRED THICKNESS: _____ Inches in cavity (R-38) _____ Inches Over Framing (R-19)
FOUNDATION WALL, GRADE TO 3 FEET DOWN	PLANNED INSULATION TYPE AND R-VALUE: _____ (MINIMUM R-5 INSULATION)

SUBSECTION H.2. Electrically Heated Homes Only

WALLS ABOVE FOUNDATION INCLUDING BOX-SILL, USE TABLES E-1 AND E-2	ALL THESE MEASURES REQUIRED: ☒ ALL WINDOWS TRIPLE-GLAZED ☒ EXPOSED FOUNDATION INSULATED TO R-10.S4 ☒ DOORS INSULATED TO R-8 (172.67 + 15.65) (Total Window Area (A.2.a. + b)) ÷ 1787.46 (Above Grade Wall Area (A.8.)) X 100 % = 10.5 % (% Window Area) 108.97 (Opaque Exposed Foundation Area (A.9.)) ÷ 1787.46 (Above-Grade Wall Area (A.8.)) X 100 % = 6.1 % (% Opaque Exposed Foundation Wall) Required Above Foundation Wall U-Value (from Table E-1): 0.044 Planned Wall Construction: 2 x 6, R 19 Batt, R 5.27 sheathing U-Value from Table E-2: 0.044
ROOF OR CEILING, USE TABLE E-3	PLANNED INSULATION TYPE: Blown Fiberglass R-VALUE PER INCH: 2.5 REQUIRED THICKNESS FROM TABLE E-3: 20.0 Inches
FOUNDATION WALL FOR FULL HEIGHT	PLANNED INSULATION TYPE AND R-VALUE: 2" Styrofoam, R = 10.5 (MINIMUM R-10 INSULATION)

TABLE A-1

WALL INSULATION GUIDE

(Based on U_o requirements above the foundation wall for non-electrically heated dwellings)

INSULATION TYPE	MAXIMUM PERCENT WINDOW AND DOOR AREA ALLOWABLE FOR INSULATION TYPE	
	U_o = .12	
	⅝ inch Plywood Siding	Backed Aluminum Siding
R-11 Batt	6.8	8.4
R-11 Batt, R-1.22 Fiberboard	8.7	9.9
R-11 Batt, R-5.27 Extruded Polystyrene	12.4	13.0
R-11 Batt, R-10.54 Extruded Polystyrene	14.9	15.3
R-13 Batt	8.3	9.8
R-13 Batt, R-1.22 Fiberboard	10.3	11.2
R-13 Batt, R-5.27 Extruded Polystyrene	13.1	13.6
R-13 Batt, R-10.54 Extruded Polystyrene	15.3	15.6
R-19 Batt	11.2	12.2
R-19 Batt, R-1.22 Fiberboard	12.3	13.1
R-19 Batt, R-5.27 Extruded Polystyrene	14.7	15.1
R-19 Batt, R-10.54 Extruded Polystyrene	16.3	16.6

Note: The following assumptions were used to derive this table:

1. Door area = 2% of wall and box sill area.
2. Doors are used with a U-value of 0.47.
3. Windows are used with a U-value of 0.56.
4. The insulation type is carried down through the box sill.

TABLE A-2

EXPOSED FOUNDATION INSULATION NON-ELECTRICALLY HEATED DWELLINGS

Foundation Exposure	Requirement	Insulation Type	Maximum Percent Window Area	
			Single glazed	Double glazed
Less than 25% of foundation exposed	U_o = .25	R-5.27	10.4	24.8
		R-11 batt	15.5	34.2
		Multi-cell insul. block (R-12.06)	16.0	35.0
More than 25% of foundation exposed	U_o = .13	R-11 batt	3.9	8.7
		R-13 batt	4.8	10.6
		Multi-cell insul. block (R-12.06)	4.5	9.9
	U_o = .12	R-11 batt	3.0	6.7
		R-13 batt	3.9	8.5
		Multi-cell insul. block (R-12.06)	3.5	7.8

TABLE A-3

INSULATION LEVELS REQUIRED TO MEET CEILING U VALUES FOR NON-ELECTRICALLY HEATED DWELLINGS

U_0 Value	Insulation	R-Value Required	
		In Cavity	Over Framing
.029	Fiber glass batt	R-38	R-19
	Fiber glass blown	13.6 in. (R-34)	8.1 in. (R-20)
	Rock wool	10.9 in. (R-33)	5.4 in. (R-16)
	Cellulose	9.5 in. (R-35)	4.0 in. (R-15)

Note: The following assumptions are used:

1. Fiber glass blown = R-2.5 per inch
2. Rock wool = R-3.0 per inch
3. Cellulose = R-3.7 per inch

TABLE E-1 - DIRECTIONS FOR USE

Table E-1 was formulated with the following assumptions:

The doors have R-values of at least R-8 and form 2% or less of the above-foundation wall.

$$\frac{\text{door area}}{\text{gross wall area + box sill}} \times 100\%, \text{ in this case} =$$

$$\frac{37.82}{1512.18 + 150.66} \times 100\%, = 2\%$$

Windows with an R-value of at least 2.7 (triple glazed) are used, including the foundation windows.

The exposed foundation area is insulated to a level of R-10.54.

If these assumptions are not valid for your case, the insulation level may be calculated by the method illustrated following Tables E-1 and E-2.

TABLE E-1

MAXIMUM ABOVE-FOUNDATION WALL U-VALUES FOR ELECTRICALLY HEATED HOMES

PERCENT WINDOW AREA

PERCENT OPAQUE FOUNDATION AREA	5	6	7	8	9	10	11	12	13	14	15	16
0	.065	.062	.059	.056	.053	.050	.046	.043	.040	.036	.032	.029
5	.065	.061	.058	.055	.051	.048	.044	.041	.037	.033	.029	.025
6	.064	.061	.058	.055	.051	.048	.044	.040	.037	.033	.029	.025
7	.064	.061	.058	.054	.051	.047	.044	.040	.036	.032	.029	
8	.064	.061	.057	.054	.050	.047	.043	.039	.035	.031	.027	
9	.064	.061	.057	.054	.050	.046	.043	.039	.035	.031	.027	
10	.064	.060	.057	.053	.050	.046	.042	.038	.034	.030	.026	
11	.064	.060	.057	.053	.049	.046	.042	.038	.034	.030	.025	
12	.063	.060	.056	.053	.049	.045	.041	.037	.033	.029	.025	
13	.063	.060	.056	.052	.049	.045	.041	.037	.033	.028		
14	.063	.059	.056	.052	.048	.044	.040	.036	.032	.027		
15	.063	.059	.055	.052	.048	.044	.040	.036	.031	.027		
16	.063	.059	.055	.051	.047	.043	.039	.035	.031	.026		
17	.062	.059	.055	.051	.047	.043	.039	.034	.030	.025		
18	.062	.058	.055	.051	.047	.042	.038	.034	.029			
19	.062	.058	.054	.050	.046	.042	.037	.033	.028			
20	.062	.058	.054	.050	.046	.041	.037	.032	.028			
21	.061	.057	.053	.049	.045	.041	.036	.032	.027			
22	.061	.057	.053	.049	.045	.040	.036	.031	.026			
23	.061	.057	.053	.048	.044	.040	.035	.030	.025			
24	.061	.057	.052	.048	.044	.039	.034	.029				
25	.060	.056	.052	.048	.043	.038	.034	.029				

TABLE E-2

FRAME WALL & BOX SILL U-VALUES FROM DIFFERENT BUILDING MATERIALS AND METHODS

Insulation Type	2 × 4 FRAMING 16" O.C.[1]	2 × 6 FRAMING 16" O.C.	2 × 6 FRAMING 24" O.C.[2]	Double 2 × 4 or 2 × 8 FRAMING 24" O.C.
R-11 Batt	0.091			
R-11 Batt, R1.22 Fiberboard	0.081			
R-11 Batt, R5.27 Polystyrene	0.060			
R-11 Batt, R10.54 Polystyrene	0.045			
R-11 Batt, R7.21 Isocyanurate	0.054			
R-11 Batt, R14.4 Isocyanurate	0.038			
R-13 Batt	0.083			
R-13 Batt, R1.22 Fiberboard	0.074			
R-13 Batt, R5.27 Polystyrene	0.056			
R-13 Batt, R10.54 Polystyrene	0.043			
R-13 Batt, R7.21 Isocyanurate	0.050			
R-13 Batt, R14.4 Isocyanurate	0.036			
R-19 Batt		0.060	0.058	0.056
R-19 Batt, R1.22 Fiberboard		0.055	0.053	0.052
R-19 Batt, R5.27 Polystyrene		0.044	0.043	0.042
R-19 Batt, R10.54 Polystyrene		0.036	0.035	0.034
R-19 Batt, R7.21 Isocyanurate		0.040	0.039	0.039
R-19 Batt, R14.4 Isocyanurate		0.031	0.030	0.030
Two R-11 Batts				0.053
Two R-11 Batts, R1.22 Fiberboard				0.049
Two R-11 Batts, R5.27 Polystyrene				0.040
Two R-11 Batts, R10.54 Polystyrene				0.033
Two R-11 Batts, R7.21 Isocyanurate				0.037
Two R-11 Batts, R14.4 Isocyanurate				0.029
Two R-13 Batts				0.048
Two R-13 Batts, R1.22 Fiberboard				0.045
Two R-13 Batts, R5.27 Polystyrene				0.037
Two R-13 Batts, R10.54 Polystyrene				0.030
Two R-13 Batts, R7.21 Isocyanurate				0.034
Two R-13 Batts, R14.4 Isocyanurate				0.027

[1]Assumes 20% framing, 80% cavity.

[2]Assumes 17% framing, 83% cavity.

MANUAL CALCULATION METHOD

To calculate the required wall U-value without using Tables E-1 and E-2, use the method outlined below:

Step 1: Calculate the above grade wall composition.

% Window area = 10.53%

% Door area = 2.12%

% Opaque foundation area = 6.10%

% Opaque wall & box sill area = 82.25%

Step 2: Use the following formula to calculate the maximum allowable U-value for the opaque wall and box sill.

$$\frac{Uo - (Uw \times \%w) - (Ud \times \%d) - (Uf \times \%f)}{\%wall} = U_{wall}$$

Where:

U_o	= Required overall above grade wall U-value, use 0.080 for an electrically heated home
U_w	= The U-value of the windows (= 1/R-value)
$\%_w$	= The fraction of window area calculated in Step 1
U_d	= The U-value of the doors (= 1/R-value)
$\%_d$	= The fraction of door area calculated in Step 1
U_f	= The U-value of the insulated foundation
$\%_f$	= The fraction of exposed foundation calculated in Step 1
$\%_{wall}$	= The fraction of opaque wall and box sill area as calculated in Step 1
U_{wall}	= The maximum U-value of the opaque wall and box sill to be calculated

In our example:

The window R-value = R-2.78	U = 1/2.78 = 0.341
The door R-value = R-8.85	U = 1/8.85 = 0.113
The foundation R-value = R-12.4	U = 1/12.4 = 0.080

$$U_{wall} = \frac{0.080 - (0.341 \times 0.1053) - (0.113 \times 0.0212) - (0.080 \times 0.0610)}{0.8225} = 0.045$$

In this case, the maximum U-value of the opaque wall and box sill is 0.045 Btu/hr. sq. ft. °F. For compliance, the insulation which is installed in the wall and box sill must provide a U-value which is less than or equal to 0.045. Table E-3 shows the U-values obtainable from different insulation materials and framing types.

TABLE E-3 DIRECTIONS FOR USE

Table E-3 gives the amount of installed insulation which would be necessary to achieve a required U-value in the ceiling or attic.

Table E-3 was formulated with the following assumptions:

— The loose fill insulation, if used, is installed to provide the following R-values:

Cellulose	R = 3.7/in
Expanded perlite	R = 2.7/in
Mineral Fiber (rock, slag, or glass)	R = 3.3/in
Polystyrene beads	R = 2.9/in
Fiber glass, blown	R = 2.5/in

— The insulated area is 90% cavity and 10% 2 × 6 framing

— There are no skylights in the ceiling/attic assembly

— The R-value of the ceiling finish materials plus air films is R-1.2

— The attic hatch is insulated to the same level as the rest of the attic floor, if it is a part of the thermal envelope.

If these assumptions are not valid for your case, you may calculate the required U-value as shown after Table E-3.

TABLE E-3

INSULATION LEVELS REQUIRED TO MEET CEILING U_0 VALUES

Dwelling Fuel Type	U_0	Insulation Type	Amount Required In Cavity Depth (R-Value)
Electrically Heated	0.020	Fiber glass Batts	R-54
		Cellulose	14.1 in. (R-52)
		Expanded Pearlite	18.6 in. (R-50)
		Mineral Fiber	15.6 in. (R-51)
		Polystyrene Beads	17.5 in. (R-52)
		Blown Fiber glass	20.0 in. (R-50)

MANUAL CALCULATION METHOD

To calculate the required ceiling insulation level for ceiling/attic assemblies, use the following method.

Step 1: Calculate the required U-value for the attic floor, U_F, with the following formula.

$$U_F = \frac{UoAo - UsAs - Uh\,Ah}{A_F}$$

Where:

U_F = The required U-value for the attic floor

U_0 = The overall U-value set by the code, use 0.020 for an electrically heated dwelling

A_0 = The overall attic/ceiling area including the attic floor, any skylights and the attic hatch or access panel

U_S = The U-value of the skylights including the frame

A_S = The area of skylights, including the frame (if there are no skylights, set equal to zero)

U_h = The U-value of the attic hatch or access panel

A_h = The area of the attic hatch or access panel (If the hatch is to be insulated to the same level as the attic floor, add the area to the floor area, A_F, and set A_h equal to zero. If the attic hatch or access panel is not a part of the thermal envelope, set A_h equal to zero.)

A_F = The area of the insulated attic floor, equal to the overall attic/ceiling area minus the attic hatch and skylight areas, if any.

Example: For the attic of an electrically heated dwelling with an overall attic area of 1500 sq. ft. The attic hatch is 14" × 24" and is to be insulated with two R-19 fiber glass batts, the rest of the attic is to be insulated with blown mineral fiber with an R-value of 3.3-R/inch. There are two skylights, each 6 square feet with R-values of 1.8.

The R-value of the attic hatch is the sum of the R-values of the batts plus R-2 for the finish materials and air films.

$R = 19 + 19 + 2 = 40$

The U-value of the hatch is $U_h = 1/40 = 0.025$

The U-value of the skylights $U_s = 1/1.8 = 0.56$

The area of the hatch = 2 ft × 1.17 ft = 2.3 sq. ft.

The area of the skylights is 12 square feet

The area of the floor is 1500 − 12 − 2.3 = 1486 sq. ft.

$$U_F = \frac{(0.020)(1500) - (0.56)(12) - (0.025)(2.3)}{1486} = 0.0156$$

Step #2: To calculate the amount of insulation needed over the framing and cavity areas, d, of the attic floor use the following formula:

$$d = \frac{1}{U_F\,(R/in)} - \frac{(RW/in)\;h}{(\%C)(RW/in) + (\%W)(R/in)} - \frac{R_{fin} + h}{(R/in)}$$

Where:

d	=	depth of insulation at cavity in inches
U_F	=	required U-value of floor calculated in Step #1
R/in	=	R-value per inch of insulating material obtained from manufacturer or Table A-4
h	=	height of framing, 5-1/2" for 2 × 6 framing or 7-1/4" for 2 × 8 framing, for example.
%C	=	fraction of floor which is cavity (usually assume 0.9)
%W	=	fraction of floor which is framing (usually assume 0.1)
RW/in	=	R-value per inch of wood framing (usually assume 1.25 R/inch)
R_{fin}	=	R-value of interior ceiling finish materials, including air films (usually assume R-1.2)

$$d = \frac{1}{(0.0156)(3.3)} + 5.5 - \frac{(1.25)(5.5)}{(0.9)(1.25) + (0.1)(3.3)} - \frac{1.2}{3.3} = 19.59 \text{ inches}$$

The floor of the attic is to be covered with insulation so that the depth in the cavities is equal to 19.59 inches.

TABLE A-4

COMMON CONSTRUCTION MATERIAL R-VALUES*

Material	Description	Density (lb per cu ft)	Per inch thickness R-Value	For thickness listed R-Value
BUILDING BOARD Boards, panels, subflooring, sheathing, woodbased panel products	Asbestos-cement board.....	120	0.25	—
	Asbestos-cement board ..... ⅛ in.	120	—	0.03
	Asbestos-cement board ..... ¼ in.	120	—	0.06
	Gypsum or plaster board ..... ⅜ in.	50	—	0.32
	Gypsum or plaster board ..... ½ in.	50	—	0.45
	Plywood.....	34	1.25	—
	Plywood..... ¼ in.	34	—	0.31
	Plywood..... ⅜ in.	34	—	0.47
	Plywood..... ½ in.	34	—	0.62
	Plywood or wood panels ..... ¾ in.	34	—	0.93
	Insulating board			
	Sheathing, reg. density ..... ½ in.	18	—	1.32
	.... 25/32 in.	18	—	2.06
	Sheathing, intermediate density ..... ½ in.	22	—	1.22
	Nail-base sheathing..... ½ in.	25	—	1.14
	Shingle backer..... ⅜ in.	18	—	0.94
	Shingle backer..... 5/16 in.	18	—	0.78
	Sound deadening board ..... ½ in.	15	—	1.35
	Tile and lay-in panels, plain or acoustic.....	18	2.50	—
	..... ½ in.	18	—	1.25
	..... ¾ in.	18	—	1.89
	Laminated paperboard	30	2.00	—
	Homogeneous board from repulped paper	30	2.00	—
	Hardboard			
	Medium density siding ..... 7/16 in.	40	—	0.67
	Other medium density.....	50	1.37	—
	High density, underlay.....	55	1.22	—
	High density std. tempered ..	63	1.00	—
	Particleboard			
	Low density	37	1.85	—
	Medium density	50	1.06	—
	High density	62.5	0.85	—
	Underlayment..... ⅝ in.	40	—	0.82
	Wood subfloor..... ¾ in.	—	—	0.94
BUILDING PAPER	Vapor-permeable felt.....	—	—	0.06
	Vapor-seal, 2 layers of mopped 15 lb. felt	—	—	0.12
	Vapor-seal, plastic film.....	—	—	Negl.
ROOF INSULATION	Preformed, for use above deck			
	Approximately ..... ½ in.	—	—	1.39
	Approximately ..... 1 in.	—	—	2.78
	Approximately ..... 1½ in	—	—	4.17
	Approximately ..... 2 in.	—	—	5.56
	Approximately ..... 2½ in.	—	—	6.67
	Approximately ..... 3 in.	—	—	8.33
	Cellular glass.....	9	2.50	—

Material	Description	Density (lb per cu ft)	Per inch thickness R-Value	For thickness listed R-Value
MASONRY MATERIALS Concrete	Cement mortar	116	0.20	—
	Gypsum-fiber concrete 87½% gypsum, 12½% wood chips	51	0.60	—
	Lightweight aggregates	120	0.19	—
	including expanded shale,	100	0.28	—
	clay or slate, expanded	80	0.40	—
	slags; cinders; pumice;	60	0.59	—
	vermiculite; also cellular	40	0.86	—
	concretes	30	1.11	—
		20	1.43	—
	Perlite	40	1.08	—
		30	1.41	—
		20	2.00	—
	Sand and gravel or stone aggregate (oven dried)	140	0.11	—
	Sand and gravel or stone aggregate (not dried)	140	0.08	—
	Stucco	116	0.20	—
MASONRY UNITS	Brick, common	120	0.20	—
	Brick, face	130	0.11	—
	Clay tile, hollow:			
	1 cell deep 3 in.	—	—	0.80
	1 cell deep 4 in.	—	—	1.11
	2 cells deep 6 in.	—	—	1.52
	2 cells deep 8 in.	—	—	1.85
	2 cells deep 10 in.	—	—	2.22
	3 cells deep 12 in.	—	—	2.50
	Concrete blocks, 3 oval core:			
	Sand & gravel aggregate 4 in.	—	—	0.71
	8 in.	—	—	1.11
	12 in.	—	—	1.28
	Cinder aggregate 3 in.	—	—	0.86
	4 in.	—	—	1.11
	8 in.	—	—	1.72
	12 in.	—	—	1.89
	Lightweight 3 in.	—	—	1.27
	aggregate(expanded 4 in.	—	—	1.50
	shale, clay, slate 8 in.	—	—	2.00
	or slag; pumice) 12 in.	—	—	2.27
	Concrete blocks, rectangular core			
	Sand & gravel aggregate			
	2 core, 8" 36 lb	—	—	1.04
	Same with filled cores	—	—	1.93
	Lightweight aggregate (expanded shale, clay, slate or slag, pumice):			
	3 core, 6" 19 lb —	—	1.65	
	Same with filled cores —	—	2.99	
	2 core, 8" 24 lb —	—	2.18	
	Same with filled cores —	—	5.03	
	3 core, 12" 38 lb —	—	2.48	
	Same with filled cores —	—	5.82	
	Stone, lime or sand	—	0.08	—
	Gypsum partition tile:			
	3 x 12 x 30 in. solid	—	—	1.26
	3 x 12 x 30 in. 4-cell	—	—	1.35
	4 x 12 x 30 in. 3-cell	—	—	1.67

Material	Description	Density (lb per cu ft)	Per inch thickness R-Value	For thickness listed R-Value
PLASTERING MATERIALS	Cement plaster, sand aggregate	116	0.20	—
	Sand aggregate ¾ in.	—	—	0.08
	Sand aggregate ¾ in.	—	—	0.15
	Gypsum plaster:			
	Lightweight aggregate ½ in.	45	—	0.32
	Lightweight aggregate ⅝ in.	45	—	0.39
	Lightweight aggregate on metal lath ¾ in.	—	—	0.47
	Perlite aggregate	45	0.67	—
	Sand aggregate	105	0.18	—
	Sand aggregate ½ in.	105	—	0.09
	Sand aggregate ⅝ in.	105	—	0.11
	Sand aggregate on metal lath ¾ in	—	—	0.1
	Vermiculite aggregate	45	0.59	—
ROOFING	Asbestos-cement shingles	120	—	0.21
	Asphalt roll roofing	70	—	0.15
	Asphalt shingles	70	—	0.44
	Built-up roofing ⅜ in	70	—	0.33
	Slate ½ in.	—	—	0.05
	Wood shingles, plain plastic film faced —	—	0.94	
SIDING MATERIALS (On flat surface)	Shingles:			
	Asbestos-cement	120	—	0.21
	Wood, 16", 7½" exposure	—	—	0.87
	Wood, double, 16", 12" exposure	—	—	1.19
	Wood, plus insulating backer board 5/16 in.	—	—	1.40
	Siding:			
	Asbestos-cement, ¼" lapped	—	—	0.21
	Asphalt roll siding	—	—	0.15
	Asphalt insulating siding (½" bd.)	—	—	1.46
	Wood drop 1 x 8"	—	—	0.79
	Wood bevel, ½" x 8" lapped	—	—	0.81
	Wood bevel, ¾ x 10" lapped	—	—	1.05
	Wood plywood ⅜" lapped	—	—	0.59
	Aluminum or steel, over sheathing, hollow-backed	—	—	0.61
	Insulating-board backed nominal ⅜"	—	—	1.82
	Insulating-board backed nominal ⅜" foil backed	—	—	2.96
	Architectural glass	—	—	0.10
FINISH FLOORING MATERIALS	Carpet and fibrous pad	—	—	2.08
	Carpet and rubber pad	—	—	1.23
	Cork tile ¼ in.	—	—	0.28
	Terrazzo 1 in.	—	—	0.08
	Tile-asphalt, linoleum, vinyl, rubber	—	—	0.05
	Wood, hardwood finish ¾ in.	—	—	0.08
INSULATING MATERIALS Blanket and batt	Mineral fiber, fibrous form processed from rock, slag or glass			
	Approx. 2 to 2¾"... Note 1	—	—	7

Material	Description	Density (lb per cu ft)	Per inch thickness R-Value	For thickness listed R-Value
	Approx. 3 to 3½" ... Note 1	—	—	11
	Approx. 5¼ to 6½" ..... Note 1	—	—	19
Board and Slabs	Cellular glass.....	9	2.50	—
	Glass fiber, organic bonded.....	4-9	4.00	—
	Expanded rubber (rigid)	4.5	4.55	—
	Expanded polystyrene extruded, plain.....	1.8	4.00	—
	Expanded polystyrene extruded (R-12 exp.).....	2.2	5.00	—
	Expanded polystyrene extruded (R-12 exp.) (Thickness 1" and greater).....	3.5	5.26	—
	Expanded polystyrene, molded beads.....	1.0	3.57	—
	Expanded polyurethane (R-11 exp.)	1.5	6.25	—
	Mineral fiber with resin binder.	15	3.45	—
	Mineral fiberboard wet felted			
	Core or roof insulation	16-17	2.94	—
	Acoustical tile	18	2.86	—
	Acoustical tile	21	2.70	—
	Mineral fiberboard wet molded			
	Acoustical tile	23	2.38	—
	Wood or cane fiberboard			
	Acoustical tile ..... ½ in.	—	—	1.25
	Acoustical tile ..... ¾ in.	—	—	1.89
	Interior finish (plank, tile)	15	2.86	—
	Insulating roof deck			
	Approximately ..... 1½ in.	—	—	4.17
	Approximately ..... 2 in.	—	—	5.56
	Approximately ..... 3 in.	—	—	8.33
	Wood shredded (cemented in preformed slabs).....	22	1.67	—
	Foil faced, glass fiber — reinforced cellular polyisocyanurate	2	7.04	—
	Nominal 0.5 in.....	2	—	3.6
	Nominal 1.0 in.....	2	—	7.2
	Nominal 2.0 in.....	2	—	14.4
Loose Fill	Cellulose insulation (milled paper or wood pulp)	2.5-3	3.70	—
	Sawdust or shavings	0.8-1.5	2.22	—
	Wood fiber, softwoods	2.0-3.5	3.33	—
	Perlite, expanded	5.0-8.0	2.70	—
	Mineral fiber (rock, slag or glass):			
	Approximately 3" ..... Note 1	8-15	—	9
	Approximately 4½" ..... Note 1	8-15	—	13
	Approximately 6¼" ..... Note 1	8-15	—	19
	Approximately 7¼" ..... Note 1	8-15	—	24
	Silica aerogel.....	7.6	5.88	—
	Vermiculite (expanded).....	7.0-8.2	2.13	—
	.....	4.0-6.0	2.27	—

Material	Description		Density (lb per cu ft)	Per inch thickness R-Value	For thickness listed R-Value
WOODS	Maples, oak and similar hardwoods		45	0.91	—
	Fir, pine, and similar softwoods		32	1.25	—
	Fir, pine, and similar softwoods	¾ in.	32	—	0.94
	.....	1½ in.	32	—	1.89
	.....	2½ in.	32	—	3.12
	.....	3½ in.	32	—	4.35

Note 1: R-value varies with fiber diameter. Insulation is produced by different densities; therefore, there is a wide variation in thickness for the same R-value between various manufacturers. (See Batt and Loose Fill Insulation.)

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TABLE A-5

COEFFICIENTS OF TRANSMISSION (U) OF WINDOWS, SKYLIGHTS, AND LIGHT TRANSMITTING PARTITIONS*

(These values are for heat transfer from air to air.)
Btu per (hr) (sq ft) (F Deg)

PART A
VERTICAL PANELS (EXTERIOR WINDOWS, SLIDING PATIO DOORS AND PARTITIONS) — FLAT GLASS, GLASS BLOCK AND PLASTIC SHEET

Description	Exterior[1] Winter	Exterior[1] Summer	Interior
Flat Glass			
single glass	1.13	1.06	0.73
insulating glass—double[2]			
3/16 in. air space	0.69	0.64	0.51
¼ in. air space	0.65	0.61	0.49
½ in. air space	0.58	0.56	0.46
½ in. air space, low emissivity coating[3]			
emissivity = 0.20	0.38	0.36	0.32
emissivity = 0.40	0.45	0.44	0.38
emissivity = 0.60	0.52	0.50	0.42
insulating glass—triple[2]			
¼ in. air spaces	0.47	0.45	0.38
½ in. air spaces	0.36	0.35	0.30
storm windows			
1 in.-4 in. air space	0.56	0.54	0.44
Glass Block[4]			
6 x 6 x 4 in. thick	0.60	0.57	0.46
8 x 8 x 4 in. thick	0.56	0.54	0.44
—with cavity divider	0.48	0.46	0.38
12 x 12 x 4 in. thick	0.52	0.50	0.41
—with cavity divider	0.44	0.42	0.36
12 x 12 x 2 in. thick	0.60	0.57	0.46
Single Plastic Sheet	1.09	1.00	0.70

[1]See Part C for adjustment for various window and sliding patio door types.
[2]Double and triple refer to the number of lights of glass.
[3]Coating on either glass surface facing air space; all other glass surfaces uncoated.
[4]Dimensions are nominal.

PART B
HORIZONTAL PANELS (SKYLIGHTS)
FLAT GLASS, GLASS BLOCK AND PLASTIC BUBBLES

Description	Exterior[1] Winter[5]	Exterior[1] Summer[6]	Interior[5]
Flat Glass			
single glass	1.22	0.83	0.96
insulating glass—double[2]			
3/16 in. air space	0.75	0.49	0.62
¼ in. air space	0.70	0.46	0.59
½ in. air space	0.66	0.44	0.56
½ in. air space, low emissivity coating[3]			
emissivity = 0.20	0.46	0.31	0.39
emissivity = 0.40	0.53	0.36	0.45
emissivity = 0.60	0.60	0.40	0.50
Glass Block[4]			
11 x 11 x 3 in. thick with cavity divider	0.53	0.35	0.44
12 x 12 x 4 in. thick with cavity divider	0.51	0.34	0.42
Plastic Bubbles[7]			
single walled	1.15	0.80	—
double walled	0.70	0.46	—

[5]For heat flow up.
[6]For heat flow down.
[7]Based on area of opening, not total surface area.

(See following page for Part C of this table.)

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PART C
ADJUSTMENT FACTORS FOR VARIOUS WINDOW AND SLIDING PATIO DOOR TYPES
(Multiply U values in Parts A and B by these factors)

Description	Single Glass	Double or Triple Glass	Storm Windows
Windows			
All Glass[8]	1.00	1.00	1.00
Wood Sash—80% Glass	0.90	0.95	0.90
Wood Sash—60% Glass	0.80	0.85	0.80
Metal Sash—80% Glass	1.00	1.20	1.20[9]
Sliding Patio Doors			
Wood Frame	0.95	1.00	—
Metal Frame	1.00	1.10	—

[8]Refers to windows with negligible opaque area.
[9]Value becomes 1.00 when storm sash is separated from prime window by a thermal break.

TABLE A-6

COEFFICIENTS OF TRANSMISSION (U) FOR SLAB DOORS*
Btu per (hr) (sq ft) (F Deg)

Thickness[1]	Winter			Summer,
	Solid Wood, No Storm Door	With Storm Door		
		Wood	Metal	No Storm Door
1 in.	0.64	0.30	0.39	0.61
1¼ in.	0.55	0.28	0.34	0.53
1½ in.	0.49	0.27	0.33	0.47
2 in.	0.43	0.24	0.29	0.42
	Steel Door			
1¾ in.				
A[3]	0.59	—	—	0.58
B[4]	0.19	—	—	0.18
C[5]	0.47	—	—	0.46

[1]Nominal thickness.

[2]Values for wood storm doors are for approximately 50% glass; for metal storm doors values apply for any percent of glass.

[3]A = Mineral fiber core (2 lb/cu ft).

[4]B = Solid urethane foam core with thermal break.

[5]C = Solid polystyrene core with thermal break.

Note: Hollow core doors 1⅜ in. thick - R = 2.17; U = 0.46
1¾ in. thick - R = 2.22; U = 0.45

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APPENDIX C

INSULATION, EQUIPMENT AND CONDENSATION CONTROL

This appendix is a guide for the proper installation of insulation. The preceding appendices indicated the required amounts and types of insulation necessary to provide the various thermal resistance values for the building envelope. In order to attain the resistance values specified, it is important that the insulation be properly installed. This appendix includes types of materials currently available and common application practices.

Condensation control should be provided in the form of vapor barriers and thermal breaks. Vapor barriers should be installed on the warm side (area heated in winter) of all walls, ceilings, and insulated floors. All metal window, skylight, and door frames should contain a thermal break.

Insulation is manufactured in many forms and types. The most commonly used materials in residential construction are batts and blankets, rigid insulation, reflective insulation, loose fill, and sprayed insulation. The following is a list of types of materials and the federal specifications governing their characteristics.

Cork board	FS HH-I-561
Cellular glass	FS HH-I-551
Duct insulation	FS HH-I-558b
Expanded polystyrene insulation board	FS HH-I-524
Fiberboard	FS LLL-I-535 or ASTM C-208 Class C
Insulation board (urethane)*	FS HH-I-530
Insulation, thermal (perlite)	FS HH-I-574
Mineral fiber, pneumatic or poured	FS HH-I-1030A
Mineral fiber, insulation blanket	FS HH-I-521E
Perlite	FS HH-I-526a
Perimeter insulation	FS HH-I-524a Type II
	FS HH-I-558b Form A, Class 1 or 2
Reflective, thermal	FS HH-I-1552
Structural fiberboard insulation roof deck	AIMA IB Spec. No. 1
Cellulose; vegetable or wood fiber	FS HH-I-515b-25
Vermiculite	FS HH-I-585
Vermiculite, water repellent loose fill	FHA UM-30
Mineral fiber, roof insulation	HH-I-526c

BATTS AND BLANKETS

These materials are usually identified on the package and on the vapor barrier facing with their "R" values. Under the federal specifications, there are 3 standard products identified as R-7, R-11, and R-19. These values are based on the insulation value of the mass. Some manufacturers offer other products such as R-8, R-13 and R-22. The specific thickness of insulation required for a specific "R" value may vary from one manufacturer to another due to differences in base materials and manufacturing processes.

General Guidelines

1. Install insulation so the vapor barrier faces the interior of the dwelling.
2. Vapor barriers should not be left exposed.
3. Insulate all voids of the building envelope including small spaces, gaps, around receptacles, pipes, etc.
4. Place insulation on the cold side of pipes and ducts (see Fig. 4). Insulation is not required for supply and return air ducts in heated basements and cellars.

Ceilings

There is a variety of methods for installing blanket insulation in ceilings.

1. Fastening from below (Fig. 1b).
2. Installing unfaced (without a vapor barrier), friction-fit blankets (Fig. 2).
3. Laying the insulation in from above when the ceiling finish material is in place (Fig. 1a).

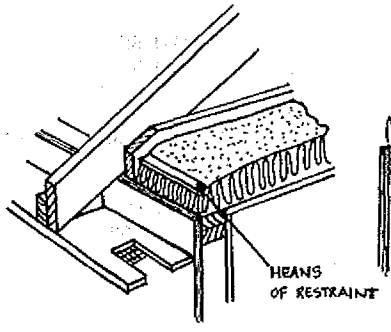


Fig. 1a

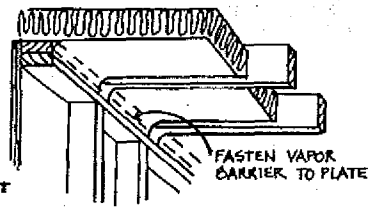


Fig. 1b

Fasten flanges to the inside of ceiling joists as shown in Fig. 1b. Extend the insulation entirely across the top plate, keeping the blanket as close to the plate as possible. Fasten vapor barrier to plate. When eave vents are used, the insulation should not block air movement from eave to space above insulation (Fig. 1a).

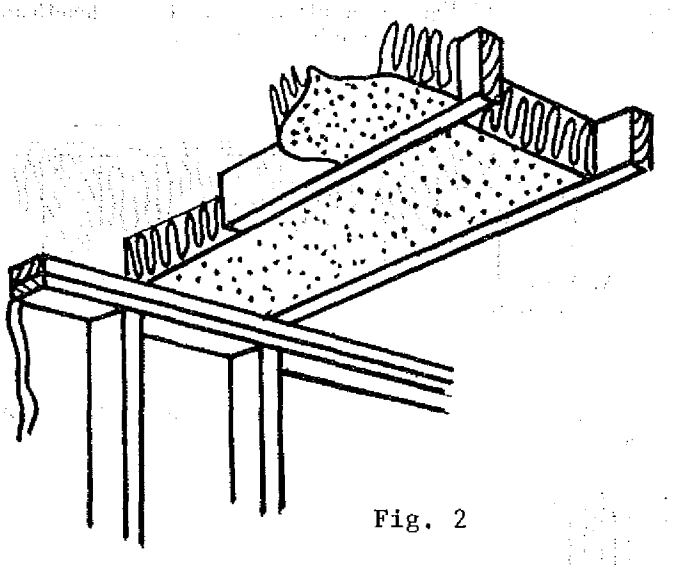


Fig. 2

Insert friction-fit blankets between ceiling joists (Fig. 2). Allow insulation to overlap the top plate of the exterior wall, but not enough to block eave ventilation. The insulation should be in contact with the top of the plate to avoid heat loss and air infiltration beneath the insulation. The required vapor barrier is not shown.

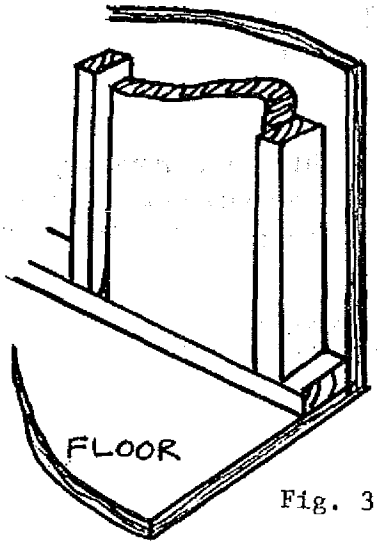


Fig. 3

Insert blankets into stud spaces. Working from the top down, space fasteners per manufacturers recommendations, fitting flanges tightly against face of stud (Fig. 3). Cut blankets slightly over length and fasten the vapor barrier to the top and bottom plates.

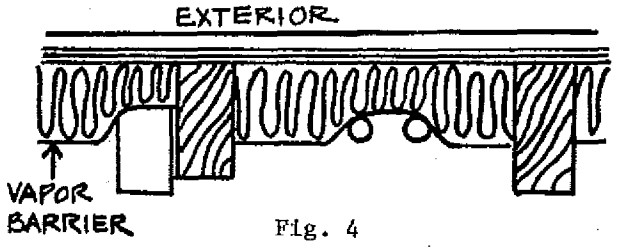


Fig. 4

Insert insulation behind (cold side in winter) pipes, ducts, and electrical boxes (Fig. 4).

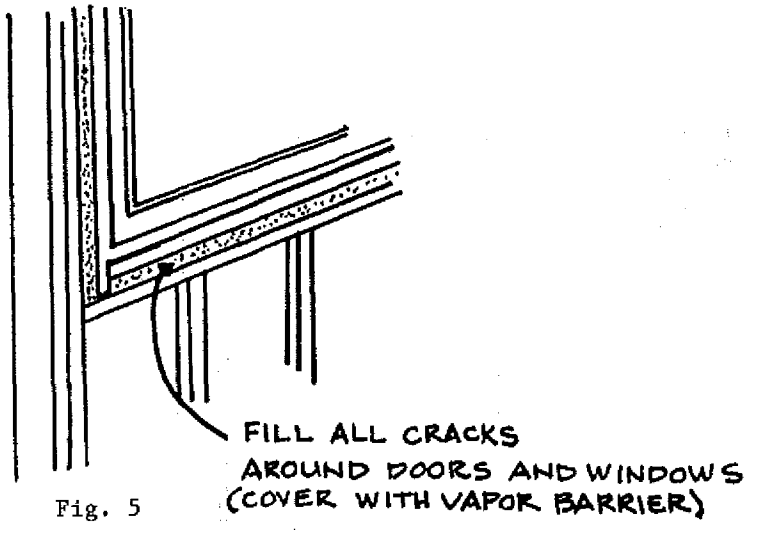


Fig. 5

Fill small spaces between rough framing and door and window heads, jambs and sills with pieces of insulation (Fig. 5).

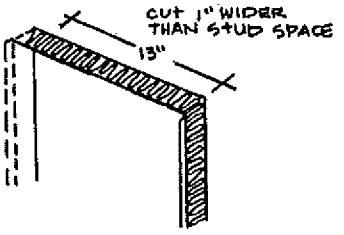


Fig. 6a

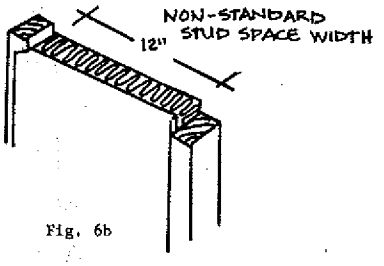


Fig. 6b

Insulate nonstandard-width stud or joist spaces by cutting the insulation and vapor barrier an inch or so wider than the space to be filled (Fig. 6a). Pull the vapor barrier on the cut side to the other stud, compressing the insulation behind it, and fasten through vapor barrier to stud face (Fig. 6b). Unfaced blankets are cut slightly oversize and fitted into place.

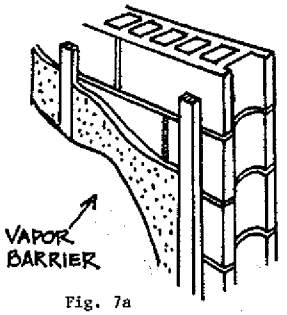


Fig. 7a

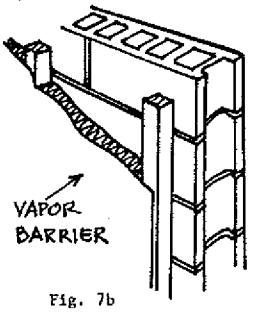


Fig. 7b

Masonry walls may be insulated by inserting insulation between furring strips spaced at 16 or 24 inches o.c. (Fig. 7a and 7b). It is recommended to apply the vapor barrier to the inside surface.

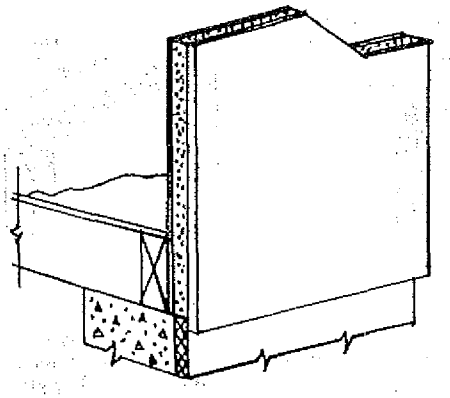


Fig. 8

Rigid insulation in stress skin panels (Fig. 8) may also be used to insulate walls, ceilings and roofs. .

Floor and Crawl Spaces

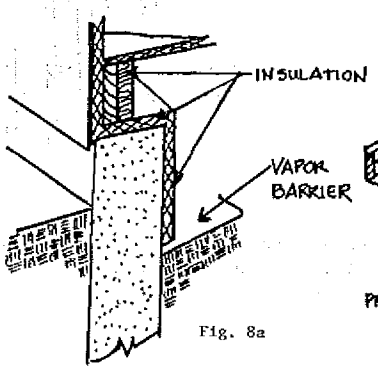


Fig. 8a

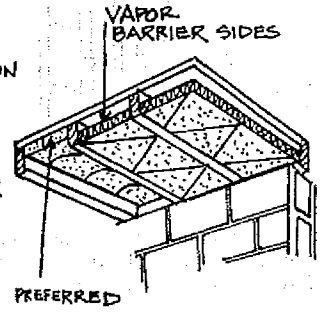


Fig. 8b

Floors over crawl spaces (Fig. 8a) should be insulated either by insulating the foundation walls or by placing insulation on or between the joists. Insulation should be securely fastened. In all cases, the vapor barrier side of the insulation should face the floor above; that is, be adjacent to the warm side in winter. A vapor barrier should be used to cover the ground.

Dropped Soffits

Insulation of dropped soffits over kitchen cabinets, bathtubs, showers, or similar areas, need special attention when they are exposed to the attic. If the dropped soffit is framed before ceiling finish material is applied, a "board" (plywood, hardboard, gypsumboard, etc.) should be installed over the cavity to support insulation.

In multiple dwellings with back-to-back kitchens or baths, it is necessary to extend ceiling finish material over dropped soffits to the party wall to avoid loss of acoustical control and to provide adequate fire stops.

Rigid Insulation

Rigid insulation is available in various sizes and thicknesses made of polystyrene, polyurethane, cork, cellular glass, mineral fiber (glass or rock wool), perlite, wood fiberboard, etc. They are used as insulation for masonry construction, as perimeter insulations around concrete slabs, as exterior sheathing under the weather barrier, as rigid insulations on top of roof decks, and other applications.

Installation Procedures

Masonry walls: Rigid insulations are applied to either face of a masonry wall(Fig. 9a and 9c) or are used as a cavity insulation between two wythes of masonry (Fig. 9b). When applied to the face of masonry walls, they are generally installed with adhesive and/or mechanical fasteners. The manufacturer's recommendation should be followed.

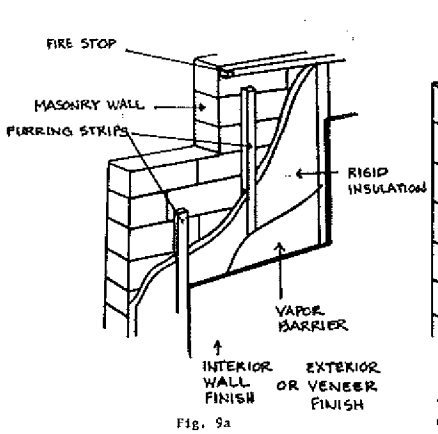


Fig. 9a

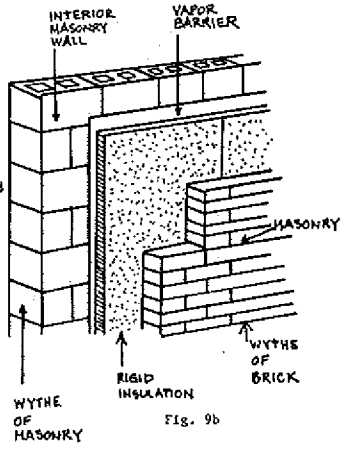


Fig. 9b

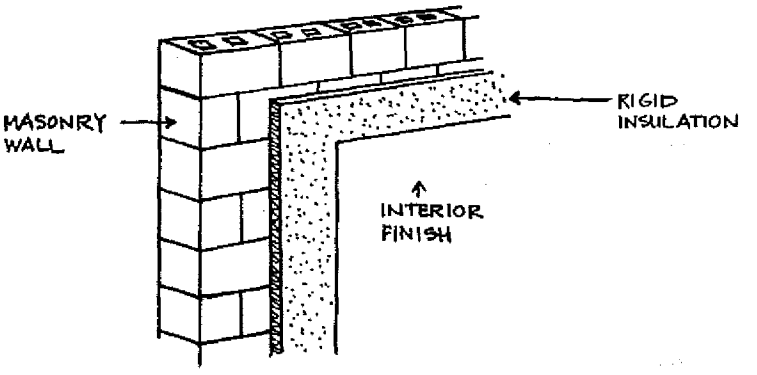


Fig. 9c

Frame Construction: When rigid insulation is used with frame construction (Fig. 10), it is usually applied as sheathing to the outside of the framing, and mechanically attached with nails to wood studs or to metal studs with screws or clips or other approved methods.

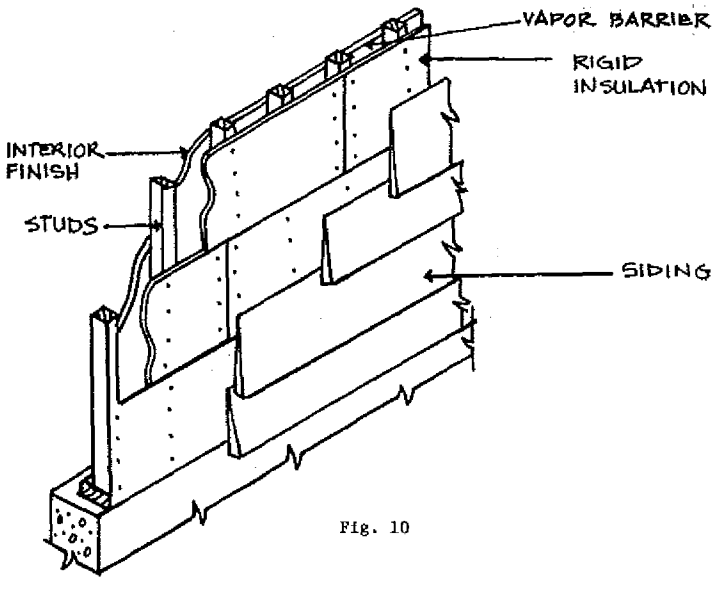


Fig. 10

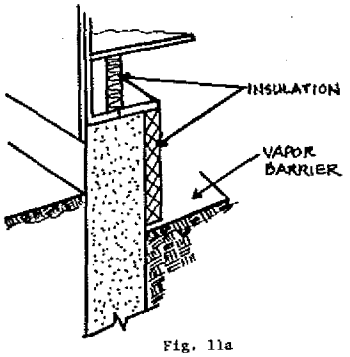


Fig. 11a

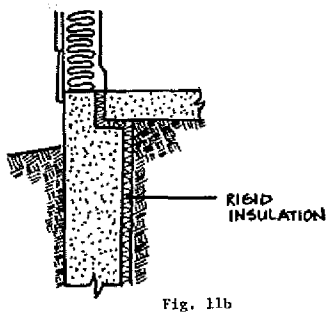


Fig. 11b

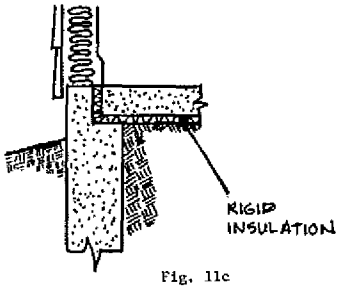


Fig. 11c

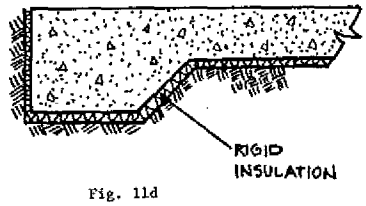


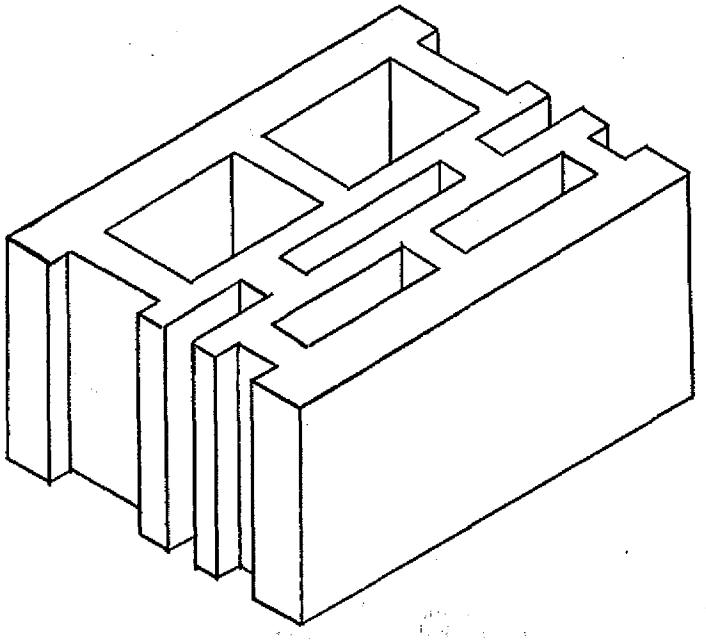
Fig. 11d

Roof Insulation: Roof insulation boards are usually installed with an approved adhesive, hot asphalt, or may be nailed to the roof sheathing. The manufacturer's instructions should be followed.

Slab-on-Grade: Rigid insulation is frequently used as insulation around the perimeter of concrete slabs-on-grade (Fig. 11b, c, d) and also may be used on the inside of foundation walls adjacent to heated crawl spaces, basements or cellars (Fig. 11a). Installation is usually accomplished with adhesive and/or mechanical fasteners. Perimeter insulation should be installed against the foundation wall or extended into the interior of the building to a distance equal to the design frost line (Fig. 11b, c and d). Where the slab bears on the foundation ledge, the insulation should be a load-bearing type.

INSULATED CONCRETE BLOCK

Concrete block manufacturers are currently producing several types of multi-celled block with improved insulating values. The thermal resistance of the block will vary depending upon the types of insulation used and the configuration of the cells. An example of a typical multi-celled block is shown below.



LOOSE FILL INSULATION

Materials of this type are those made from mineral fibers (rock or glass), cellulose materials (wood fibers or shredded paper), or other manufactured products that can easily be poured.

BLOWN ATTIC INSULATION

There are several factors pertaining to blown attic insulation that can cause differences in its installed thermal resistance value (R). For a given manufacturer's insulation, the installed thermal resistance (R) value depends on thickness and weight of insulating material applied per square foot. Federal specification HH-I-1030A for insulation requires that each bag of insulation be labeled to show the minimum thickness, the maximum net coverage, and the minimum weight of (that particular) insulation material required per square foot to produce resistance values of R-30, 22, 19, and 11. A bag label example for blown insulation is shown in Fig. 12.

The number of bags of blown insulation required to provide a given R-value to insulate an attic of a given size may be calculated from data provided by the manufacturer. If only the thickness of blown attic insulation is specified, and the density or number of bags is not, the desired or assumed thermal resistance (R) value may not be achieved. The impor-

tant characteristic is weight per square foot. Thickness is the minimum thickness, not the average thickness experienced in the field.

Adequate baffling of the vent opening or insulation blocking should be provided so as to deflect the incoming air above the surface of the installed blown or poured insulation. Baffles should be made of durable material securely fastened. Baffles should be in place at the time of framing inspection.

Three blown insulations that provide R-19 are:

Material	Minimum Thickness	Maximum Net Coverage/Bag	Bags/1000 Sq. Ft.
Cellulose	5⅛"	59 sq. ft. (40 lb. bag)	17
Glass fiber	8¾"	51 sq. ft. (24 lb. bag)	20
Rock wool	6½"	26 sq. ft. (27 lb. bag)	38

Bag Label Example: The manufacturer recommends these maximum coverages at these minimum thicknesses to provide the levels of installed insulation resistance (R) values shown:

(Based on 25-pound nominal weight bag)

R-Value	Minimum Thickness	Minimum Weight per Sq. Ft.	Bags per 1000 Sq. Ft.	Maximum Net Coverage per Bag
To obtain an insulation resistance R of:	Installed insulation should not be less than:	The weight per sq. ft. of installed insulation should be not less than:	Number of bags per 1000 sq. ft. of net area should not be less than:	Contents of this bag should not cover more than:
R-30	13¾ in. thick	0.768 lbs. per sq. ft.	30	33 sq. ft.
R-22	10 in. thick	0.558 lbs. per sq. ft.	22	45 sq. ft.
R-19	8¾ in. thick	0.489 lbs. per sq. ft.	20	51 sq. ft.
R-11	5 in. thick	0.279 lbs. per sq. ft.	11	90 sq. ft.

Weight contents: not less than 24 lbs.

R-values are determined in accordance with ASTM C-687 and C-236

Fig. 12

REFLECTIVE INSULATION

Reflective insulation is composed of aluminum foil in one or more layers either plain or laminated to one or both sides of kraft paper for structural strength. The insulation value for reflective air spaces, which this type of insulation provides, varies widely depending on the direction of heat flow. They are much more efficient when the heat flow is *down*. Reflective insulations which comply with the requirements when used in a floor, may not be satisfactory in ceilings or walls, where the heat flow is upward and horizontal, respectively. Reflective insulations are effective in controlling radiant heat energy when installed so that they face an air space. Insulation should be installed in such a manner that it is continuous, without holes or tears.

SPRAYED INSULATION

There are several types of insulation which are sprayed against the surface of the building materials or in cavities. Some of these are cellulose with binder, mineral wool with binder, and cellular foams. They may be

sprayed directly on concrete, masonry, wood, plastic, or metal panels or may be sprayed between the framing members. Manufacturer's recommended instructions should be followed. To determine that the proper thickness is installed, either refer to the plans and specifications, or request a certification from the supplier that the insulation installed provides the required "R" value.

TYPICAL INSULATION THICKNESSES AND VALUES

Insulation	Approximate R-Value	Thickness
Fiber glass	11	3½"
Fiber glass	13	3¾"
Fiber glass	19	6"
Fiber glass	30	8"
Fiber glass	38	12"
Extruded Polystyrene Foam	5.4	1"
Extruded Polystyrene Foam	10.8	2"

VAPOR BARRIERS

Vapor barriers are used in conjunction with insulation to decrease the chance of moisture condensation inside the building insulation. Vapor barriers are placed on the side of the wall, ceiling or floor that is warm in winter. For equal vapor pressures, moisture vapor penetration through holes or tears in the insulation vapor barrier is proportional to the size of the opening. Holes or tears should be repaired. A snug fit of blanket flanges against the framing is necessary to prevent moisture from bypassing the vapor barrier.

EQUIPMENT

The installation of the heating system can contribute to inefficiencies. A furnace which is oversized by a factor of 2 will require 8 to 10% more fuel than a furnace of correct size. An installation that has uninsulated ducts passing through an unheated crawl or attic space will lose about 1.5 Btu per hour per square foot of duct per degree of temperature differential between duct air and outside air. This can amount to 40% of a furnace output under mild conditions. Undersized ducting will reduce the amount of circulating air and will affect the capacity of the furnace, but will normally have little effect upon its efficiency. Atmospheric combustion equipment that draws its combustion and stack-dilution air from the heated space will require up to 8% more fuel in a season to heat the required makeup air than sealed combustion equipment. Stack heat recovery devices can recover from about 4% at 450° F to 8% at 800° F.

The appliance manufacturer should be consulted when retrofitting the appliance with combustion air to assure that the appliance warranty is not affected.

Effect of Sizing Limitation on Equipment

Using the example on system design illustrated in Appendix A, an analysis was made to see what impact or problem the proposal for limiting the size of equipment to 15% above the design losses would have.

Example:

Total construction loss 27,760 Btu/hour

One air change per hour:

Inside volume = 12,188 cu. ft.
Q = (12,188) (90) (.018) = 19,744 Btu/hour

Total infiltration loss	19,744 Btu/hour
	47,504 Btu/hour

Maximum furnace size:

47,504 Btu/hour + 47,504 (.15) Btu/hour = 54,630 Btu/hour

COMBUSTION AIR FOR FIREPLACES

It is recommended that combustion air from the exterior be provided for all fireplaces. Masonry fireplaces can be made more energy efficient with combustion air terminating in the fireplace. The opening of the fireplace should be equipped with a door and the combustion air duct with a damper and a louver to minimize air leakage during periods of nonuse.

CONDENSATION CONTROL

Air Infiltration

The department will accept infiltration losses determined by the air crack method or an overall value of ½ air change per hour.

The department will accept the use of engineered top-side moisture vent systems.

Relative Humidity

Winter: During the winter it is desirable to have humidity in the air in order to prevent the nostrils from becoming dry, furniture from cracking, etc. However, from an energy standpoint, it is desirable to keep the relative humidity low; the trade-off is at about 30%.

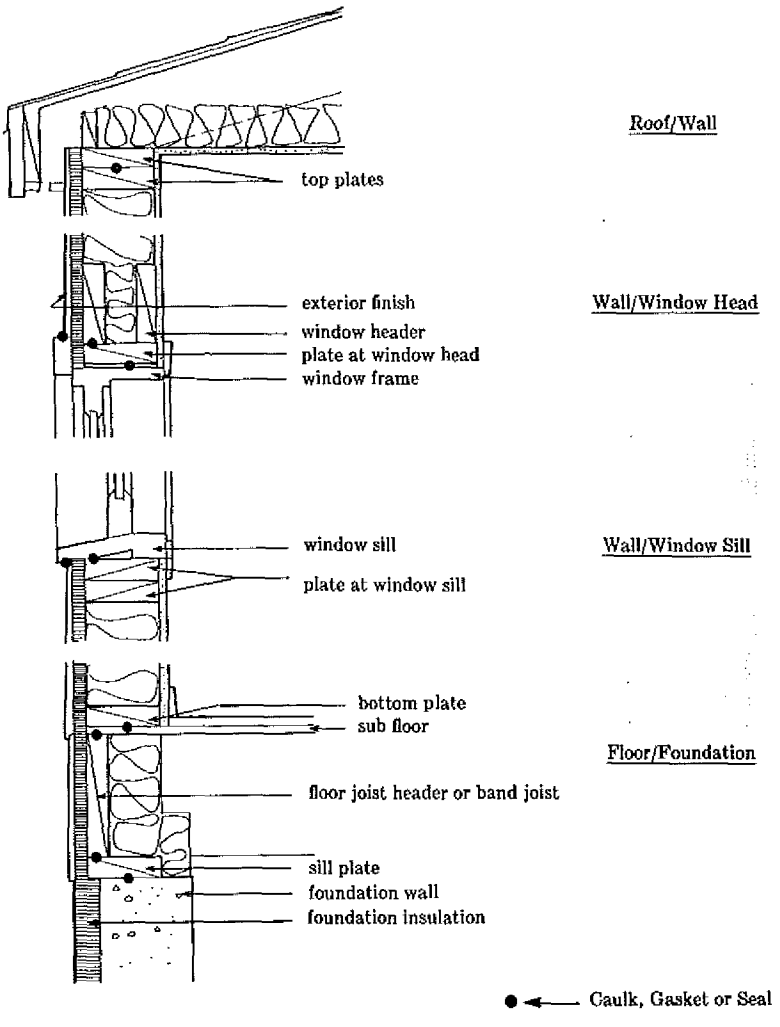
Summer: During the summer it is desirable to reduce the level of relative humidity in the building in relationship to the outside relative humidity. The relative humidity should be kept as high as possible in order to conserve energy, but low enough for comfort. The relative humidity should be kept above 55%, but less than 60%.

APPENDIX D

ILLUSTRATIONS OF EXTERIOR OPENINGS IN THE THERMAL ENVELOPE

The following illustrations show some exterior openings in the thermal envelope which may be sealed to control infiltration. A detailed list of sealing requirements for electrically heated homes is given in s. ILHR 22.13 (3).

ILHR 22.13 Infiltration Control for Electrically Heated Homes



ILHR 22.13 Infiltration Control for Electrically Heated Homes (continued)