CR 84-40

RULES CERTIFICATE

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STATE OF WISCONSIN)
) SS
DEPT. OF INDUSTRY,)
LABOR & HUMAN RELATIONS)

TO ALL TO WHOM THESE PRESENTS SHALL COME, GREETINGS:

I, Howard S. Bellman, Secretary of the Department of Industry, Labor and Human Relations, and custodian of the official records of said department, do hereby certify that the annexed rule(s) relating to Chs. ILHR 20 to 25 and ILHR 26 Uniform Dwelling Code and Cert. of Inspectors *(Subject)* were duly approved and adopted by this department on 12/20/84 *(Date)*.

I further certify that said copy has been compared by me with the original on file in this department and that the same is a true copy thereof, and of the whole of such original.

IN TESTIMONY WHEREOF, I have hereunto set my hand and affixed the official seal of the department at 10:00 a.m. in the city of Madison, this 20th day of December A.D. 19 84

Howard S. Bellman
Secretary

DILHR-ADM-6056(N.04/80)

3-1-85

ORDER OF ADOPTION

Pursuant to authority vested in the Department of Industry, Labor and Human Relations by section(s) 101.02(1),101.63(1)and(2),101.64(3) and 101.73 (1) to (6), Stats., the Department of Industry, Labor and Human Relations hereby [x] creates; [x] amends; [x] repeals and recreates; and [x] repeals and adopts rules of Wisconsin Administrative Code chapter(s):

ILHR 20 to 25 and ILHR 26 Uniform Dwelling Code and Certification of Inspectors
(Number) *(Title)*

The attached rules shall take effect on February 1, 1985, pursuant to section 227.026, Stats.

Adopted at Madison, Wisconsin, this 20th day of December, A.D., 1984.

DEPARTMENT OF INDUSTRY, LABOR AND HUMAN RELATIONS

Howard S. Bellman
Secretary

* *

Pursuant to s. 227.026 (1) (intro.), Stats., these rules shall take effect on February 1, 1985.

* *

Working with WISCONSIN

One Hundred Years of Service
April 3, 1883-April 3, 1983

The Wisconsin Department of Industry, Labor and Human Relations

Office of the Secretary
201 E. Washington Avenue
P.O. Box 7946
Madison, Wisconsin 53707
Telephone 608/266-7552

December 20, 1984

Gary Poulson
Assistant Revisor of Statutes
for Administrative Rules
411 West, State Capitol
Madison, Wisconsin

Douglas LaFollette
Secretary of State
Room 271, GEF-1
201 East Washington Avenue
Madison, Wisconsin

Dear Messrs. Poulson and LaFollette:

TRANSMITTAL OF RULE ADOPTION

CLEARINGHOUSE RULE NO. 84-40

RULE NO. Chs. ILHR 20 to 25 and ILHR 26

RELATING TO: Uniform Dwelling Code and Certification of Inspectors

Pursuant to section 227.023, Stats., agencies are required to file a certified copy of every rule adopted by the agency in the offices of the Secretary of State and the Revisor of Statutes.

At this time, the following material is being submitted to you.

1. Order of Adoption.
2. Rules Certificate Form.
3. Rules in Final Draft Form.

Pursuant to section 227.016 (6), Stats., a summary of the final regulatory flexibility analysis is also included.

Respectfully submitted,

Howard S. Bellman
Secretary

cc: Agency Contact Person

State of Wisconsin \ Department of Industry, Labor and Human Relations

RULES in FINAL DRAFT FORM

Rule: ILHR 20 to 26

Relating to: Uniform Dwelling Code

Clearinghouse Rule No.: 84-40

An order to repeal ILHR 21.02 (3) (a) Note #1 and 22.01 Note; to renumber chs. Ind 20 to 26, ILHR 21.02 (3) (a) Note #2 and #3, 21.30 and 23.11 (1) and (2); to renumber and amend ILHR 23.11 (intro.); to amend ILHR 20.02 (intro.), 20.24 (intro.), 20.24 (2), Table 21.02, Figure 21.02 legend (title), 21.02 (3) (c), 21.16 (intro.), 21.08 (3) (intro.), 21.22 (1) 21.25 (3) (b), 21.26 (3), 21.29, 23.04 (4) (b), 25.01, ch. ILHR 26 part III (title), 26.14, 26.15 (title), 26.15 (2) (e), 26.15 (2) (1), 26.15 (3) (intro.), 26.16 and 26.18; to repeal and recreate ILHR 20.02 (6), 20.14 (2) (a) 1., 20.14 (2) (b) 1., 20.24 (4), 21.02 (3) (a), 21.03, 21.04, 21.05 (1) and (2), 21.06, 21.08 to 21.10, 21.17, 21.32 (3), 23.04 (1) (b) and 23.12; and to create ILHR 20.02 (1) (d), 20.05 (1) Note, 20.07 (34m) and (36m), 20.24 (2m) and (2n), 21.02 (3) (c) 2., 21.15 (1) (a) Note, 21.18 (3) (a) 2. Note, 21.22 (1m), 21.25 (1) (d), Table 21.26-B1, 21.30, 22.05 (1) Note and 23.045.

* *

ANALYSIS OF RULES

The Department of Industry, Labor and Human Relations is responsible for establishing statewide construction standards and inspection procedures for one- and 2-family dwellings. The administration and enforcement of the Uniform Dwelling Code has been delegate to the Bureau of Buildings and Structures within the Division of Safety and Buildings.

The Uniform Dwelling Code has not been revised since its adoption in 1979. In that time, there has been a great deal of technological development in the areas of materials and construction practices. The proposed code revisions reflect such developments, as well as codify code interpretations and department administration and enforcement policies and clarify existing requirements. Subjects addressed by the proposed rules include:

- Clarifying to municipalities the option of adopting the code for alterations to existing dwellings;
- Defining floor area in relationship to ceiling height;
- Allowing a certified independent inspection agency to submit plans and specifications to the department;
- Adopting national standards for structural plain concrete, mortar unit masonry and treated wood;
- Changing minimum design loads for floors and ceilings;
- Requiring plain and reinforced concrete to be designed and installed in accordance with national standards;
- Clarifying that windows are to be available as exits;
- Clarifying the height of stair handrails;

- Clarifying the provision relating to stair landings without doors opening onto the stairs;

- Increasing spiral stair riser heights;

- Eliminating the requirement for natural light to be provided to basements, except for bedrooms;

- Clarifying how natural light may be provided in earth sheltered homes;

- Requiring natural or mechanical ventilation to bathrooms;

- Requiring exhaust ventilation to terminate to the outside in order to reduce moisture problems;

- Specifying minimum ceiling heights for rooms;

- Permitting mineral-based insulation as a firestopping material;

- Requiring smoke detectors in 2-family dwellings as specified by statutes;

- Exempting wood sills and sleepers in basements from being water resistant treated;

- Requiring identification of pressure treated wood according to national standards;

- Permitting tail ends of joists to overlap beams by more than 8 inches;

- Clarifying when joint bridging is required;

- Specifying prescriptive bracing requirements for wind loads;

- Requiring mortar mixes to comply with national standards;

- Amending provisions for masonry fireplaces;

- Establishing masonry chimney requirements;

- Requiring dwellings which are heated by wood to comply with energy standards;

- Revising woodburning requirements;

- Amending requirements for chimney flue linings, thimbles, cleanouts and caps; and

- Defining an independent inspection/evaluation agency.

The proposed rules have been reviewed by the Dwelling Code Council. Members of the Council are:

	Representing:
William J. Boncher	Labor-Bricklayer and Allied Craftsmen
Robert Mark Stevenson	Building Inspection
Norman J. Gerber	Material Supplier
R. Bruce Griffin	Housing Manufacturers
Albert Hanson	Labor-Sheet Metal Workers
Norman Hintz	Building Inspectors
Bruce Jackson	Architects
Robert Harer	Public Member
James Kruse	Labor-Electrical Workers
Christine Laughridge	Building Inspectors
R. Neal Melvin	Private Contractor
Joseph Padour	Public Member
Ron Stadler	Labor-Carpenters
Dean Wieland	Housing Manufacturers

* *

Pursuant to the authority vested in the state of Wisconsin, Department of Industry, Labor and Human Relations by ss. 101.02 (1), 101.63 (1) and (2), 101.64 (3) and 101.73 (1) to (6), Stats., the Department of Industry, Labor and Human Relations hereby repeals, repeals and recreates, amends and creates rules interpreting ss. 101.60, 101.63 (1) and (2), 101.70, 101.73 (1) and (2) and 101.74 (3), Stats., as follows:

SECTION 1. Chapters Ind 20 to 26 are renumbered ILHR 20 to 26.

[Note to Revisor: Please change all applicable "Ind" prefixes to "ILHR" prefixes in chs. Ind 20 to 26.]

SECTION 2. ILHR 20.02 (intro.) is amended to read:

ILHR 20.02 SCOPE. The provisions of ~~this code~~ chs. ILHR 20 to 25 shall apply to the construction and inspection procedures used for all new one- and 2-family dwellings ~~and~~ , manufactured buildings for dwellings and newly constructed community-based residential facilities providing care, treatment and services for 3 to 8 unrelated adults.

SECTION 3. ILHR 20.02 (1) (d) is created to read:

ILHR 20.02 (1) (d) Any municipality may, by ordinance, adopt the provisions of chs. ILHR 20 to 25 to apply to any additions or alterations to existing dwellings.

SECTION 4. ILHR 20.02 (6) is repealed and recreated to read:

ILHR 20.02 (6) LICENSING. A city, village, town or county may license persons for performing work on a dwelling in which the licensed person has no legal or equitable interest.

SECTION 5. ILHR 20.05 (1) Note is created to read:

ILHR 20.05 (1) Note: The provisions of chs. ILHR 20 to 25 may be adopted by a municipality to apply to any additions or alterations to existing dwellings.

SECTION 6. ILHR 20.07 (34m) and (36m) are created to read:

ILHR 20.07 (34m) "Floor area" means the area of a room that has a ceiling height of at least 7 feet. Rooms with ceilings less than 7 feet in height are not considered to be floor areas.

ILHR 20.07 (36m) "Groundfloor" means that level of a dwelling located on a site with a sloping grade and which has its floor line at grade.

[Note to Revisor: Legislative Council requested that all of the definitions in current s. ILHR 20.07 be changed to the proper format. Please change the format of the definitions in s. ILHR 20.07 to be in conformance with s. 1.01 (7), Administrative Rules Procedures Manual.]

SECTION 7. ILHR 20.14 (2) (a) 1. is repealed and recreated to read:

ILHR 20.14 (2) (a) 1. 'Plans and specifications'. All plans and specifications shall be submitted to the department according to subpar. a. or b.:

a. Three complete sets of building, structural, mechancial and electrical plans, (including elevations, sections and details), specifications and calculations shall be submitted to the department on behalf of the manufacturer for examination and approval.

b. At least one complete set of building, structural, mechanical and electrical plans, (including elevations, sections and details), specifications and calculations shall be submitted to the department on behalf of a manufacturer by an independent inspection/evaluation agency certified under s. ILHR 26.14. All plans and specifications submitted to the department shall be stamped "conditionally approved" by the independent inspection/evaluation agency.

SECTION 8. ILHR 20.14 (2) (b) 1. is repealed and recreated to read:

ILHR 20.14 (2) (b) 1. 'Plans and specifications'. All plans and specifications shall be submitted to the department according to subpar. a. or b.: a. At least 3 complete sets of plans and specifications for manufactured dwelling building components shall be submitted to the department on behalf of the manufacturer for examination and approval.

b. At least one complete set of plans and specifications for manufactured dwelling building components shall be submitted to the department on behalf of a manufacturer by an independent inspection/evaluation agency certified as required in s. ILHR 26.14. All plans and specifications submitted to the department shall be stamped "conditionally approved" by the independent inspection/evaluation agency.

SECTION 9. ILHR 20.24 (intro.) is amended to read:

ILHR 20.24 ADOPTION OF STANDARDS. All dwellings ~~are~~ shall be required to be designed by the method of structural analysis or the method of accepted practice outlined in ~~each chapter of the code~~ chs. ILHR 20 to 25. Dwellings designed by the method of structural analysis shall comply with the standards and manuals listed in subs. (1) ~~through~~ to (5) of this section. Pursuant to s. 227.025, Stats., the attorney general and the revisor of statutes have consented to the incorporation by reference of the following standards. Copies of the standards are on file in the offices of the department, the secretary of state~~,~~ and the revisor of statutes ~~and in each county law library~~. Copies for personal use may be obtained, at a reasonable cost, from the organizations listed.

SECTION 10. ILHR 20.24 (2) is amended to read:

ILHR 20.24 (2) American Concrete Institute (ACI), P.O. Box 19150, Redford Station, Detroit, Michigan 48219, BUILDING CODE REQUIREMENTS FOR REINFORCED CONCRETE, ACI ~~318-77~~ 318-83; BUILDING CODE REQUIREMENTS FOR STRUCTURAL PLAIN CONCRETE, ACI 318.1-83.

SECTION 11. ILHR 20.24 (2m) is created to read:

ILHR 20.24 (2m) American Society for Testing and Materials (ASTM), 1916 Race Street, Philadelphia, PA 19103, STANDARD SPECIFICATION FOR MORTAR FOR UNIT MASONRY, ASTM Designation C270-82.

SECTION 12. ILHR 20.24 (2n) is created to read:

ILHR 20.24 (2n) American Wood Preservers Bureau, 2772 S. Randolph St., P.O. Box 6085, Arlington, Virginia 22206, STANDARD FOR SOFTWOOD LUMBER, TIMBER AND PLYWOOD PRESSURE TREATED WITH WATER-BORNE PRESERVATIVES FOR ABOVE GROUND USE, AWPB standard LP-2, 1980; STANDARD FOR SOFTWOOD LUMBER, TIMBER AND PLYWOOD PRESSURE TREATED WITH WATER-BORNE PRESERVATIVES FOR GROUND CONTACT USE, AWPB standard LP-22, 1980; QUALITY CONTROL PROGRAM FOR SOFTWOOD LUMBER, TIMBER AND PLYWOOD PRESSURE TREATED WITH WATER-BORNE PRESERVATIVES FOR GROUND CONTACT USE IN RESIDENTIAL AND LIGHT COMMERCIAL FOUNDATIONS, AWPB standard FDN, 1980.

SECTION 13. ILHR 20.24 (4) is repealed and recreated to read:

ILHR 20.24 (4) National Forest Products Association, 1619 Massachusetts Ave. N.W., Washington, D.C. 20036, NATIONAL DESIGN SPECIFICATION FOR WOOD CONSTRUCTION, 1982 edition, except for sections 2.2.5.3. and 4.1.7., including DESIGN VALUES FOR WOOD CONSTRUCTION, March, 1982, supplement; THE ALL-WEATHER WOOD FOUNDATION SYSTEM, Basic Requirements, Technical Report No. 7, March, 1982, except for sections 3.3.1. and 6.7.

SECTION 14. Table 21.02 is amended to read:

TABLE 21.02

Component	~~Design~~ Live Load (pounds per sq. ft.)
Floors	40
Garage Floors	~~60~~ 50
Exterior Balconies, Decks, Porches	~~80~~ 40
Ceilings (with storage)	20
Ceilings (without storage)	~~10~~ 5

SECTION 15. Figure 21.02 legend (title) is amended to read:

Figure 21.02
ZONE MAP FOR ROOF LOADS

ROOF LIVE LOADS

Zone 1 40 PSF
Zone 2 30 PSF

SECTION 16. ILHR 21.02 (3) (a) is repealed and recreated to read:

ILHR 21.02 (3) (a) Wood. 1. Except as provided in subpar a. and b., structural lumber, glue-laminated timber, timber pilings and fastenings shall be designed in accordance with the "National Design Specification for Wood Construction" and the "Design Values for Wood Construction", a supplement to the National Design Specification for Wood Construction.

a. Section 2.2.5.3. The cumulative effects of short-time loads, such as snow, shall be considered in determining duration of load. For snow load, no greater duration of load factor than 1.05 shall be used.

b. Section 4.1.7. The provisions of this section shall also apply to reused lumber. Reused lumber shall be considered to have a duration of load factor of 0.90.

2. Span tables for joists and rafters printed in the appendix or approved by the department may be used in lieu of designing by structural analysis.

SECTION 17. ILHR 21.02 (3) (a) Note #1 is repealed.

SECTION 18. ILHR 21.02 (3) (a) Note #2 and #3 are renumbered ILHR 21.02 (3) (a) Note #1 and #2.

[Note to Revisor: ILHR 21.02 (3) (a) Note #1 and #2 follow ILHR 21.02 (3) (a) 2.]

SECTION 19. ILHR 21.02 (3) (c) is amended to read:

ILHR 21.02 (3) (c) Concrete. Plain, reinforced or prestressed concrete construction shall conform to the following ~~standard~~ standards:

1. ACI Standard 318, "Building Code Requirements for Reinforced Concrete" ~~[Ind 20.24 (2)]~~.

SECTION 20. ILHR 21.02 (3) (c) 2. is created to read:

ILHR 21.02 (3) (c) 2. ACI Standard 318.1, "Building Code Requirements for Structural Plain Concrete".

[Note to Revisor: The note following s. ILHR 21.02 (3) (c) 1. should follow s. ILHR 21.02 (3) (c) 2.]

SECTION 21. ILHR 21.03 is repealed and recreated to read:

ILHR 21.03 EXITS, DOORS AND HALLWAYS. Exits, doors and hallways shall be constructed as specified in this section.

(1) EXITS FROM THE FIRST FLOOR. (a) Every dwelling unit shall be provided with at least two exits from the first floor. One of the exits shall discharge to grade. The second exit may discharge to an outside balcony or discharge to grade or discharge into an attached garage provided with an exit door which discharges to grade. An overhead garage door may not be used as an exit door. The two required exits from the first floor shall be located as far apart as practical.

(b) Exits from bedrooms shall be in accordance with subds. 1. and 2.: 1. Every bedroom shall have at least one operable window for emergency egress or rescue. The window shall be operable from the inside without the use of separate tools. Where windows are provided as a means of egress or rescue the sill height shall be not more than 44 inches above the floor. An exit door may be used in lieu of an exit window. Where exit doors are provided, the exit shall discharge to an exterior balcony or discharge to grade.

2. All egress or rescue windows from bedrooms shall have a minimum net clear opening of 5.4 square feet. The minimum net clear opening height dimension shall be 24 inches. The minimum net clear opening width dimension shall be 20 inches. If equipped with a screen or storm, it shall be openable from the inside.

(2) EXITS FROM THE SECOND FLOOR. At least 2 exits shall be provided from the second floor. One of the exits shall be a stairway or ramp and lead to the first floor or discharge to grade. The second exit may be an exit from a bedroom specified in accordance with sub. (1) (b).

(3) EXITS ABOVE THE SECOND FLOOR. At least 2 exits shall be provided for each floor above the second floor. The exits shall be located such that in case any exit is blocked some other exit will still be accessible to the second floor. The exits shall be stairways or ramps that lead to the second floor or discharge to grade.

(4) EXITS FROM LOFTS. (a) At least one stairway exit shall be provided, to the floor below, for a loft exceeding 400 square feet in area.

(b) At least one stairway or ladder exit shall be provided to the floor below for a loft, 400 square feet or less, in area.

(5) EXITS FROM THE BASEMENT. (a) Where the entire floor of the basement is below grade, at least one exit shall be provided, unless the basement is used for sleeping. The exit shall be a stairway or ramp which leads to the first floor or discharges to grade.

(b) Where the entire floor of the basement is below grade and the basement is utilized for sleeping, at least two exits shall be provided. The two exits shall not be accessed by the same stairway and shall be in accordance with subds. 1. and 2.

1. One of the exits shall be a stairway which leads to the first floor.

2. The second exit may be a stairway which leads to grade, or a door located at the basement level which leads to grade via an exterior stairs or an outside window which can be opened from the inside without the use of tools. The window shall not be less than 20 inches in width, 24 inches in height and 5.7 square feet in area, with the bottom of the sill located not more than 44 inches above the floor. If a window is provided as the second exit, a window shall be located in each bedroom. If the window is located below grade, an areaway shall be provided. The width of the areaway shall be 1-1/2 times the depth of the areaway. The areaway shall be a minimum of 3 feet measured perpendicular from the wall. The areaway shall be constructed to prevent rainfall flowing into the areaway from entering the bedroom.

(6) EXITS FROM THE GROUNDFLOOR. (a) At least one exit shall be provided for the ground floor unless the groundfloor is used for sleeping. The exit may be a swing door or a sliding glass door which discharges directly to grade or may be a stairway which leads to the first floor.

(b) If the groundfloor is used for sleeping, at least two exits shall be provided in accordance with subds. 1. and 2.

1. One of the exits shall discharge to grade via a swing door or sliding glass door.

2. The second exit may be a door which discharges directly to grade or meets the requirements of sub. (5) (b).

(7) DOORS. One exterior exit door from a dwelling unit shall be a swing type door at least 3 feet wide by 6 feet 8 inches high. All other exterior exit doors shall be at least 2 feet 8 inches wide by 6 feet 8 inches high. Where double doors are provided, the width of each door leaf shall be at least 2 feet 6 inches. The double doors shall not have an intermediate mullion.

(8) INTERIOR CIRCULATION. All passageway doors to at least 50% of the bedrooms, at least one full bathroom, and the common-use areas such as kitchens, dining rooms, living rooms and family rooms shall be at least 2 feet 8 inches wide by 6 feet 8 inches high. Where cased or uncased openings are provided in lieu of doors, the clear width of the passageway openings shall be at at least 2 feet 6 inches wide.

(9) HALLWAYS. Hallways shall be at least 3 feet in width except that door hardware, finish trim and heating registers may infringe upon this dimension.

SECTION 22. ILHR 21.04 is repealed and recreated to read:

ILHR 21.04 STAIRS. Every exterior or interior stairs shall conform to the requirements of this section.

(1) LANDINGS. (a) Intermediate landings. Intermediate landings located in a flight of stairs shall be at least as wide as the stairs and shall measure at least 3 feet in the direction of travel. Trim and handrails may project no more than 3-1/2 inches into the required width.

(b) Landings at the top and base of stairs. A level landing shall be provided at the top and at the foot of every stairs. The landing shall be at least as wide as the stairs and shall measure at least 3 feet in the direction of travel.

(c) Doors at landings. Where a door is provided at the head or foot of a stairs, a level landing on each side of the door shall be provided between the door and the stairs, regardless of the door swing.

1. 'Exception'. A landing shall not be required between the door and the head of interior stairs within a dwelling unit, provided the door does not swing over the stairs.

2. 'Exception'. A storm door or screen door shall be permitted to swing over an exterior platform or sidewalk provided the platform or sidewalk is located not more than 8-1/4 inches below the door sill and provided the platform has a length at least equal to the width of the door.

(2) HANDRAILS AND GUARDRAILS. (a) Handrails. Every stairs of more than 3 risers shall be provided with at least one handrail. Handrails shall be provided on all open sides of stairways.

(b) Guardrails. All openings between floors, open sides of landings, platforms, balconies or porches which are more than 24 inches above grade or a floor, shall be protected with guardrails.

(c) Handrail and guardrail details. 1. 'Height'. Handrails shall be located at least 30 inches, but not more than 34 inches, above the nosing of the treads. Guardrails shall be located at least 36 inches above the upper surface of the floor.

2. 'Open railings'. Open guardrails or handrails shall be provided with intermediate rails or an ornamental pattern to prevent the passage of a sphere with a diameter larger than 9 inches.

3. 'Clearance'. The clearance between the handrail and the wall surface shall be at least 1-1/2 inches.

4. 'Loading'. Handrails and guardrails shall be designed and constructed to withstand a 200 pound load applied in any direction.

5. 'Exterior rails'. Exterior handrails and guardrails shall be constructed of metal, decay resistant or pressure treated wood or shall be protected from the weather.

(3) STAIR DETAILS. Stairs shall meet the following requirements:

(a) Minimum width. Every stairs shall measure at least 3 feet in width.

(b) Headroom. Every stairs shall be provided with a minimum headroom clearance of 6 feet 4 inches. The minimum clearance shall be measured vertically from a line parallel to the nosing of the treads to the ceiling or soffit directly above that line.

(c) Treads and risers. Risers shall not exceed 8 inches in height measured vertically from tread to tread. Treads shall be at least 9 inches wide, measured horizontally from nosing to nosing. There shall be no variation in uniformity exceeding 3/16-inch in the width of tread or in the height of risers. No flight of stairs may exceed 12 feet in height unless landings are provided.

(d) Winders. Winder steps may be used in stairs where the length of the tread is at least 3 feet and the winder tread measures at least 7 inches in width at a point one foot from the narrow end of the tread.

(e) Spiral stairs. Spiral stairs may be used as an exit stairs. The tread shall measure at least 26 inches from the outer edge of the supporting column to the inner edge of the handrail and at least 7 inches in width from nosing to nosing at a point one foot from the narrow end of the tread.

(f) Ladders. 1. 'Design load'. Ladders shall be designed to withstand loads of at least 200 pounds.

2. 'Tread or rungs'. a. Minimum tread requirements shall be specified in Table 21.04. Treads less than 9 inches in width shall have open risers. All treads shall be uniform in dimension.

Table 21.04

Pitch of Ladder Angle to Horizontal (degrees)	Maximum Rise (inches)	Minimum Tread (inches)
41.6 to 48.4	8	9
greater than 48.4 to 55.0	9	8
greater than 55.0 to 61.4	10	7
greater than 61.4 to 67.4	11	6
greater than 67.4 to 71.6	12	5
greater than 71.6 to 75.9	12	4
greater than 75.9 to 80.5	12	3
greater than 80.5 to 90	12	2

b. Rungs may only be used for ladders with a pitch range of 75° to 90°. Rungs shall be at least 1 inch in diameter for metal ladders and 1-1/2 inch for wood ladders. All rungs shall be uniform in dimension.

3. 'Risers'. Risers shall be uniform in height and shall conform with Table 21.04.

4. 'Width'. The width of the ladder shall be a minimum of 20 inches wide and a maximum of 30 inches wide.

5. 'Handrails'. a. Handrails shall be required for ladders with pitches less than 65°.

b. Handrails shall be located at least 30 inches, but not more than 34 inches, above the nosing of the treads.

c. Open handrails shall be provided with intermediate rails or an ornamental pattern such that a sphere with a diameter larger than 9 inches cannot pass through.

d. The clearance between the handrail and the wall surface shall be at least 1-1/2 inches.

e. Handrails shall be designed and constructed to withstand a 200 pound load applied in any direction.

6. 'Clearances'. a. The ladder shall have a minimum clearance of at least 15 inches on either side of the center of the tread.

b. The edge of the tread nearest to the wall should be separated from the wall by at least 7 inches.

c. A passage way clearance of at least 30 inches parallel to the slope of a 90° ladder shall be provided. A passage way clearance of at least 36 inches parallel to the slope of a 75° ladder shall be provided. Clearances for intermediate pitches shall vary between these two limits in proportion to the slope.

d. For ladders with less than a 75° pitch the vertical clearance above any tread or rung to an overhead obstruction shall be at least 6 feet 4 inches measured from the leading edge of the tread or rung.

SECTION 23. ILHR 21.05 (1) and (2) are repealed and recreated to read:

ILHR 21.05 (1) NATURAL LIGHT. All habitable rooms shall be provided with natural light by means of glazed openings. The area of the glazed openings shall be at least 8 % of the net floor area, except under the following circumstances:

(a) Exception. Habitable rooms, other than bedrooms, located in basements need not be provided with natural light.

(b) Exception. Natural light may be obtained from adjoining areas through glazed openings, louvers or other approved methods. Door openings into adjoining areas may not be used to satisfy this requirement.

(2) VENTILATION. (a) Natural Ventilation. Natural ventilation shall be provided to all habitable rooms, kitchens and bathrooms by means of openable exterior doors or windows. The net area of the openable exterior doors or windows shall be at least 3.5 percent of the net floor area of the room. Mechanical ventilation may be provided in lieu of openable exterior doors or windows provided the system is capable of providing at least one air change per hour.

(b) Exhaust ventilation. All exhaust ventilation shall terminate outside the building.

SECTION 24. ILHR 21.06 is repealed and recreated to read:

ILHR 21.06 CEILING HEIGHT. All habitable rooms, kitchens, hallways, bathrooms and corridors shall have a ceiling height of at least 7 feet. Habitable rooms may have ceiling heights of less than 7 feet provided at least 50 % of the room's floor area has a ceiling height of at least 7 feet. Beams and girders or other projections shall not project more than 8 inches below the required ceiling height.

SECTION 25. ILHR 21.08 to ILHR 21.10 are repealed and recreated to read:

ILHR 21.08 FIRESTOPPING, DRAFTSTOPPING AND FIRE SEPARATION. (1) FIRESTOPPING LOCATIONS. Firestopping shall be provided in the following locations:

(a) In concealed spaces of walls and partitions, including furred spaces, at the ceiling and floor levels;

(b) At all interconnections between concealed vertical and horizontal spaces such as occur at soffits, drop ceilings and cove ceilings; and

(c) In concealed spaces between stair stringers at the top and bottom of the run.

(2) FIRESTOPPING MATERIALS. Firestopping shall consist of 2-inches nominal lumber or 2 thicknesses of one inch nominal lumber or one thickness of 3/4-inch plywood with joints backed by 3/4-inch plywood. Gypsum wallboard, mineral wool insulation or other noncombustible material may also be used for firestopping.

(3) DRAFTSTOPPING LOCATIONS. Draftstopping shall be provided in the following locations:

(a) In floor-ceiling assemblies above and in line with the tenant separation, when tenant separation walls do not extend to the floor sheathing above;

(b) In the attic, mansard, overhang or other concealed roof space above and in line with the tenant separation when tenant separation walls do not extend to the roof sheathing above. Where flat roofs with solid joist construction are used, draftstopping over tenant separation walls is not required; and

(c) At openings around vents, pipes, ducts, chimneys and fireplaces at ceiling and floor levels.

(4) DRAFTSTOPPING MATERIALS. Except as provided in sub. (3) (c), draftstopping materials shall be not less than 1/2-inch gypsumboard, 3/8-inch plywood, mineral-based insulation or other approved noncombustible materials.

(5) FIRE SEPARATION. Garage space and accessory buildings shall be separated from the dwelling unit in accordance with Table 21.08 and the following requirements:

Table 21.08

Distance from Dwelling Wall to the Closest Garage Wall or Accessory Building Wall	Fire-rated Construction
0 to 5 feet	3/4-hour
5 to 10 feet with windows in either wall	3/4-hour
5 to 10 feet without windows in either wall	No requirements
10 feet or more	No requirements

(a) The garage shall be separated from habitable and nonhabitable areas of the dwelling unit, as well as attics. The vertical separation shall extend from the top of the concrete or masonry foundation to the underside of the roof sheathing or ceiling. The fire-rated construction shall conform with Table 21.08.

1. 'Exception'. Gypsum drywall on the garage side may be untaped provided at least 5/8-inch firecode drywall is used on the garage side and all edges are tightly fitted.

2. 'Exception'. Gypsum drywall on the garage side may be untaped provided at least 1/2-inch drywall is used on both sides of the wall separating the garage and the dwelling and all edges are tightly fitted.

3. 'Exception'. Two layers of 1/2-inch drywall on the garage side may be untaped where no drywall is installed on the interior provided all edges are tightly fitted.

(b) The door and frame assembly between the garage and the dwelling unit shall have a minimum fire rating of 20 minutes. A 1-3/4-inch solid core wood or insulated metal door may be installed with a pair of 1-1/2-inch steel hinges in a 1-7/32-inch minimum thick solid wood frame with a 1/2-inch thick door stop.

(c) Garage floors shall be constructed of noncombustible materials. The garage floor shall slope toward the exterior garage opening or shall slope to an interior drain.

ILHR 21.09 SMOKE DETECTORS. Each living unit in one- and 2-family dwellings shall be provided with an approved, listed and labeled smoke detector sensing visible or invisible particles of combustion installed in the basement of the dwelling and on each floor level except the attic or storage area of each dwelling unit.

Note: Section 50.035 (2), Stats., created by 1983 Wisconsin Act 363 requires the installation of a complete low voltage, interconnected or radio-transmitting smoke detection system in all community-based residential facilities including those having 8 or less beds.

ILHR 21.10 PROTECTION AGAINST DECAY AND TERMITES. (1) GENERAL. Except as provided in sub. (2), wood used in the following locations shall be pressure treated with preservative, shall be a naturally durable, decay resistant species of lumber and shall be protected against termites:

(a) Wood floor joists closer than 18 inches or wood girders closer than 12 inches to earth;

(b) Sills which rest on concrete or masonry walls or floors which are less than 8 inches from exposed earth;

(c) Ends of wood girders entering masonry or concrete walls and having clearances of less than 1/2 inch on the tops, sides and ends;

(d) Wood siding having a clearance of less than 6 inches from the earth;

(e) Wood embedded in earth; and

(f) Bottom plates of load bearing walls in basements.

(2) EXCEPTION. Wood used in basements as furring or finish material or in nonbearing walls need not comply with this section.

(3) IDENTIFICATION. All pressure-treated wood and plywood shall be identified by a quality mark or certificate of inspection of an approved inspection agency which maintains continued supervision, testing and inspection over the quality of the product in accordance with the adopted standards of the American Wood Preservers Bureau specified in s. ILHR 20.24 (2n).

SECTION 26. ILHR 21.15 (1) (a) Note is created to read:

Note: Unstable soil includes soils which are unable to support themselves after excavation.

SECTION 27. ILHR 21.16 (intro.) is amended to read:

ILHR 21.16 FROST PENETRATION. Footings and foundations, including those for ramps and stoops, shall be placed below the frost penetration level, but in no case less than ~~42~~ 48 inches below the ground. ~~Such footings~~ Footings shall not be placed over frozen material.

SECTION 28. ILHR 21.17 is repealed and recreated to read:

ILHR 21.17 DRAIN TILES. (1) WHERE REQUIRED. Drain tiles or pipe shall be provided around footings located in soils where ground water levels occur above the elevation of the footing.

(a) Municipalities exercising jurisdiction. Municipalities exercising jurisdiction under chs. ILHR 20 to 25 may determine the soil types, natural and seasonal groundwater levels for which drain tile is required.

(b) All other areas. Drain tiles shall be required whenever a soil test shows evidence of periodic or seasonal saturation at any depth less than 72 inches. When the on-site evaluation shows no evidence of saturation, drain tiles need not be installed. Under all other conditions, drain tiles shall be installed on each side of foundation walls at the footing level.

(2) MATERIALS AND INSTALLATION REQUIREMENTS. (a) Drain tiles or pipes used for foundation drainage shall be at least 3 inches inside diameter.

(b) Where individual tiles are used, they shall be laid with 1/8-inch open joints. Joints between the tiles shall be covered with a strip of sheathing paper or asphalt or tar saturated felt.

(c) The tile or pipe shall be placed upon at least 2 inches of washed rock and shall be covered with at least 12 inches of washed rock which meets the following criteria:

1. 90-100 % of the rock must pass a 3/4-inch sieve; and

2. 20-55 % of the rock must pass a 3/8-inch sieve.

(d) The basement slab shall be placed on at least 4 inches of gravel.

(e) Bleeder tiles shall be provided to connect the exterior footing drain tile to the interior footing tile and shall be placed in the footing such that the tiles are spaced at 8 foot intervals.

(f) The drain tiles or pipe shall be laid at a grade of not less than 1/8 inch per foot leading to the sump pit.

(3) DRAIN TILE DISCHARGE. Drain tiles shall be connected to a sump pit. The sump shall discharge to natural grade or be equipped with a pump to discharge water away from the dwelling via surface drainage channels.

(a) Sumps. 1. 'Construction and installation'. The sump shall have a rim extending at least one inch above the floor immediately adjacent to the sump, except where the sump is installed in an exterior meter pit. The sump shall have a removable cover of sufficient strength for anticipated loads. The sump shall have a solid bottom.

2. 'Location'. All sumps installed for the purpose of receiving clear water, basement or foundation drainage water shall be located at least 15 feet from any water well.

3. 'Size'. The size of each clear water sump shall be as recommended by the sump pump manufacturer, but shall be not smaller than 18 inches in diameter and 24 inches in depth.

(b) Sump pump systems. 1. 'Pump size'. The pump shall have a capacity appropriate for anticipated use.

2. 'Discharge piping'. Where a sump discharges into a storm building drain or sewer, a free flow check valve shall be installed.

(4) SUMP DISCHARGE DISPOSAL. (a) Storm sewer. Storm water, surface water, groundwater and clear water wastes shall be drained to a storm sewer where available.

(b) Other disposal methods. 1. Where no storm sewer system is available or exists or is not adequate to receive the anticipated load, the storm water, surface water, groundwater and clear water wastes shall be discharged in accordance with local governmental requirements.

2. Where approved by the local governmental authority, storm water, surface water, groundwater and clear water wastes of the properties of one- and 2-family dwellings may be discharged onto flat areas, such as streets or lawns, so long as the water flows away from the buildings and does not create a nuisance.

(c) Segregation of wastes. 1. Storm and clear water wastes shall not discharge to any part of a sanitary drain system, not shall sanitary wastes discharge to any part of a storm or clear water drain system; except the clear water wastes of a refrigerated drinking fountain, water heater relief valve or water softner may discharge to a sanitary drain system.

2. Storm water wastes and clear water wastes shall not be combined until discharging into the storm building drain.

Note: Subsections (3) (a) and (b) and (4) are excerpts from the state uniform plumbing code, s. ILHR 82.36.

SECTION 29. ILHR 21.18 (3) (intro.) is amended to read:

ILHR 21.18 (3) WOOD FOUNDATIONS. Wood foundations shall be designed and constructed in accordance with the National Forest Products Association standard, "The All-Weather Wood Foundation System, ~~Design, Fabrication, Installation Manual~~ Basic Requirements, Technical Report No. 7" ~~[ILHR 21.24 (4)]~~ and the following exceptions. The thickness of the foundation wall shall be no less than the thickness of the wall it supports.

SECTION 30. ILHR 21.18 (3) (a) 2. Note is created to read:

Note: Additional explanatory information regarding wood foundations can be obtained in "All-Weather Wood Foundation Systems, Design, Fabrication, Installation Manual", published by the National Forest Products Association.

SECTION 31. ILHR 21.22 (1) is amended to read:

ILHR 21.22 (1) FLOOR JOISTS. Wood floor joists shall comply with the requirements of section ILHR 21.02 (3) (a). The minimum live loads shall be determined from section ILHR 21.02. Where sill plates are provided, the sill plates shall be fastened to the foundation. Double floor joists shall be provided underneath all bearing walls which are parallel to the floor joists.

SECTION 32. ILHR 21.22 (1m) is created to read:

ILHR 21.22 (1m) FLOOR JOISTS RESTING ON MASONRY WALLS. On masonry walls the floor joists shall rest upon a mortar filled core concrete block or a solid top concrete block or a sill plate. The dimensions of the sill plate shall not be less than 2 inches by 6 inches. The mortar used shall be determined as in ILHR 21.26 (3).

SECTION 33. ILHR 21.25 (1) (d) is created to read:

ILHR 21.25 (1) (d) Bracing. Exterior walls shall be braced at the corners by:

1. Nominal 1 inch by 4 inch continuous diagonal members set into the face of the studs at an angle between 45° and 60°; or

2. Four feet by 8 feet plywood sheathing panels not less than 5/16 inch thick for 16-inch stud spacing and not less than 3/8 inch thick for 24-inch stud spacing; or

3. Preformed metal T-bracing not less than 22 gage (.0296 inches) thick and 1-3/4 inch wide; or

4. Other approved wind bracing materials.

Note: See Appendix for acceptable nailing schedule.

[Note to Revisor: ILHR 21.25 (1) (d) follows ILHR 21.25 (1) (c) Note.]

SECTION 34. ILHR 21.25 (3) (b) is amended to read:

ILHR 21.25 (3) (b) Header support. The ends of the header shall be supported on the stud and fastened to a single stud when the span is ~~limited to~~ not more than 3 feet. ~~Double studs~~ A second stud shall be provided on each side of the header in load-bearing walls exceeding 3 feet in width. Where the opening in load-bearing walls exceeds 6 feet in width, the end of the header shall be supported directly on ~~one of the~~ at least 2 studs (shoulder stud) and an additional stud shall be provided and fastened to the end of header.

SECTION 35. ILHR 21.26 (3) is amended to read:

ILHR 21.26 (3) TYPES OF MORTAR. The type of masonry mortar to be used for various kinds of masonry work shall be determined from Table 21.26-A. The mortar shall conform to the property requirements of Table 21.26-B1 and to the requirements of ASTM C-270 or shall be mixed in accordance with the proportions specified in Table 21.26-B.

SECTION 36. Table 21.26-B1 is created to read:

TABLE 21.26-B1

MORTAR PROPERTY REQUIREMENTS

Mortar Type	Compressive Strength Min. (psi)	Water Retention Min. (%)	Air Content Max. (%)
M	2,500	75	18
S	1,800	75	18
M	750	75	18

SECTION 37. ILHR 21.29 is amended to read:

ILHR 21.29 MASONRY FIREPLACES. Masonry fireplaces shall be constructed of masonry, stone or ~~reinforced~~ concrete and shall be provided with masonry chimneys. Masonry fireplaces shall be supported on foundations of concrete or masonry. Structural walls shall be at least 8 inches thick. Masonry fireplaces shall conform to the following requirements:

(1) FLUE SIZE. The fireplace flue size shall be based on the type of flue and the fireplace opening indicated in Table 21.29.

TABLE 21.29
MINIMUM FLUE SIZE FOR MASONRY FIREPLACES

Type of Flue	Minimum Cross-Sectional Area
Round	1/12 of fireplace opening but not less than 75 square inches.
Square or rectangular	1/10 of fireplace opening but not less than 75 square inches.
~~Lined with Firebrick~~	~~1/8 of fireplace opening~~

(2) TERMINATION OF CHIMNEY. Masonry fireplace chimneys shall extend at least 3 feet above the highest point where the chimney passes through the roof and at least 2 feet higher than any portion of the dwelling within 10 feet of the chimney.

(3) FIREBOX MATERIALS. The firebox shall be of the preformed metal type, at least 1/4 inch thick, or listed by a nationally recognized laboratory; or shall be lined with firebrick, at least 2 inches thick and laid in thin joints of refractory cement. The back and sidewalls of the firebox, including the lining, shall be at least 8 inches nominally thick masonry, at least 4 inches of which shall be solid ~~masonry~~.

(4) LINTEL. Masonry over the fireplace opening shall be supported by a lintel of steel ~~of noncombustible material~~ or masonry.

(5) DUCTS. Warm-air circulating ducts ~~used with steel fireplace units~~ shall be constructed of masonry or metal.

(6) HEARTH. ~~Fireplace hearths shall be constructed of noncombustible material and extend at least 8 inches on each side of the fireplace opening and 16 inches from the firebox.~~ Where the fireplace hearth is an integral part of the floor, there shall be a minimum of 4 inches of reinforced concrete under the hearth surface. The minimum dimensions of the hearth shall be based on the size of the fireplace opening as specified in Table 21.29-1.

TABLE 21.29-1
HEARTH DIMENSIONS

Fireplace Opening (Sq. Ft.)	Extension from Firebox (inches)	
	Side	Front
Less than 6	8	16
6 or Greater	12	20

[Note to Revisor: Table 21.29-1 is a created table.]

(7) DAMPERS. Dampers shall be made of cast iron or at least No. 12 gauge sheet metal. The area of the damper opening shall be at least 90% of the required flue area when in the open position.

(8) HOODS. Metal hoods, used ~~as part of a fireplace~~ in lieu of a masonry smoke chamber, shall be constructed of at least No. 19 gauge corrosion-resistant metal with all seams and connections of smokeproof construction. The hood shall be sloped at an angle of 45° or less from the vertical and shall extend horizontally at least 6 inches beyond the firebox limits. Metal hoods shall be kept a minimum of 18 inches from the combustible materials unless approved for reduced clearances.

Note: The department will accept dampers and hoods listed by nationally recognized laboratories.

(9) FLUE LINERS. Masonry chimneys shall be provided with fireclay flue liners of at least 5/8-inch thickness, vitrified clay sewer pipe or material that will resist corrosion, softening or cracking from flue gases at temperatures up to 1800°F. Flue liners shall start at the top of the fireplace throat and extend to a point at least 4 inches above the top of the enclosing masonry walls. The nominal thickness of the masonry chimney wall shall be at least 4 inches. Flue liners shall be laid in a full mortar bed ~~of refractory cement. If the flue liners are separated from the exterior shell by more than 4 inches,~~ and each individual flue shall be wrapped and laterally supported by at least 4 inches of masonry. Firebrick material may be used in lieu of flue liners in the throat of the fireplace.

(10) CLEANOUT OPENINGS. Fireplaces with ash dumps shall be provided with cleanout openings at the base. Doors and frames of the opening shall be made of ferrous materials.

(11) MANTEL SHELVES AND COMBUSTIBLE TRIM. Woodwork or other combustible materials shall not be placed within 6 inches of the fireplace opening. Combustible materials located within 12 inches of the fireplace opening shall not project perpendicularly more than 1/8-inch for each inch distance from the opening.

(12) CHIMNEY CAPS. Precast or cast-in-place concrete caps shall have a minimum thickness of 2 inch s ~~and a minimum of one inch overhang~~. A minimum of a 1/4-inch ~~soft~~ mortar joint shall be used between flues and caps and shall be caulked or sealed.

(13) FRAMING AROUND FIREPLACES. ~~All wood headers, joists, beams, rafters and studs shall be located at least 2 inches from the outside face of the chimney or fireplace masonry and at least 6 inches from the inside surface of the flue lining. All spaces between the framing and the fireplace shall be firestopped with noncombustible material.~~ Combustible materials located near fireplaces shall be installed in accordance with s. ILHR 21.31 (9).

(14) CORBELING. Unless designed through structural analysis, masonry chimneys shall not be corbeled from a wall more than 6 inches nor shall a masonry chimney be corbeled from a wall less than 12 inches in nominal thickness unless it projects equally on each side of the wall. The corbeling shall not exceed one-inch projection for each brick course.

SECTION 38. ILHR 21.30 is renumbered ILHR 21.32.

SECTION 39. ILHR 21.30 is created to read:

ILHR 21.30 MASONRY CHIMNEYS. Masonry chimneys shall conform to the following provisions:

(1) MATERIALS. No masonry chimney shall rest upon wood. The foundation shall be designed and built in conformity with the requirements for foundations. Masonry chimney walls shall be at least 4 inches in nominal thickness. Hollow cored masonry units may be used to meet the 4 inch nominal thickness requirement.

(2) FLUE SIZE. Chimney flues for appliances shall be at least equal in area to that of the area of the connector from the appliance.

(3) MULTIPLE FLUE SEPARATION. When more than one flue is contained in the same chimney, a masonry separation of at least 4 inches nominal in thickness shall be provided between the individual flues. The joints of adjacent flue linings shall be staggered by at least 7 inches.

(4) CORBELING. Unless designed through structural analysis, masonry chimneys shall not be corbeled from a wall more than 6 inches nor shall a masonry chimney be corbeled from a wall less than 12 inches in nominal thickness unless it projects equally on each side of the wall. The corbeling shall not exceed one-inch projection for each brick course.

(5) INLETS. Inlets to masonry chimneys shall enter the side and be provided with thimbles. Thimbles shall be at least No. 24 manufacturer's standard gauge (0.024 inch) or 5/8-inch thick refractory material. Each chimney shall have an inlet installed at the time of construction.

(6) CLEAN-OUT OPENING. Every masonry chimney shall be provided with a clean-out opening at the base. Such openings shall be equipped with metal doors and frames arranged to remain closed when not in use. Cleanout openings shall be located below the lowest inlet to the flue.

(7) FLUE LINERS. (a) Masonry chimneys shall be lined with fireclay flue lining at least 5/8-inch thick, vitrified clay, sewer pipe or with material that will resist corrosion, softening or cracking from flue gases at temperatures up to 1800° F. Flue liners shall commence at the chimney footing.

(b) All flue liners shall be laid in a full mortar bed.

(c) Variations in inside and outside dimensions shall not exceed 1/4-inch for clay flue liners.

(8) CHIMNEY CAPS. Precast or cast-in-place concrete caps shall have a minimum thickness of 2 inches. A minimum of a 1/4-inch mortar joint shall be used between flues and caps and shall be caulked or sealed.

(9) CLEARANCE TO COMBUSTIBLES. (a) The minimum clearance between masonry chimneys and combustible material shall be 2 inches for interior chimneys and 1/2 inch for chimneys located at the exterior wall.

(b) The clearance between the masonry chimney and combustible flooring and trim shall be at least 1/2 inch.

(c) Ends of wood girders may be supported on a corbeled shelf of a masonry chimney provided there is at least 8 inches of solid masonry between the ends of the girder and the flue liner.

(d) Combustible lath, combustible furring or combustible plaster grounds shall not be placed closer than 1-1/2 inches from the masonry. This requirement shall not:

1. Prevent plastering directly on the masonry or on metal lath or on metal furring or

2. Prevent attaching combustible furring and sheathing to the masonry exterior.

(e) All spaces between the masonry and the framing shall be draft stopped.

SECTION 40. ILHR 21.32 (3) is repealed and recreated to read:

ILHR 21.32 (3) HEARTH EXTENSIONS. Hearth extensions of not less than 3/8-inch thick hollow metal, stone, tile or other approved material shall be provided. The minimum dimensions of the hearth shall be based upon the size of the fireplace opening as specified in Table 21.32-1.

TABLE 21.32-1
HEARTH DIMENSIONS

Fireplace Opening (Sq. Ft.)	Extension from Firebox (inches)	
	Side	Front
Less than 6	8	16
6 or Greater	12	20

SECTION 41. ILHR 22.01 Note is repealed.

SECTION 42. ILHR 22.05 (1) Note is created to read:

Note: In truss floor/ceiling systems, the vapor barriers may be applied to the bottom chord of the truss, extending up along each side of the truss and across the back side of the insulation in the truss cavity. Rigid plastic insulation board may be applied to the bottom chord, if protected with 1/2-inch gypsum wallboard.

SECTION 43. ILHR 23.04 (1) (b) is repealed and recreated to read:

ILHR 23.04 (1) (b) Unvented Furnaces and Space Heaters. The use of unvented furnaces and space heaters fueled by natural gas, kerosene, alcohol or other fuel shall be prohibited due to concerns about oxygen depletion; contamination from carbon monoxide, carbon dioxide, nitrogen dioxide, formaldehyde and other combustion related contaminants; and water vapor buildups.

SECTION 44. ILHR 23.04 (4) (b) is amended to read:

ILHR 23.04 (4) (b) Chimneys. Wood-burning appliances shall be connected to a masonry chimney with a flue liner or an all-fuel, residential type factory-built chimney. Wood-burning equipment shall not be connected to a flue serving a fireplace or other equipment. The chimney shall be designed to create a natural draft to carry away the products of combustion or provision shall be made for mechanically maintaining constant updraft during equipment operation. A cleanout opening shall be provided. A listed multi-fuel heating appliance may be vented into a single flue.

SECTION 45. ILHR 23.045 is created to read:

ILHR 23.045 SOLID FUEL BURNING APPLIANCES. (1) GENERAL. Solid fuel-burning appliances shall be installed as specified in this section. The installations shall also be in accordance with the appliance manufacturer's installation instructions if the manufacturer specifies the use of increased protection or greater clearances than those specified in this section.

(2) LOCATION OF APPLIANCES. (a) Servicing. Every appliance shall be located to permit access to the appliance. Sufficient clearance shall be maintained around the equipment to permit cleaning of surfaces; the replacement of air filters, blowers, motors, controls and chimney connectors; the lubrication and servicing of moving parts; and the adjustment and servicing of stokers and appliance components.

(b) Combustion Air. Solid fuel-burning appliances shall not be installed in spaces where the volume of the room (measured in cubic feet) is less than 1/20th of the maximum input BTU rating of the appliance, unless combustion air is provided by one of the following methods:

1. 'Air from inside the dwelling'. Two openings shall be provided to the equipment enclosure. One opening shall be located within 12 inches from the floor and one opening shall be located within 24 inches from the top of the room. Each opening shall provide a minimum area of one square inch per 1,000 BTU per hour input.

2. 'Air from outside the dwelling'. Two openings shall be provided to the equipment enclosure. One opening shall be located within 12 inches from the floor and one opening shall be located within 24 inches from the top of the room. Each opening shall provide a minimum area of one square inch per 4,000 BTU per hour input.

3. 'Combustion air openings'. Openings required for combustion air to solid fuel-burning appliances shall be in addition to openings required for other appliances.

Note: Wood has a value of 8,600 BTU per pound.

(3) CHIMNEYS. (a) Solid fuel-burning appliances shall not be connected to a flue serving a fireplace or other equipment.

(b) Solid fuel-burning appliances shall be connected to one of the following types of chimneys:

1. 'Factory-built chimneys or vents'. A listed residential type and building heating appliance chimney or "building heating appliance only" chimney may be used with solid fuel-burning appliances where the flue gas temperature does not exceed 1,000° F continuously, and does not exceed 1,400° F for infrequent brief periods of forced firing.

2. 'Masonry chimneys'. Masonry chimneys shall be constructed as specified in s. ILHR 21.30.

(4) CHIMNEY CONNECTORS. (a) All solid fuel-burning appliances shall be connected to chimneys with factory-built chimney material, Type L vent material or steel pipe with minimum thicknesses as specified in Table 23.045-A.

Table 23.045-A
METAL THICKNESS FOR PIPE CONNECTORS

Diameter of Connector (inches)	Galvanized Sheet Gage No.	Mininum Thickness Inches
6 to 10	24	.023
over 10 to 16	22	.029
over 16	16	.056

(b) The required clearance to combustibles for chimney connectors shall be 18 inches. This clearance can be reduced in accordance with Table 23.045-D. The specified protection shall be applied to and cover all combustible material as specified in Figure 23.045.

(c) Connectors and chimneys for solid fuel-burning appliances shall be designed, located and installed to permit ready access for internal inspection and cleaning.

(d) 1. Chimney connectors shall have no more than two 90° elbows.

2. The horizontal length shall not exceed 75 % of the total vertical height of the entire venting system measured from the appliance outlet.

3. The connector shall maintain a rise of at least 1/4 inch per foot from the appliance outlet to the chimney inlet.

4. Connectors shall be securely supported and joints fastened with a minimum of 3 sheet metal screws or rivets.

5. Appliances used mainly for wood burning shall have the joints assembled so that the crimped end points towards the stove. Appliances burning coal shall have the joints assembled so that the crimped end points away from the appliance.

6. A connector to a masonry chimney shall extend through the wall to the innerface of the liner but not beyond.

7. The effective area of the connector shall not be less than the area of the appliance flue collar.

(e) No chimney connectors may pass through any floor, ceiling, window, door or combustible wall nor be concealed in any closet, attic or similar space. A connector may pass through a combustible wall if the connector is guarded at the point of passage by one of the following methods:

1. Metal ventilated thimble not less than 12 inches larger in diameter than the connector.

2. All combustible material in the wall is cut away from the connector a sufficient distance to provide the required 18-inch clearance. Any material used to close up such openings shall be noncombustible.

(f) A manual, cast iron damper to control draft shall be provided in the chimney connector. The damper shall not obstruct more than 80 % of the connector area. Listed solid-fuel appliances whose listing prohibits the use of manual dampers in the connector shall not require a manual damper to be installed.

(5) MOUNTING ON FLOORS. (a) Appliances shall be placed on surfaces as described in Table 23.045-B. Solid fuel-burning appliances listed specifically for installation on a floor constructed of combustible material may be installed in accordance with the terms of the listing and the manufacturer's instructions.

Table 23.045-B
Floor Mountings for Solid Fuel-Burning Appliances

Kind of Appliance	Allowed Mounting
(1) All forced air and gravity furnaces, steam and water boilers. (2) Residential-type ranges, fireplace stoves, room heaters and combination fireplace stove/room heaters, having less than 2 inches of ventilated open space beneath the fire chamber or base of the unit.	Floors of fire-resistive construction with noncombustible water heaters, fireplace flooring and surface finish, or fire-resistive arches or slabs. These constructions shall have no combustible material against the underside Such construction shall extend at least 18 inches beyond the appliance on all sides. These appliances shall not be placed on combustible floors.
(3) Residential-type ranges, water heaters, fireplace stoves, room heaters and combination fireplace stove/room heaters having legs or pedestals providing 2 to 6 inches of ventilated open space beneath the fire chamber or base of the heater.	On combustible floors when such floors are protected by 4 inches of hollow masonry, laid to provide air circulation through the masonry layer. Such masonry shall be covered with 24 gage sheet metal. The required floor protection shall extend at least 18 inches on all sides of the appliance. Noncombustible floors shall extend at least 18 inches on all sides of the appliance.
(4) Residential-type ranges, water heaters, fireplace stoves, room heaters and combination fireplace stove/room heaters having legs or pedestals providing over 6 inches of ventilated open space beneath the fire chamber or base of the covered heater.	On combustible floors, when such floors are protected by closely spaced masonry units of brick, concrete or stone, which provide at least 2 inches of thickness. Such masonry shall be covered by or placed over a sheet of 24 gage steel. The required floor protection shall extend at least 18 inches on all sides of the appliance. Noncombustible floors shall extend at least 18 inches on all sides of the appliance.

(6) CLEARANCES. (a) Solid fuel-burning equipment shall be installed with clearances not less than specified in Table 23.045-C.

(b) 1. 'Listed appliances exception'. Listed appliances may be installed with clearances other than that specified by Table 23.045-C if installed in accordance with the terms of their listing and the manufacturer's instructions.

2. 'Clearances with protection exception'. Chimney and vent connectors may be installed with reduced clearances provided the combustible material is protected as described in Table 23.045-D. The specified protection shall be applied to and cover all combustible material as specified in Figure 23.045.

Table 23.045-C
Standard Clearances for Solid Fuel-Burning Appliances

Type of Appliance	Above Top of Casing or Appliance. Above Top and Sides of Furnace Plenum or Bonnet (inches)	Minimum Standard Clearances (inches)		
		From Front	From Back	From Sides
Residential Appliances Steam Boilers - 15 psi Water Boilers - 250° F max. Water Boilers - 200° F max. All Water Walled or Jacketed	6	48	6	6
Furnaces Gravity and Forced Air	18	48	18	18
Room Heaters, Fireplace Stoves, Combinations	36	36	36	36
			Firing Side	Opp. Side
Ranges Lined Firechamber Unlined Firechamber	30 30	36 36	24 36	18 18

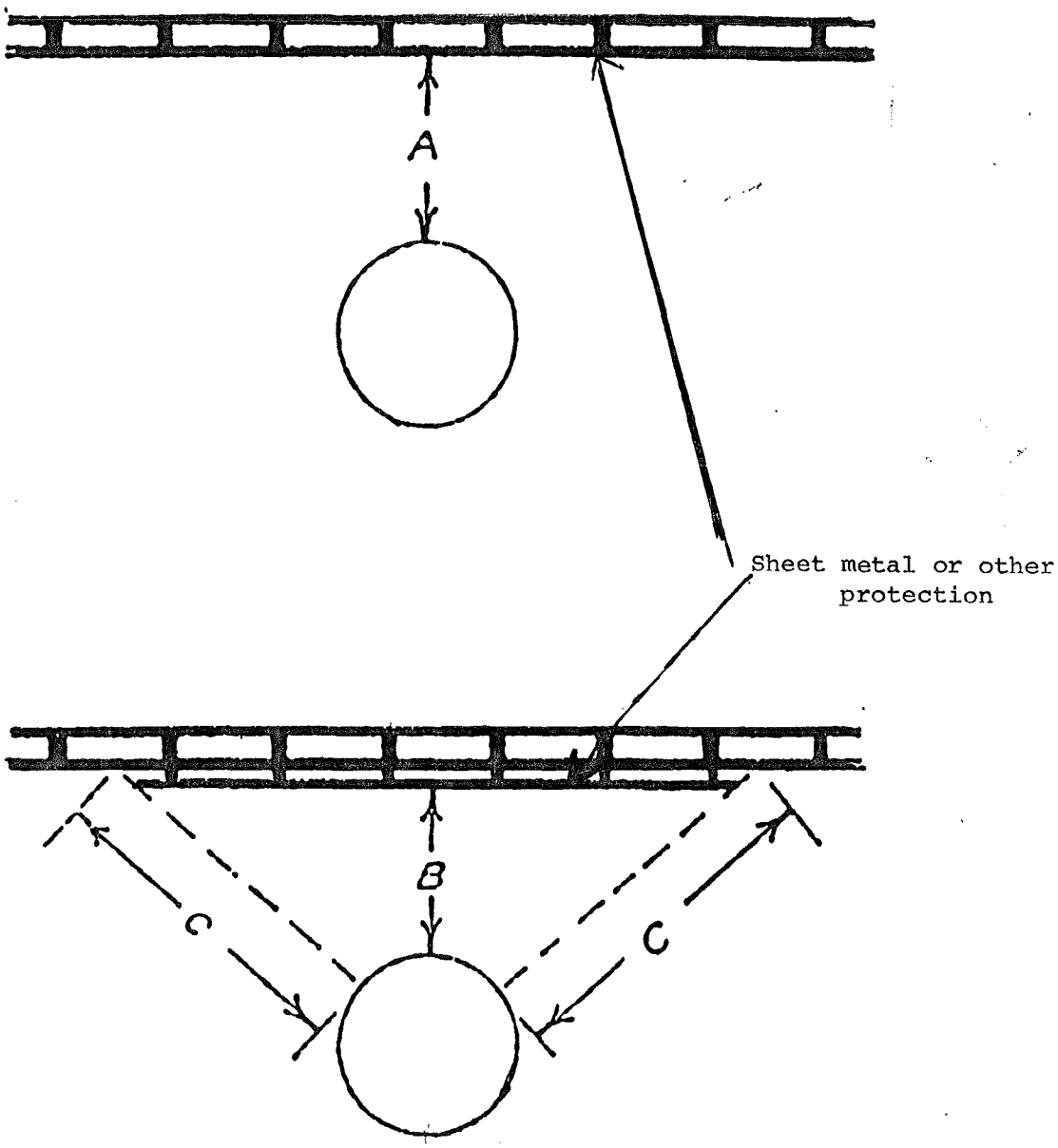
Table 23.045-D

Connector Clearances With Specified Forms of Protection [1,2,3,4,5,6]

Type of Protection	Minimum Required Connector Clearances for: (inches)		
	Ranges, Room Heaters Fireplace Stoves, Combinations	Furnaces	Residential Appliances (Boilers)
No protection.	36	18	6
0.013 in. (28 gage) sheet metal spaced out a minimum of one inch.	18	9	2
3-1/2 in. thick masonry wall spaced out a minimum of one inch and adequately tied to the wall being protected (see Note 4).	18	9	2
0.027 in. (22 gage) sheet metal on one-inch mineral wool batts reinforced with wire or equivalent spaced out a minimum of one inch.	12	3	2

[1] Spacers and ties shall be of noncombustible material.
[2] All methods of protection require adequate ventilation between protective material and adjacent combustible walls and ceilings.
[3] Mineral wool batts (blanket or board) shall have a minimum density of 8 pounds per foot and a minimum melting point of 1550° F.
[4] If a single wall connector passes through the masonry wall there shall be at least 1/2 inch of open ventilated air space between the connector and the masonry.
[5] There shall be at least one inch between the appliance and the protector.
[6] Clearances in front of the appliances shall not be reduced from those in Table 23.045-C.

FIGURE 23.045
CONSTRUCTION USING COMBUSTIBLE MATERIAL



"A" Equals the required clearance with no protection, specified in Table 23.045-D.

"B" Equals the reduced clearance permitted in accordance with Table 23.045-D. The wall protection should extend far enough in each direction to make 'C' equal to 'A'.

(7) ACCESSORIES. Accessories for solid fuel-burning appliances such as heat exchangers, stove mats, floor pad and protection shields, shall be listed and shall be installed in accordance with the terms of their listing.

(8) SUPPLEMENTAL UNITS. Supplemental solid fuel-burning units connected to a furnace shall be connected to the warm air side of the furnace and shall conform to the following provisions:

(a) Return Air Duct. The area of the return air duct shall be at least equal to the area of the warm air supply duct. The return air duct shall be of the same material as specified for supply air ducts.

(b) Blower. The blower on the furnace shall maintain the manufacturer's specifications for cubic feet per minute air flow and static pressure when the supplemental unit is in operation.

(c) Outside Air Intake. The outside air intake shall be connected to the cold air return plenum of the furnace. A volume damper shall be placed in the duct for the fresh air intake.

(d) Thermostat. The thermostat control on the supplemental heating unit shall activate the blower motor at a temperature between 100° and 120° F.

(9) SUPPLY DUCTS. Supply ducts connected to solid fuel-burning appliances shall have the following minimum clearances to combustibles:

(a) Horizontal Ducts. The clearance from combustibles for horizontal ducts shall be as specified in Table 23.045-E.

Table 23.045-E

Distance of Ducts From Bonnet or Plenum (inches)	Clearance to Combustibles[1] Required (inches)
0 to 36	18
over 36 to 72	6
over 72	1

[1] Clearance can be reduced in accordance with Table 23.045-D

(b) Vertical Ducts. 1. Air shall travel 6 feet and change directions equivalent to one 90° turn before entering an enclosure of combustible material.

2. Ducts shall have 3/16 inch clearance between the duct and any combustible material.

(10) COMBINATION APPLIANCES. Appliances capable of burning multi-types of fuel shall be listed and installed in accordance with their listing.

SECTION 44. ILHR 23.11 (1) and (2) are renumbered ILHR 23.11 (2) and (3).

SECTION 47. ILHR 23.11 (intro.) is renumbered ILHR 23.11 (1) and amended to read:

ILHR 23.11 GENERAL REQUIREMENTS. (1) TYPES OF CHIMNEYS AND VENTS. All heating appliances using solid, liquid or gas fuels shall be vented to the outside by an all-fuel factory-built ~~or~~ , masonry chimney or other listed venting system designed to remove the products of combustion. ~~Gas-fired water heaters may be connected to an approved type "B" vent. Vented wall furnaces may be connected to an approved type "BW" vent. Listed appliances with direct vent systems may also be used.~~

SECTION 48. ILHR 23.12 is repealed and recreated to read:

ILHR 23.12 MASONRY CHIMNEYS. Masonry chimneys shall conform to the following provisions:

(1) MATERIALS. No masonry chimney shall rest upon wood. The foundation shall be designed and built in conformity with the requirements for foundations. Masonry chimney walls shall be at least 4 inches in nominal thickness. Hollow-cored masonry units may be used to meet the 4 inch nominal thickness requirement.

(2) FLUE SIZE. Chimney flues for appliances shall be at least equal in area to that of the area of the connector from the appliance.

(3) MULTIPLE FLUE SEPARATION. When more than one flue is contained in the same chimney, a masonry separation of at least 4 inches nominal in thickness shall be provided between the individual flues. The joints of adjacent flue linings shall be staggered by at least 7 inches.

(4) CORBELING. Unless designed through structural analysis, masonry chimneys shall not be corbeled from a wall more than 6 inches nor shall a masonry chimney be corbeled from a wall less than 12 inches in nominal thickness unless it projects equally on each side of the wall. The corbeling shall not exceed one-inch projection for each brick course.

(5) INLETS. Inlets to masonry chimneys shall enter the side and be provided with thimbles. Thimbles shall be at least No. 24 manufacturer's standard gauge (0.024 inch) or 5/8-inch thick refractory material. Each chimney shall have an inlet installed at the time of construction.

(6) CLEAN-OUT OPENING. Every masonry chimney shall be provided with a clean-out opening at the base. Such openings shall be equipped with metal doors and frames arranged to remain closed when not in use. Clean-out openings shall be located below the lowest inlet to the flue.

(7) FLUE LINERS. (a) Masonry chimneys shall be lined with fireclay flue lining at least 5/8-inch thick, vitrified clay sewer pipe or with material that will resist corrosion, softening or cracking from flue gases at temperatures up to 1800° F. Flue liners shall commence at the chimney footings.

(b) All flue liners shall be laid in a full mortar bed.

(c) Variations in inside and outside dimensions shall not exceed 1/4-inch for clay flue liners.

(8) CHIMNEY CAPS. Precast or cast-in-place concrete caps shall have a minimum thickness of 2 inches. A minimum of a 1/4-inch mortar joint shall be used between flues and caps and shall be caulked or sealed.

(9) CLEARANCE TO COMBUSTIBLES. (a) The minimum clearance between masonry chimneys and combustible material shall be 2 inches for interior chimneys and 1/2 inch for chimneys located at the exterior wall.

(b) The clearance between the masonry chimney and combustible flooring and trim shall be at least 1/2 inch.

(c) Ends of wood girders may be supported on a corbeled shelf of a masonry chimney provided there is at least 8 inches of solid masonry between the ends of the girder and the flue liner.

(d) Combustible lath, combustible furring or combustible plaster grounds shall not be placed closer than 1-1/2 inches from the masonry. This requirement shall not:

1. Prevent plastering directly on the masonry or on metal lath and metal furring or

2. Prevent attaching combustible furring and sheathing to the masonry exterior.

(e) All spaces between the masonry and the framing shall be draft stopped.

SECTION 49. ILHR 25.01 is amended to read:

ILHR 25.01 SCOPE. All one- and 2-family dwellings shall be provided with potable water and plumbing systems in accordance with the standards listed in this chapter and shall comply with chs. ILHR 82 to 84.

SECTION 50. Chapter ILHR 26 Part III (title) is amended to read:

PART III - INDEPENDENT INSPECTION/EVALUATION
AGENCY CERTIFICATION FOR
MANUFACTURED DWELLINGS

SECTION 51. ILHR 26.14 is amended to read:

ILHR 26.14 INDEPENDENT INSPECTION/EVALUATION AGENCY CERTIFICATION. Any independent inspection/evaluation agency offering to perform in-plant inspections or approval of plans and specifications of manufacturing facilities, processes, fabrication and assembly of manufactured dwellings and certify compliance for manufactured dwellings under the uniform dwelling code or commercial building code shall be certified and shall satisfy the requirements of this part.

SECTION 52. ILHR 26.15 (title) is amended to read:

ILHR 26.15 APPLICATION FOR INDEPENDENT INSPECTION/EVALUATION AGENCY CERTIFICATION OR RECERTIFICATION.

SECTION 53. ILHR 26.15 (2) (e) is amended to read:

ILHR 26.15 (2) (e) An organizational chart of the ~~independent inspection~~ agency.

SECTION 54. ILHR 26.15 (2) (l) is amended to read:

ILHR 26.15 (2) (l) A list of all persons having contracts with the ~~independent inspection~~ agency to perform certified inspections.

SECTION 55. ILHR 26.15 (3) (intro.) is amended to read:

ILHR 26.15 (3) Any independent inspection/evaluation agency to be certified by the department shall agree in writing:

SECTION 56. ILHR 26.16 is amended to read:

ILHR 26.16 RECIPROCITY. Independent inspection/evaluation agency certification may be accomplished through reciprocity provided that the certification program of the state in which the agency is certified is approved by the department.

SECTION 57. ILHR 26.18 is amended to read:

ILHR 26.18 ISSUANCE OF INDEPENDENT INSPECTION/EVALUATION AGENCY CERTIFICATE. Upon acceptance of the application and finding of eligibility, the department shall notify the agency in writing and shall issue an independent inspection/evaluation agency certificate. The certificate shall bear the name of the independent inspection/evaluation agency, certificate number, and expiration date. The certificate shall be valid for a period of one year.

[Note to Revisor: Legislative Council requested that all "parts" in chapters ILHR 20 to 26 be changed to "subchapters", except in chapter ILHR 25 where all "parts" should be eliminated. Please make these changes and also correct the format of the reference in section ILHR 24.01.]

[Note to Revisor: Please make the following changes in the Appendix to chapter ILHR 21.]

A. On page 99 of the original Uniform Dwelling Code in the section entitled, SPAN TABLES FOR JOISTS AND RAFTERS, and subsection entitled, EXPLANATION OF TABLES, paragraph three, change the following:

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

to

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

B. On page 100 of the original Uniform Dwelling Code in the section entitled, SPAN TABLES FOR JOISTS AND RAFTERS, and subsection entitled, LUMBER DESIGN VALUES, paragraphs three and four, change the following:

For rafters, design values in bending (F_b) may be greater than the design values for normal duration of load, by the following amounts:

15% for 2 months' duration, as for snow.
25% for 7 days' duration, as for construction load.

The design value tables provide values for bending for repetitive-member use of joists and rafters under normal, 2-month and 7-day duration of load.

to

The "Joists" column in the design value tables provide values for bending for repetitive-member use under normal conditions. The "Rafters" column if the design value tables provide values for bending for repetitive-member use adjusted for snow-loading.

C. The following tables are removed from the Appendix to chapter Ind 21:

(1) Table R-1
Flat or Sloped Rafters
Supporting Drywall Ceiling
(Flat Roof or Cathedral Ceiling with no Attic Space)
Live Load - 20 lb. per sq. ft.
(Pages 114 through 117)

(2) Table R-4
Flat or Sloped Rafters
Supporting Plaster Ceiling
(Flat Roof or Cathedral Ceiling with no Attic Space)
Live Load - 20 lb. per sq. ft.
(Pages 126 through 129)

D. The following table titles in the Appendix to chapter Ind 21 are amended to read:

(1)

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

(2)

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

(3)

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

(4)

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

E. The following span tables from "Span Tables for Joists and Rafters" published by the National Forest Products Association are added to the Appendix to chapter Ind 21, with table titles amended as indicated. Add the following 24 pages between the present page 137 and 138.

(1)

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

(2)

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

(3) 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

(4) 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

(5) 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

(6) 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

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

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.

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 (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	5-6 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)	RAFTER 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	2x6
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	
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	2x8
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	
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	
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	2x10
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	
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	2x12
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)

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 (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	3-0 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	
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	2x4
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	
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	2x6
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	
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	2x8
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	
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	2x10
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)

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	
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	2x4
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	
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	2x6
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	
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	2x8
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	
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	2x10
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)

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 0.66	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	
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	2x8
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	
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	2x10
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)

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	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	
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	2x8
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	
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	2x10
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.

F. Remove the tables on pages 142 through 151 and insert the following 14 pages.

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". Joists	Design Value in Bending "F_b". Rafters	Modulus of Elasticity "E"	Grading Rules Agency
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)
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	West Coast Lumber Inspection Bureau
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		1550	1630	1,200,000	Lumber
No. 1 & Appearance	2x4	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		800	840	1,000,000	Northern
Standard	2x4	450	470	1,000,000	Hardwood & Pine
Utility		200	210	1,000,000	Manufacturers Association
Select Structural	2x5	1350	1420	1,200,000	
No. 1 & Appearance	and	1150	1210	1,200,000	
No. 2	wider	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		2300	2420	1,700,000	
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	2x4	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	Southern Pine Inspection Bureau
Stud		900	950	1,400,000	
Construction		1150	1210	1,400,000	
Standard	2x4	675	710	1,400,000	
Utility		300	320	1,400,000	(See note 3)
Select Structural		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	2x5 and wider	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	2x4	1250	1310	1,500,000	
Standard		725	760	1,500,000	
Utility		300	320	1,500,000	(See note 3)
Select Structural	2x5 and wider	2150	2260	1,800,000	
Dense Select Structural		2500	2630	1,900,000	
No. 1		1850	1940	1,800,000	
No. 1 Dense		2150	2260	1,900,000	
No. 2		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 Grades Auth. (A Canadian Agency -
Stud		650	680	1,200,000	
Construction		850	890	1,200,000	
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	2x4	2100	2210	1,600,000	Western Wood Products Association (See notes 1 and 3)
No. 1 & Appearance	2x4	1800	1890	1,600,000	
No. 2	2x4	1450	1520	1,400,000	
No. 3	2x4	800	840	1,300,000	
Stud	2x4	800	840	1,300,000	
Construction	2x4	1050	1100	1,300,000	West Coast Lumber Inspection Bureau
Standard	2x4	600	630	1,300,000	
Utility	2x4	275	290	1,300,000	
Select Structural	2x5 and wider	1800	1890	1,600,000	
No. 1 & Appearance	2x5 and wider	1550	1630	1,600,000	
No. 2	2x5 and wider	1250	1310	1,400,000	
No. 3	2x5 and wider	750	790	1,300,000	
Stud	2x5 and wider	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 (See notes 1 and 3)
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	
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.