CERTIFICATE

By Authority Of
THE UNITED STATES OF AMERICA
Legally Binding Document

By the Authority Vested By Part 5 of the United States Code § 552(a) and Part 1 of the Code of Regulations § 51 the attached document has been duly INCORPORATED BY REFERENCE and shall be considered legally binding upon all citizens and residents of the United States of America. *HEED THIS NOTICE*: Criminal penalties may apply for noncompliance.

Document Name: CABO: One and Two Family Dwelling Code

CFR Section(s): 24 CFR 200.926b(c)

Standards Body: Council of American Building Officials

APPROVED

Official Incorporator:
THE EXECUTIVE DIRECTOR
OFFICE OF THE FEDERAL REGISTER
WASHINGTON, D.C.

CABO ONE and TWO FAMILY DWELLING CODE

CABO
ONE AND TWO FAMILY DWELLING CODE
1992 EDITION

FIFTH PRINTING

UNDER THE
NATIONALLY RECOGNIZED MODEL CODES

BOCA National Building Code
BUILDING OFFICIALS AND CODE ADMINISTRATORS INTERNATIONAL, INC. (BOCA)
4051 West Flossmoor Road
Country Club Hills, Illinois 60478-5795

Uniform Building Code
INTERNATIONAL CONFERENCE OF BUILDING OFFICIALS (ICBO)
5360 South Workman Mill Road
Whittier, California 90601

Standard Building Code
SOUTHERN BUILDING CODE CONGRESS INTERNATIONAL, INC. (SBCCI)
900 Montclair Road
Birmingham, Alabama 35213-1206

PREFACE

The purpose of this code is to provide minimum requirements to safeguard life or limb, health, and public welfare and the protection of property as it relates to these safeguards by regulating and controlling the design, construction, prefabrication, equipment or appliance installation, quality of materials, use and occupancy location and repair of detached one- or two-family dwellings, not more than three stories in height. Also the purpose is to further standardize requirements by using a compilation of data from the following national model codes:

BUILDING

BOCA National Building Code
Standard Building Code
Uniform Building Code

PLUMBING

BOCA National Plumbing Code
Standard Plumbing Code
Uniform Plumbing Code

MECHANICAL

BOCA National Mechanical Code
Code for the Installation of Heat-Producing Appliances
Standard Gas Code
Standard Mechanical Code
Uniform Mechanical Code

ELECTRICAL

National Electrical Code

This code is dedicated to the development of better building construction and greater safety to the public and uniformity in building laws; to the granting of full justice to all building materials on a fair basis of the true merits of each material; and to development on a sound economic basis for the future growth of our urban areas through unbiased and equitable dealing with building construction.

All of the nationally recognized model codes upon which this code is based are comprehensive and flexible and make provision for the use of all safe materials or methods of construction. Consequently, there are construction materials and practices other than listed in this code which are adequate for the purposes intended. These other methods represent either seldom-used systems or performance-type systems which require individual consideration by the professional architect or engineer based on either test data or engineering analysis and are therefore not included herein. The construction methods covered in this code are time tested and therefore do not need additional substantiating data to justify their adequacy.

Vertical lines in the margins indicate changes from the 1989 edition except where the entire chapter was revised, a new chapter was added or the change was minor. Where an entire chapter was changed or a new chapter was added, a notation appears at the beginning of that chapter.

Asterisks (*) in the margins indicate locations from which the 1989 edition text has either been deleted or relocated.

Certain editorial enhancements have been included in this edition. Most notably, tables and figures have been relocated to follow the primary section in which the tables and figures are referenced.

ADOPTING ORDINANCE
CABO ONE AND TWO FAMILY DWELLING CODE

ORDINANCE NO. _____

An ordinance regulating the fabrication, erection, construction, enlargement, alteration, repair, location and use of detached one- and two-family dwellings, their appurtenances and accessory structures in the jurisdiction of _____; and providing for the issuance of permits therefore providing penalties for the violation thereof, and repealing all ordinances and parts of ordinances in conflict therewith.

Be it ordained by the _____
of the jurisdiction of _____
as follows:

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R-106.2 Violations: It is hereby declared that any violation of this code constitutes a public nuisance, and in addition to any other remedies provided by this code for its enforcement, the city may bring civil suit to enjoin the violation of any provisions of this code.

If for any reason any one or more sections, sentence clauses or parts of this code are held invalid, such judgment shall not affect, impair or invalidate the remaining provisions.

R-106.3 Penalty: Any person, firm or corporation violating any of the provisions of this code shall be guilty of a misdemeanor and each such person shall be deemed guilty of a separate offense for each and every day or portion thereof during which any violation of any of the provisions of this code is committed, continued or permitted, and upon conviction of any such violation such person shall be punishable by a fine, or by imprisonment, or by both such fine and imprisonment as established by local applicable laws.

SECTION R-107 — RIGHT OF APPEAL

All persons shall have the right to appeal the building official's decision through a body appointed by the appropriate authority of the jurisdiction and qualified by experience and training to pass upon matters pertaining to building construction.

SECTION R-108 — ALTERNATE MATERIALS AND SYSTEMS

R-108.1 General: The provisions of this code are not intended to limit the appropriate use of materials, appliances, equipment or methods of design or construction not specifically prescribed by this code, provided the building official determines that the proposed alternate materials, appliances, equipment or methods of design or construction are at least equivalent of that prescribed in this code in suitability, quality, strength, effectiveness, fire resistance, durability, dimensional stability, safety and sanitation.

The building official may require that evidence or proof be submitted to substantiate any claims that may be made regarding the proposed alternate.

R-108.2 Tests: Determination of equivalence shall be based on design or test methods or other such standards approved by the building official. The building official may accept as supporting data to assist in this determination duly authenticated reports from the Building Officials and Code Administrators International, Inc., Southern Building Code Congress International, Inc., International Conference of Building Officials, the National Evaluation Service Committee of the Council of American Building Officials, acceptance documents from the U.S. Department of Housing and Urban Development or from other approved authoritative sources for all materials or assemblies proposed for use which are not specifically provided for by this code. The costs of all tests, reports and investigations required under these provisions shall be paid by the applicant.

SECTION R-109 — LIABILITY

The building official or the building officials's authorized representative, acting in good faith and without malice in the discharge of his duties shall not render himself personally liable for any damage that may accrue to persons or property as a result of any act or by reason of any act or omission in the discharge of his duties. Any suit brought against the building official or employees because of such an act or omission performed in the enforcement of this code shall be defended by the jurisdiction until final determination and any judgement thereof shall be assumed by the jurisdiction.

This code shall not relieve or lessen the responsibility of an owner, operator or controller of a building for any damages to the person or property caused by defects, nor shall the building department or its jurisdiction be held to assume any such liability by reason of inspection or permits authorized by this code.

SECTION R-110 — PERMIT

R-110.1 Permit required: A permit shall be obtained before beginning construction, alteration or repairs, other than ordinary repairs, using application forms furnished by the building official.

Ordinary repairs are nonstructural repairs and do not include addition to, alteration of, or replacement or relocation of water supply, sewer, drainage, drain leader, gas, soil, waste, vent or similar piping, electrical wiring, or mechanical or other work for which a permit is required by the building official.

R-110.2 Permit fees: Permit fees shall be established by the local jurisdiction.

R-110.3 Expiration: Every permit issued by the building official under the provisions of this code shall expire by limitation and become null and void if the building or work authorized by such permit is not commenced within six months from the issue date of the permit, or if the building or work authorized by such permit is suspended or abandoned at any time after the work is commenced for a period of six months. Before work can be resumed, a new permit shall be obtained to do so, and the fee therefore shall be one-half the amount required for a new permit for such work, provided no changes have been made in the original plans and specifications for such work; and provided further that such suspensions or abandonment has not exceeded six months.

A permittee holding an unexpired permit may apply for a one-time extension, provided he can show good and satisfactory reasons, and beyond his control the work cannot be commenced within the six-month period from the issue date. In order to renew work on a permit after it has expired, the permittee shall pay a new full permit fee.

R-110.4 Permit Validity. The issuances of a permit shall not authorize the violation of any of the provisions of this Code.

SECTION R-111 — PLANS

R-111.1 Plans Required: When required by the building official, plans shall be drawn to scale and shall be of sufficient clarity to indicate the nature and extent of the work proposed and shall show in detail that it will conform to the provisions of this code and all relevant laws, ordinances, rules and regulations. Plans shall include a plot plan drawn to scale showing the location of all easements, drainage facilities, adjacent grades, property lines, the proposed building and of every existing building on the property.

R-111.2 Plans on job required: A copy of approved plans when required by the building official shall be kept on the site of the building or work at the time of inspection.

SECTION R-112 — INSPECTION

R-112.1 Types of inspections: For on-site construction, from time to time the building official, upon notification from the permit holder or his agent, shall make or cause to be made any necessary inspections and shall either approve that portion of the construction as completed or shall notify the permit holder or his agent wherein the same fails to comply with this code.

R-112.1.1 Foundation inspection: Commonly made after poles or piers are set or trenches or basement areas are excavated and forms erected and any required reinforcing steel is in place and prior to the placing of concrete. The foundation inspection shall include excavations for thickened slabs intended for the support of bearing walls, partitions, structural supports, or equipment and special requirements for wood foundations.

R-112.1.2 Plumbing, mechanical and electrical: Rough inspection: Commonly made prior to covering or concealment, before fixtures are set, and prior to framing inspection.

R-112.1.3 Frame and masonry inspection: Commonly made after the roof, masonry, all framing, firestopping, draftstopping and bracing are in place and after the plumbing, mechanical and electrical rough inspections are approved.

R-112.1.4 Lath and/or wallboard inspection: Commonly made after all lathing and/or wallboard interior is in place, but before any plaster is applied, or before wallboard joints and fasteners are taped and finished.

R-112.1.5 Other inspections: In addition to the called inspections above, the building department may make or require any other inspections to ascertain compliance with this code and other laws enforced by the building department.

R-112.1.6 Final inspection: Commonly made after the building is completed and ready for occupancy.

SECTION R-113—PREFABRICATED CONSTRUCTION

A certificate of approval by an approved agency shall be furnished with every prefabricated assembly, except where all elements of the assembly are readily accessible to inspection at the site. Placement of prefabricated assemblies at the building site shall be inspected by the building official to determine compliance with this code, and a final inspection shall be provided in accordance with Section R-112.1.6.

NOTE: Provisions for foundation systems and building service equipment connections necessary to provide for the installation of new manufactured homes on privately owned (nonrental) lots and existing manufactured homes to which additions, alterations or repairs are made are contained in Appendix C and shall be enforced only when specifically adopted by the jurisdiction.

SECTION R-114—BARRIERS FOR SWIMMING POOLS, SPAS AND HOT TUBS

Provisions for barriers for swimming pools, spas and hot tubs are contained in Appendix F and shall be enforced only when specifically adopted by the jurisdiction.

SECTION R-115—INSPECTION CARD

The permit holder or his agent shall post the inspection record on the jobsite in an accessible and conspicuous place to allow the building official to make the required entries. The record shall be maintained by the permit holder until the final inspection has been made and approved.

SECTION R-116—EXISTING INSTALLATIONS

Buildings and structures in existence at the time of the adoption of this code may have their existing use continued if such use was legal at the time of the adoption of this code, provided such continued use is not dangerous to life.

SECTION R-117—STOP WORK ORDERS

Upon notice from the building official, work on any building, structure, electrical, gas, mechanical or plumbing system that is being done contrary to the provisions of this code shall immediately cease. Such notice shall be in writing and shall be given to the owner of the property, or to his agent, or to the person doing the work, and shall state the specific violations and the conditions under which work may be resumed. Where an emergency exists, the building official shall not be required to give a written notice prior to stopping the work.

SECTION R-118 — DEFINITIONS

For the purpose of this code, certain abbreviations, terms, phrases, words and their derivatives shall be construed as defined in the locally adopted model code in this section. Words used in the singular include the plural, and the plural the singular. Words used in the masculine gender include the feminine, and the feminine the masculine.

Accessory structure: A building, the use of which is incidental to that of the main building and which is located on the same lot.

Approved: Approved refers to approval by the building official as the result of investigation and tests conducted by him, or by reason of accepted principles or tests by nationally recognized organizations.

Approved agency: An established and recognized agency regularly engaged in conducting tests or furnishing inspection services, when such agency has been approved by the building official.

Balcony (exterior): An exterior floor system projecting from a structure and supported by that structure, with no additional independent supports.

Basement: That portion of a building which is partly or completely below grade (see "Story above grade").

Building: Building shall mean any one- and two-family dwelling or portion thereof, which is used, or designed or intended to be used for human habitation, for living, sleeping, cooking or eating purposes, or any combination thereof, and shall include structures accessory thereto.

Building, existing: Existing building is a building erected prior to the adoption of this code, or one for which a legal building permit has been issued.

Building official: Building official is the officer or other designated authority charged with the administration and enforcement of this code.

Ceiling height: Ceiling height shall be the clear vertical distance from the finished floor to the finished ceiling.

Court: Court is a space, open and unobstructed to the sky, located at or above grade level on a lot and bounded on three or more sides by walls or a building.

Deck: An exterior floor system supported on at least two opposing sides by an adjoining structure and/or posts, piers, or other independent supports.

Dwelling: Dwelling is any building which contains one or two "Dwelling Units" used, intended, or designed to be built, used, rented, leased, let or hired out to be occupied, or which are occupied for living purposes.

Dwelling unit: Dwelling unit is a single unit providing complete independent living facilities for one or more persons including permanent provisions for living, sleeping, eating, cooking and sanitation.

Family: Family is an individual, two or more persons related by blood, marriage or law, or a group of not more than any five persons living together in a dwelling unit. Servants having common housekeeping

facilities with a family consisting of an individual, or two or more persons related by blood, marriage or law, are a part of the family for this code.

Grade: The finished ground level adjoining the building at all exterior walls.

Grade floor window: A window located such that the sill height of the window is not more than 44 inches above or below the finished grade adjacent to the window.

Greenhouse: An enclosed detached accessory structure consisting primarily of light-transmitting materials and used exclusively for growing plants.

Guardrail system: A system of building components located near open sides of elevated walking surfaces.

Habitable room: Habitable room shall mean any room meeting the requirements of this code for sleeping, living, cooking or dining purposes, excluding such enclosed places as closets, pantries, bath or toilet rooms, hallways, laundries, storage spaces, utility rooms and similar spaces.

Handrail: A horizontal or sloping rail grasped for guidance or support.

Hollow masonry: Load-bearing or nonload-bearing construction using masonry units where the net cross-sectional area of each unit in any plane parallel to the bearing surface is less than 75 percent of its gross cross-sectional area. Hollow masonry units shall conform to ASTM C90, C129 or C652 listed in Section S-26.115.

Hot water: Hot water means water at a temperature of not less than 120 degrees F.

Kitchen: Kitchen shall mean an area used, or designated to be used, for the preparation of food.

Listed and listing: Terms referring to equipment which is shown in a list published by an approved testing agency qualified and equipped for experimental testing and maintaining an adequate periodic inspection of current productions and whose listing states that the equipment complies with nationally recognized standards.

Loads, live and dead: Dead loads are the weight of the walls, partitions, framing, floors, ceilings, roofs and all other permanent stationary construction entering into and becoming a part of the building. Live loads are all loads except dead and lateral loads.

Manufactured home: Manufactured home means a structure, transportable in one or more sections, which in the traveling mode is 8 body feet or more in width or 40 body feet or more in length, or, when erected on site, is 320 or more square feet, and which is built on a permanent chassis and designed to be used as a dwelling with or without a permanent foundation when connected to the required utilities, and includes the plumbing, heating, air-conditioning and electrical systems contained therein; except that such term shall include any structure which meets all the requirements of this paragraph except the size requirements and with respect to which the manufacturer voluntarily files a certification

required by the secretary (HUD) and complies with the standards established under this title. For mobile homes built prior to June 15, 1976, a label certifying compliance to the Standard for Mobile Homes, NFiPA 501, ANSI 119.1, in effect at the time of manufacture is required. For the purpose of these provisions, a mobile home shall be considered a manufactured home.

Occupied space: The total area of all buildings or structures on any lot or parcel of ground projected on a horizontal plane, excluding permitted projections as allowed by this code.

Solid masonry: Load-bearing or nonload-bearing construction using masonry units where the net cross-sectional area of each unit in any plane parallel to the bearing surface is not less than 75 percent of its gross cross-sectional area. Solid masonry units shall conform to ASTM C55, C62, C73, C145, or C216 listed in Section S-26.115.

Stack bond: The placement of masonry units such that head joints in successive courses are horizontally offset at less than one-fourth the unit length.

Story: Story is that portion of a building included between the upper surface of any floor and the upper surface of the floor next above, except that the topmost story shall be that habitable portion of a building included between the upper surface of the topmost floor and ceiling or roof above.

Story above grade: Any story having its finished floor surface entirely above grade except that a basement shall be considered as a story above grade when the finished surface of the floor above the basement is:

1. More than 6 feet above grade;
2. More than 6 feet above the finished ground level for more than 50 percent of the total building perimeter; or
3. More than 12 feet above the finished ground level at any point.

Townhouse: Townhouse is a single-family dwelling unit constructed in a row of attached units separated by property lines and with open space on at least two sides.

Window: Window shall mean a glazed opening, including portions of glazed doors.

Yard: Yard is an open, unoccupied space, other than a court, unobstructed from the ground to the sky, except where specifically provided by this code, on the lot on which a building is situated.

Chapter 2
BUILDING PLANNING

SECTION R-201—DESIGN CRITERIA

R-201.1 Design: Buildings and structures, and all parts thereof, shall be designed and constructed to support safely all loads, including dead loads, without exceeding the allowable stresses (or ultimate strengths when appropriate load factors are applied) for the materials of construction in the structural members and connections.

R-201.2 Climatic criteria: Buildings shall be constructed in accordance with the provisions of this code using the design criteria set forth in Table No. R-201.2. These criteria shall be established by the jurisdiction based solely or in part on the climatic and geographic conditions set forth in Appendix A.

Table No. R-201.2

CLIMATIC AND GEOGRAPHIC DESIGN CRITERIA

ROOF LIVE LOAD[1] (Lbs. per Sq. Ft.)	ROOF SNOW LOAD[1] (Lbs. per Sq. Ft.)	WIND PRESSURE[4] (Lbs. per Sq. Ft.)	SEISMIC CONDITION BY ZONE	SUBJECT TO DAMAGE FROM[2]		SUBJECT TO DAMAGE FROM[3]		WINTER DESIGN[5] TEMP. FOR HTG. FACILITIES
				Weathering	Frost Line Depth	Termite	Decay	

[1]Roof live and snow loads are not additive.

[2]Weathering may require a higher strength concrete or grade of masonry than necessary to satisfy structural requirements of this code. The weathering column shall be filled in with the weathering index (i.e., "negligible," "moderate," or "severe") for concrete as determined from the Weathering Probability Map in Appendix A. The grade of masonry units shall be determined from ASTM C34, C55, C62, C73, C90, C129, C145, C216, or C652 listed in Section S-26.201. The frost line depth may require deeper footings than indicated in Figure No. R-303. The jurisdiction shall fill in the frost line depth column with "yes" or "no" including minimum depth of footing below finish grade.

[3]The jurisdiction shall fill in this part of the table with "yes" or "no" depending on whether there has been a history of local damage.

[4]The jurisdiction shall fill in this portion of the table with wind design loads determined from the Wind Probability Map in Appendix A, or ASCE 7 listed in Section S-26.201.

[5]If heating facilities are not required in this climate enter "None Required."

R-201.3 Dead load: In estimating the dead load for the purposes of structural design, the actual weights of materials and construction shall be used with consideration for the dead load of fixed service equipment.

R-201.4 Live load: The minimum uniformly distributed live load shall be as provided in Table No. R-201.4. Elevated garage floors shall be capable of supporting a 2000 pound load applied over a 20 square inch area.

R-201.5 Partition load: Interior walls and partitions shall be designed to resist a minimum lateral load of 5 psf.

Table No. R-201.4
MINIMUM UNIFORMLY DISTRIBUTED LIVE LOADS

USE	LIVE LOAD
Balconies (exterior)	60
Decks	40
Fire escapes	40
Garages (passenger cars only)	50
Attics (no storage with roof slope not steeper than 3 in 12)	10
Attics (limited attic storage)	20
Dwelling units (except sleeping rooms)	40
Sleeping rooms	30
Stairs	40

R-201.6 Deflection: The allowable deflection of any structural member under the approved live load listed in Sections R-201.4 and R-201.5 shall not exceed the values in Table No. R-201.6.

Table No. R-201.6
ALLOWABLE DEFLECTION OF STRUCTURAL MEMBERS

STRUCTURAL MEMBER	ALLOWABLE DEFLECTION
Rafters having slopes >3/12 with no ceiling load	L/180
Interior Walls and Partitions	L**/180
Floors and plastered Ceilings	L/360
All Other Structural Members	L/240

Notes:
L = span length
L** = vertical span

SECTION R-202—LOCATION ON LOT

R-202.1 Exterior walls: Exterior walls located less than 3 feet from property lines shall have not less than a 1-hour fire-resistive rating. The fire-resistive rating of exterior walls located less than 3 feet from property line shall be rated for exposure from both sides.

R-202.2 Openings: Openings shall not be permitted in exterior walls of dwellings located less than 3 feet from the property line.

SECTION R-203—LIGHT, VENTILATION AND HEATING

R-203.1 Habitable rooms: All habitable rooms shall be provided with aggregate glazing area of not less than 8 percent of the floor area of such rooms. One-half of the required area of glazing shall be openable.

Exceptions:

1. The glazed areas need not be openable where an approved mechanical ventilation system is provided capable of producing a change of air every 30 minutes and the opening is not required by Section R-210.
2. The glazed areas may be omitted in rooms where an approved mechanical ventilation system is provided capable of producing a change of air every 30 minutes, artificial light is provided capable of producing an average illumination of 6 footcandles over the area of the room at a height of 30 inches above the floor level, and the opening is not required by Section R-210.

R-203.2 Alcove rooms: When alcove rooms open without obstruction into adjoining rooms, the required window openings to the outer air shall be based on the combined floor area of room and alcove. For purpose of determining light and ventilation requirements, any room may be considered as a portion of an adjoining room when at least one-half of the area of the common wall is open and unobstructed and provides an opening of not less than one-tenth of the floor area of the interior room but not less than 25 square feet.

R-203.3 Bathrooms: Bathrooms, water closet compartments and other similar rooms shall be provided with aggregate glazing area in windows of not less than 3 square feet, one-half of which must be openable.

Exception: The glazed areas shall not be required where artificial light and an approved mechanical ventilation system capable of producing a change of air every 12 minutes are provided. Bathroom exhausts shall be vented directly to the outside.

R-203.4 Required glazed openings: Required glazed openings shall open directly onto a street or public alley, or a yard or court located on the same lot as the building.

Required glazed openings may face into a roofed porch where the porch abuts a street, yard or court and the longer side of the porch is at least 65 percent open and unobstructed and the ceiling height is not less than 7 feet.

R-203.5 Required Heating: When required by Table No. R-201.2, every dwelling unit shall be provided with heating facilities capable of maintaining a room temperature of 68° F at a point 3 ft above the floor at the design temperature in all habitable rooms.

SECTION R-204—ROOM SIZES

Every dwelling unit shall have at least one habitable room which shall have not less than 150 square feet of floor area. Other habitable rooms shall have an area of not less than 70 square feet. Every kitchen shall have

not less than 50 square feet of floor area.

Habitable rooms, except kitchens, shall be not less than 7 feet in any horizontal dimension.

SECTION R-205—CEILING HEIGHT

Habitable rooms, except kitchens, shall have a ceiling height of not less than 7 feet 6 inches for at least 50 percent of their required areas. Not more than 50 percent of the required area may have a sloped ceiling less than 7 feet 6 inches in height with no portion of the required areas less than 5 feet in height. If any room has a furred ceiling, the prescribed ceiling height is required for at least 50 percent of the area thereof, but in no case shall the height of the furred ceiling be less than 7 feet.

Portions of a room with a sloping ceiling measuring less than 5 feet 0 inches or a furred ceiling measuring less than 7 feet 0 inches from the finished floor to the finished ceiling shall not be considered as contributing to the minimum required habitable area for that room.

Exceptions

1. Beams and girders spaced not less than 4 feet on center may project not more than 6 inches below the required ceiling height.
2. All other rooms including kitchens, baths and hallways may have a ceiling height of not less than 7 feet measured to the lowest projection from the ceiling.
3. Ceiling height in basements without habitable spaces may be not less than 6 feet 8 inches clear except for under beams, girders, ducts or other obstructions where the clear height shall be 6 feet 4 inches.

SECTION R-206—SANITATION

Every dwelling unit shall be provided with a water closet, lavatory and a bathtub or shower.

Each dwelling unit shall be provided with a kitchen area and every kitchen area shall be provided with a sink of approved nonabsorbent material.

All plumbing fixtures shall be connected to a sanitary sewer or to an approved private sewage disposal system. All plumbing fixtures shall be connected to an approved system of water supply and provided with hot and cold running water, except water closets may be provided with cold water only.

SECTION R-207—TOILET, BATH AND SHOWER SPACES

R-207.1 Privacy required: Every water closet, bathtub or shower required by this code shall be installed in a room which will afford privacy to the occupant.

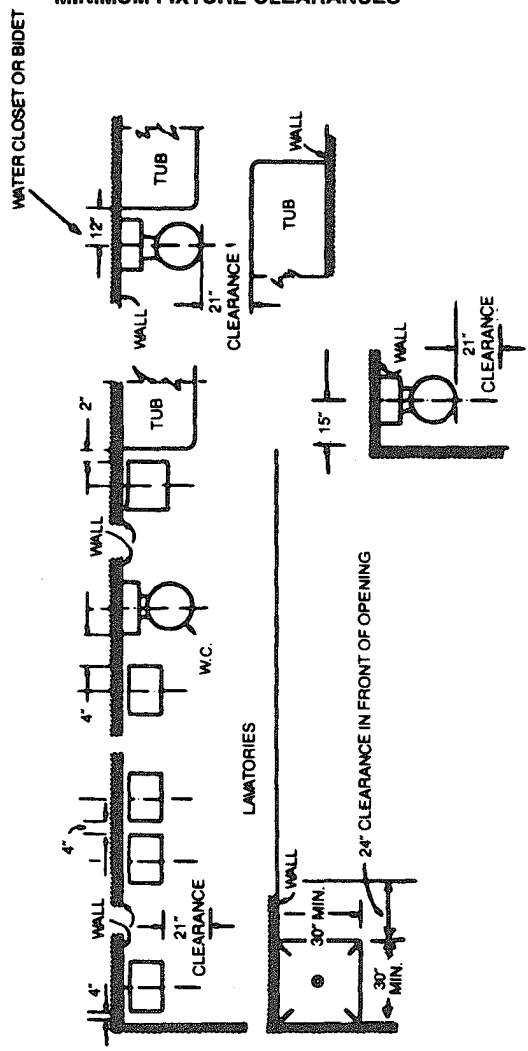
R-207.2 Space required: Fixtures shall be spaced as per Figure No. R-207.2.

SECTION R-208—GLAZING

R-208.1 Labeling: Each light shall bear the manufacturer's label designating the type and thickness of glass. Labels may be omitted from other than safety glazing materials unless specifically required by the building official.

To qualify as glass with special performance characteristics, each unit of laminated, heat-strengthened, tempered glass shall be permanently identified by the manufacturer. The identification of tempered glass shall be etched or ceramic fired on the glass and be visible when the unit is glazed. Heat-strengthened and tempered spandrel glasses are exempted from permanent labeling. This type of glass shall be labeled with a removable paper label by the manufacturer.

Figure No. R-207.2
MINIMUM FIXTURE CLEARANCES



R-208.2 Louvered windows or jalousies: Regular, float, wired or patterned glass in jalousies and louvered windows shall be no thinner than nominal 3/16 inch and no longer than 48 inches. When other glass types are used, design shall be submitted to the building official for approval. Exposed glass edges shall be smooth.

Wired glass with wire exposed on longitudinal edges shall not be used in jalousies or louvered windows.

R-208.3 Human impact loads: Individual glazed areas in hazardous locations such as those indicated in Section R-208.4 shall pass the test requirements of CPSC 16-CFR, Part 1201 listed in Section S-26.208, or by comparative test shall be proven to produce at least equivalent performances.

Exceptions

1. Polished wire glass for use in fire doors, fire windows and view panels in 1-hour fire-resistive walls shall comply with ANSIZ97.1 listed in Section S-26.208.
2. The unbacked specimens of plastic materials shall be exposed in Arizona and Florida to 45 degrees facing south for three years. Approved plastic materials shall be acceptable if the impact strength is not reduced by more than 25 percent during exposure when tested in accordance with Section 1201.4 (c) (2) (ii) of the CPSC standard, referenced in this section. Some discoloration is permissible, but defects other than this discoloration shall not be permissible. No bubbles or other noticeable decomposition shall be permissible in the irradiated portion.

R-208.4 Hazardous locations: The following shall be considered specific hazardous locations for the purposes of glazing:

1. Glazing in ingress and means of egress doors except jalousies.
2. Glazing in fixed and sliding panels of sliding (patio) door assemblies and panels in swinging doors.
3. Glazing in storm doors.
4. Glazing in all unframed swinging doors.
5. Glazing in doors and enclosures for hot tubs, whirlpools, saunas, steam rooms, bathtubs and showers. Glazing in any part of a building wall enclosing these compartments where the bottom edge of the glazing is less than 60 inches above the drain inlet.
6. Glazing, in an individual fixed or operable panel adjacent to a door where the nearest vertical edge is within a 24 inch arc of the door in a closed position and whose bottom edge is less than 60 inches above the floor or walking surface.
7. Glazing in an individual fixed or operable panel, other than those locations described in items 5 and 6 above, that meets all of the following conditions:
   1. Exposed area of an individual pane greater than 9 sq ft.
   2. Bottom edge less than 18 inches above the floor.
   3. Top edge greater than 36 inches above the floor.

4. One or more walking surfaces within 36 inches horizontally of the glazing.

8. All glazing in railings regardless of an area or height above a walking surface. Included are structural baluster panels and nonstructural in-fill panels.

Exceptions: The following products, materials and uses are exempt from the above hazardous locations:

1. Openings in doors through which a 3-inch sphere is unable to pass.
2. Leaded glass panels.
3. Faceted and decorative glass.
4. Glazing in Section R-208.4 item 6 when there is an intervening wall or other permanent barrier between the door and the glazing.
5. Glazing in Section R-208.4 item 7 when a protective bar is installed on the accessible side(s) of the glazing 36 inches ± 2 inches above the floor. The bar shall be capable of withstanding a horizontal load of 50 lbs per linear ft without contacting the glass and be a minimum of 1-1/2 inches in height.
6. Outboard panes in insulating glass units and other multiple glazed panels in Section R-208.4 item 7 when the bottom edge of the glass is 25 ft or more above grade, a roof, walking surface, or other horizontal (within 45° of horizontal) surface adjacent to the glass exterior.
7. Louvered windows and jalousies complying with the requirements of Section R-208.2.

R-208.5 Wind loads: Safety glass or glass areas in exterior walls in screens, in partitions and in other openings subject to wind loading shall be capable of safely withstanding the wind loads as shown in Section R-201 acting either inward or outward. In the case of regular plate, float or sheet glass supported on four sides, the design shall be not less than 2 1/2. Adjustment factors for other types of glass are given in Table No. R-208.5.

Table No. R-208.5

RELATIVE RESISTANCE TO WIND LOAD
(Assuming equal thickness)

GLASS TYPE	APPROXIMATE RELATIONSHIP*
Laminated	0.6
Wired Glass	0.5
Heat-strengthened	2.0
Tempered	4.0
Sealed Insulated Glass**	1.5
Rough-rolled Plate	1.0
Sandblasted	0.4
Regular Plate or Sheet	1.0

*Before using Wind Load Chart (Figure No. R-208.5), divide the design wind load from Section R-201 by the value shown for the glass type involved.

**Use thickness of the thinner of the two lights, not thickness of unit.

SECTION R-209—ATTACHED GARAGES

R-209.1 Opening protection: Openings from a private garage directly into a room used for sleeping purposes shall not be permitted. Other openings between the garage and residence shall be equipped with either solid wood doors not less than 1 3/8 inch in thickness or 20-minute fire-rated doors, or equivalent.

R-209.2 Separation required: The garage shall be completely separated from the residence and its attic area by means of 1/2-inch gypsum board or equivalent applied to the garage side.

R-209.3 Floor surface: Garage and carport floor surfaces shall be of approved noncombustible material. That area of floor used for parking of automobiles or other vehicles shall be sloped to facilitate the movement of liquids toward the main vehicle entry doorway. Where approved by the building official, other means of dispersing spilled liquids from the area may be used to prevent the flow of liquids through doorways into adjoining enclosed areas of the dwelling.

SECTION R-210—EXITS

R-210.1 Exit required: Not less than one exit conforming to this chapter shall be provided from each dwelling unit.

R-210.2 Emergency egress openings: Every sleeping room shall have at least one operable window or exterior door approved for emergency egress or rescue. The units must be operable from the inside to a full clear opening without the use of separate tools. Where windows are provided as a means of egress or rescue they shall have a sill height of not more than 44 inches above the floor

All egress or rescue windows from sleeping rooms must have a minimum net clear opening of 5.7 square feet. The minimum net clear opening height dimension shall be 24 inches. The minimum net clear opening width dimension shall be 20 inches.

Exception: Grade floor window may have a minimum net clear opening of 5 square feet.

R-210.3 Under stair protection: Enclosed accessible space under stairs shall have walls and soffits protected on the enclosed side with 1/2 inch gypsum board.

SECTION R-211—DOORS AND HALLWAYS

The required exit door shall be a side-hinged door not less than 3 feet in width and 6 feet 8 inches in height. Other exterior hinged or sliding doors shall not be required to comply with these minimum dimensions. The minimum width of a hallway or exit access shall be not less than 3 feet.

SECTION R-212—LANDINGS

A minimum 3-foot by 3-foot landing shall be required on each side of an egress door.

Exception: At the top of an interior flight of stairs, provided the door does not swing over the stairs.

The floor or landing shall not be more than 1 1/2 inches lower than the top of the threshold.

Exception: The landing at the exterior of an exterior doorway shall not be more than 8 1/2 inches below the top of the threshold.

SECTION R-213—STAIRWAYS

R-213.1 General: When risers are closed, all treads may have a uniform projection not to exceed 1 1/2 inches.

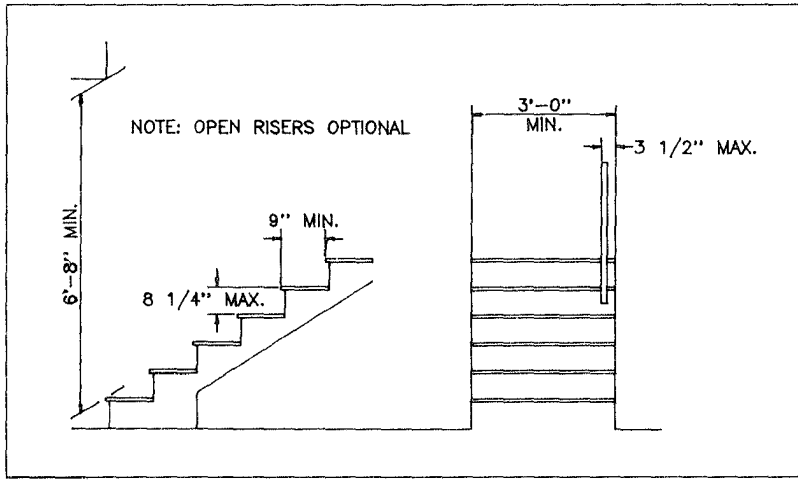
The greatest riser height within any flight of stairs shall not exceed the smallest by more than 3/8 inch. The greatest tread run within any flight of stairs shall not exceed the smallest by more than 3/8 inch.

Stairways shall not be less than 3 feet in clear width, and the headroom, rise and run shall conform to Figure No. R-213.1. Handrails may project from each side of a stairway a distance of 3 1/2 inches into the required width.

R-213.2 Winders: Winders are permitted, provided the width of the tread at a point not more than 12 inches from the side where the treads are narrower is not less than 9 inches, the minimum width of any tread is not less than 6 inches, and the average width of any tread is not less than 9 inches.

R-213.3 Spiral stairs: Spiral stairways are permitted, provided the minimum width shall be 26 inches with each tread having a 7 1/2-inch minimum tread width at 12 inches from the narrow edge. All treads shall be identical, and the rise shall be no more than 9 1/2 inches. A minimum headroom of 6 feet 6 inches shall be provided.

Figure No. R-213.1
STAIRWAYS



SECTION R-214—HANDRAILS AND GUARDRAILS

R-214.1 Handrails: Handrails having minimum and maximum heights of 30 inches and 38 inches, respectively, measured vertically from the nosing of the treads, shall be provided on at least one side of stairways of three or more risers. Spiral stairways and winders shall have the required handrail located on the outside radius. All required handrails shall be continuous the full length of the stairs. Ends shall be returned or shall terminate in newel posts or safety terminals.

The handgrip portion of the handrails shall not be more than 2 5/8 inches in cross-sectional dimension, or the shape shall provide an equivalent gripping surface. The handgrip portion of handrails shall have a smooth surface with no sharp corners.

Handrails projecting from a wall shall have a space of not less than 1 1/2 inches between the wall and the handrail.

R-214.2 Guardrails: Porches, balconies or raised floor surfaces located more than 30 inches above the floor or grade below shall have guardrails not less than 36 inches in height.

Open sides of stairs with a total rise of more than 30 inches above the floor or grade below shall have guardrails not less than 34 inches in height measured vertically from the nosing of the treads.

Required guardrails on open sides of stairways, raised floor areas, balconies and porches shall have intermediate rails or ornamental closures which will not allow passage of an object 6 inches or more in diameter. Horizontal spacing between the vertical members in required guardrails shall be a maximum of 4 inches at the nearest point between the members.

Exception: The triangular openings formed by the riser, tread and bottom rail of a guard at the open side of a stairway may be of such a size that a sphere 6 inches in diameter cannot pass through.

SECTION R-215—SMOKE DETECTORS

R-215.1 Smoke detectors required: Smoke detectors shall be installed outside of each separate sleeping area in the immediate vicinity of the bedrooms and on each additional story of the dwelling, including basements and cellars but not including crawl spaces and uninhabitable attics. In dwellings or dwelling units with split levels, a smoke detector need be installed only on the upper level, provided the lower level is less than one full story below the upper level, except that if there is a door between levels then a detector is required on each level. All detectors shall be interconnected such that the actuation of one alarm will actuate all the alarms in the individual unit and shall provide an alarm which will be audible in all sleeping areas. All detectors shall be approved and listed and shall be installed in accordance with the manufacturer's instructions.

When alterations, repairs or additions requiring a permit occur, or when one or more sleeping rooms are added or created in existing dwellings, the entire building shall be provided with smoke detectors located as required

for new dwellings; the smoke detectors are not required to be interconnected unless other remodeling considerations require removal of the appropriate wall and ceiling coverings to facilitate concealed interconnected wiring.

R-215.2 Power source: Required smoke detectors shall receive their primary power from the building wiring when such wiring is served from a commercial source, and when primary power is interrupted, shall receive power from a battery. Wiring shall be permanent and without a disconnecting switch other than those required for overcurrent protection. Smoke detectors may be battery operated when installed in buildings without commercial power.

SECTION R-216—FOAM PLASTIC

R-216.1 General: The provisions of this section shall govern the requirements and uses of foam plastic insulation.

Except where otherwise noted in Section R-216.2, all foam plastic or foam plastic cores in manufactured assemblies used in building construction shall have a flame-spread rating of not more than 75 and shall have a smoke-developed rating of not more than 450 when tested in the maximum thickness intended for use in accordance with ASTM E84 listed in Section S-26.216.

Foam plastic, except where otherwise noted, shall be separated from the interior of a building by an approved thermal barrier of 1/2-inch gypsum wallboard or equivalent thermal barrier material which will limit the average temperature rise of the unexposed surface to not more than 250 degrees F. after 15 minutes of fire exposure complying with the standard time-temperature curve of ASTM E119 listed in Section S-26.216. This equivalence may be determined through the use of the "Small-Scale Horizontal Exposure Furnace."

The thermal barrier shall be installed in such a manner that it will remain in place for the duration of the particular test used, the procedures outlined in either UL 1715, FM 4880, or UL 1040 listed in Section S-26.216, and meet the acceptance criteria thereof.

R-216.2 Specific requirements: The following requirements shall apply to all uses of foam plastic unless specifically approved in accordance with Section R-216.3 or by other sections of the code.

R-216.2.1 Masonry or concrete construction: Foam plastics may be used without the thermal barrier described in Section R-216.1 when the foam plastic is protected by a minimum 1-inch thickness of masonry or concrete.

R-216.2.2 Roofing: Foam plastic may be used in a roof-covering assembly without the thermal barrier when the foam is separated from the interior of the building by plywood sheathing not less than 15/32 inch in thickness bonded with exterior glue, with edge supported by blocking, tongue-and-groove joints or other approved type of edge support, or an equivalent material. Foam plastic roof insulation which complies with FM

4450 or UL 1256, listed in Section S-26.216, need not meet the requirements of Section R-216.1 for all roof applications. The smoke-developed rating shall not be limited.

R-216.2.3 Attics and crawl spaces: Within an attic or crawl space where entry is made only for service of utilities, foam plastics shall be protected against ignition by 1 1/2-inch-thick mineral fiber insulation, 1/4-inch-thick plywood, 3/8-inch particleboard, 1/4-inch hardboard, or 3/8-inch gypsum wallboard, corrosion-resistant steel having a base metal thickness of 0.016 inch, or other approved material installed in such a manner that the foam plastic is not exposed. The protective covering shall be consistent with the requirements for the type of construction.

R-216.2.4 Foam-filled doors: Foam-filled doors are exempt from the requirements of Section R-216.1.

R-216.2.5 Siding backer board: Foam plastic board of not more than 1/2-inch thickness may be used as siding backer board when separated from interior spaces by not less than 2 inches of mineral fiber insulation or equivalent barrier against ignition of the plastic board from an interior source, or installed over existing exterior wall finish in conjunction with re-siding, providing the plastic board does not have a potential heat of more than 2,000 Btu per square foot when tested in accordance with NFiPA 259, listed in Section S-26.216.

R-216.2.6 Interior trim: Foam plastic trim defined as picture molds, chair rails, baseboards, handrails, ceiling beams, door trim and window trim may be installed, provided:

1. The minimum density is 20 pounds per cubic foot,
2. The maximum thickness of the trim is 1/2 inch and the maximum width is 4 inches,
3. The trim constitutes no more than 10 percent of the area of any wall or ceiling, and
4. The flame-spread rating does not exceed 75 when tested per ASTM E84 listed in Section S-26.216. The smoke-developed rating is not limited.

R-216.3 Specific approval: Plastic foam not meeting the requirements of Sections R-216.1 and R-216.2 may be specifically approved on the basis of approved tests such as, but not limited to, a tunnel test in accordance with ASTM E84, FM 4880, UL 1040, ASTM E152, or UL 1715, listed in Section S-26.216, or fire tests related to actual end-use configurations. The specific approval may be based on the end use, quantity, location and similar considerations where such tests would not be applicable or practical.

Foam plastics which are used as interior finish shall also meet the flame-spread requirements for interior finish.

SECTION R-217—FLAME-SPREAD AND SMOKE DENSITY

R-217.1 Wall and ceiling: Wall and ceiling finishes shall have a flame-spread classification of not greater than 200.

Exception: Flame-spread requirements for finishes shall not apply to trim defined as picture molds, chair rails, baseboards and handrails; to

doors and windows or their frames; nor to materials which are less than 1/28 -inch in thickness cemented to the surface of walls or ceilings if these materials have a flame-spread characteristic no greater than paper of this thickness cemented to a noncombustible backing.

R-217.2 Insulation: All exposed insulation materials, including facings, such as vapor barriers or breather papers installed within the floor-ceiling assemblies, roof-ceiling assemblies, wall assemblies, crawl spaces or attics, shall have a flame-spread rating not to exceed 25.

Exception: When such materials are installed in concealed spaces, the flame-spread and smoke development limitations do not apply to the facings, provided that the facing is installed in substantial contact with the unexposed surface of the ceiling, floor or wall finish.

R-217.3 Smoke density: The smoke density shall be not greater than 450.

R-217.4 Testing: Tests shall be made in accordance with ASTM E84 listed in Section S-26.217.

SECTION R-218—DWELLING UNIT SEPARATION

R-218.1 Two-family dwellings: Dwelling units in two-family dwellings shall be separated from each other by wall and/or floor assemblies of not less than 1-hour fire-resistive rating when tested in accordance with ASTM E119 listed in Section S-26.218. Fire-resistive-rated floor-ceiling and wall assemblies shall extend to and be tight against the exterior wall, and wall assemblies shall extend to the underside of the roof sheathing.

R-218.2 Townhouses: Each townhouse shall be considered a separate building and separated by separate walls meeting the requirements of Section R-202.

Exception: A common 2-hour fire-resistive wall is permitted for townhouses if such walls do not contain plumbing or mechanical equipment, ducts or vents in the cavity of the common wall. Electrical installations are limited to electrical wire installed in raceways and electrical outlet boxes.

Metallic electrical outlet boxes shall not exceed 16 square inches in surface area. The aggregate surface area of the boxes shall not exceed 100 square inches for any 100 square feet of wall area. Metallic outlet boxes on opposite sides of walls shall be separated by a minimum distance of 24 inches.

Metallic electrical outlet boxes shall be installed in accordance with their listings.

R-218.2.1 Continuity: The common wall for townhouses shall be continuous from the foundation to the underside of the roof sheathing, deck or slab and shall extend the full length of the common wall.

R-218.2.2 Parapets: Parapets shall be provided for townhouses as an extension of the common wall in accordance with the following:

1. Where roof surfaces adjacent to the wall are at the same elevation,

the parapet shall extend not less than 30 inches above the roof surfaces.

2. Where roof surfaces adjacent to the wall are at different elevations and the higher roof is not more than 30 inches above the lower roof, the parapet shall extend not less than 30 inches above the lower roof surface.

   Exception: A parapet is not required in the two cases above when the roof is covered with a minimum Class C roof covering, and the roof decking or sheathing is of noncombustible materials or approved fire-retardant-treated wood for a distance of 4 feet on each side of the wall, or one layer of 5/8-inch Type X gypsum board is attached to the underside of the roof decking or sheathing for a distance of 4 feet on each side of the wall.

3. A parapet is not required where roof surfaces adjacent to the wall are at different elevations and the higher roof is more than 30 inches above the lower roof. The wall construction from the lower roof to the underside of the higher roof deck shall have not less than a 1-hour fire-resistive rating. The fire-resistive rating shall be rated for exposure from both sides.

R-218.2.3 Structural independence: Each individual townhouse shall be structurally independent.

Exceptions:

1. Foundations supporting common walls.
2. Nonstructural wall coverings.
3. Flashing at termination of roof covering over common wall.
4. The lower unit of a two-story duplex may structurally support the upper unit.

R-218.3 Sound transmission: Wall and floor-ceiling assemblies separating dwelling units shall provide airborne sound insulation for walls and both airborne and impact sound insulation for floor-ceiling assemblies.

Airborne sound insulation for wall and floor-ceiling assemblies shall meet a Sound Transmission Class (STC) of 45 when tested in accordance with ASTM E90 listed in Section S-26.218.

Penetrations or openings in the assembly for pipes or ventilation or exhaust ducts shall be sealed, lined, insulated or otherwise treated to maintain the required ratings.

Impact sound insulation for floor-ceiling assemblies shall meet an Impact Insulation Class (IIC) of 45 when tested in accordance with ASTM E492 listed in Section S-26.218. Floor covering may be included in the assembly to obtain the required rating.

SECTION R-219—RAMPS

All egress ramps shall have a maximum slope of 1 in 8.

Handrails shall be provided on at least one side of all ramps exceeding a 1 in 12 slope.

A minimum 3-foot by 3-foot landing shall be provided at the top and bottom of ramps where doors open onto the ramp and where the ramp changes direction.

SECTION R-220—MOISTURE VAPOR RETARDERS

In all frame walls and floors, and ceilings, not ventilated to allow moisture to escape, an approved vapor retarder having a maximum perm rating of 1.0, when tested in accordance with Procedure for Desiccant of Method ASTM E 96 listed in Section S-26.220 shall be used on the warm-in-winter side of the thermal insulation.

Exceptions:

1. In construction where moisture or its freezing will not damage the materials.
2. In hot and humid climate areas where either of the following conditions occur: 67°F or higher wet-bulb temperature for 3000 or more hours during the warmest six consecutive months of the year, or 73°F or higher wet-bulb temperature for 1500 or more hours during the warmest six consecutive months of the year.

Chapter 3
FOUNDATIONS

SECTION R-301—GENERAL

R-301.1 Applications: The provisions of this chapter shall control the design and construction of the foundation and foundation spaces for all buildings. Conformity to the specifications herein or the use of other materials or methods of construction accomplishing the purpose intended by this code and approved by the building official in accordance with Section R-108 shall be accepted as complying with this code.

R-301.2 Requirements: The foundation and its structural elements shall be capable of accommodating all superimposed live, dead and other loads according to Section R-201 and all lateral loads in accordance with the provisions of this code or accepted engineering design practice. Fills which support footings and foundations shall be designed, installed and tested in accordance with accepted engineering practice. Gravel fill used as footings for wood foundations shall comply with R-303.

R-301.3 Drainage: Lots shall be provided with adequate drainage and shall be graded so as to drain surface water away from foundation walls. The grade away from foundation walls shall fall a minimum of 6 inches within the first 10 feet, except as restricted by lot lines where the fall will be a minimum of 6 inches regardless of the horizontal distance available.

R-301.4 Soil tests: In areas likely to have expansive, compressible, shifting or other unknown soil characteristics, the building official may require a soil test to determine the soil's characteristics at a particular location. The building official may require that this determination be made by an approved agency using an approved method.

R-301.5 Expansive, compressible or shifting soil: When top or subsoils are expansive, compressible or shifting, such soils shall be removed to a depth and width sufficient to assure stable moisture content in each active zone and shall not be used as fill; or stabilized within each active zone by chemical, dewatering, presaturation or equivalent techniques when approved by the building official; or remain where footings, foundations and foundation slabs are designed in accordance with approved methods to prevent structural damage and excessive differential movement.

SECTION R-302—MATERIALS

R-302.1 Wood foundations: Wood foundation systems shall be designed and installed in accordance with NFoPA Technical Report No. 7 listed in Section S-26.302. All lumber and plywood shall be treated in accordance with AWPA C22 listed in Section S-26.302 and shall be identified as to conformance with such standard by an approved inspection agency.

R-302.2 Concrete: Concrete subject to weathering as indicated in Table No. R-201.2 shall have a minimum specified compressive strength and air content as shown in Table No. R-302.2. The minimum cement content of concrete mixtures for exterior porches, carport slabs, and steps that will be exposed to freezing and thawing in the presence of deicing chemicals shall be 520 lbs of cement meeting ASTM C150 or C595, per cu yd of concrete.

Table No. R-302.2
MINIMUM SPECIFIED COMPRESSIVE STRENGTH OF CONCRETE

TYPE OR LOCATIONS OF CONCRETE CONSTRUCTION	MINIMUM SPECIFIED COMPRESSIVE STRENGTH[1] (f'_c)		
	Weathering Potential[2]		
	Negligible	Moderate	Severe
Basement walls and foundations not exposed to the weather	2,500	2,500	2,500[3]
Basement slabs and interior slabs on grade, except garage floor slabs	2,500	2,500	2,500[3]
Basement walls and foundation walls, exterior walls, and other vertical concrete work exposed to the weather	2,500	3,000[4]	3,000[4]
Porches, carport slabs and steps exposed to the weather, and garage floor slabs	2,500	3,000[4,5]	3,000[4,5]

[1] At 28 days psi.

[2] See Table No. R-201.2 for weathering potential.

[3] Concrete in these locations which may be subject to freezing and thawing during construction shall be air-entrained concrete in accordance with Footnote 4.

[4] Concrete shall be air entrained. Total air content (percent by volume of concrete) shall be not less than 5 percent or more than 7 percent.

[5] See Section R-302.2 for minimum cement content.

SECTION R-303—FOOTINGS

All exterior walls, bearing walls, columns and piers shall be supported on continuous solid masonry or concrete footings, wood foundations, or other approved structural systems which shall be of sufficient design to support safely the loads imposed as determined from the character of the soil, and except when erected upon solid rock or otherwise protected from frost, shall extend below the frost line. Minimum sizes for concrete footings shall be as set forth in Figure No. R-303. Footings for wood foundations shall be in accordance with the details set forth in Figure Nos.

R-304.5a and R-304.5b and NFoPA Technical Report No. 7 listed in Section S-26.303.

The top surface of footings shall be level. The bottom surface of footings may have a slope not exceeding 1 in 10. Footings shall be stepped where it is necessary to change the elevation of the top surface of the footings or where the slope of the bottom surface of the footing will exceed 1 in 10.

Structural slabs-on-ground and mat-type footings for dwellings located on expansive soils shall be designed and installed in accordance with PTI "Post-Tensioned Slabs-on-Ground" or WRI "Design of Slabs-on-Ground Foundations" listed in Section S-26.303, or in accordance with other approved methods.

SECTION R-304—FOUNDATION WALLS

R-304.1 Concrete and masonry: Foundation walls shall be constructed in accordance with the provisions of this section with footings as shown in Figure No. R-303 and in accordance with ACI 318, ACI 318.1, BIA "Building Code Requirements for Engineered Brick Masonry," or NCMA TR68-A, or ACI/ASCE 530 except Appendix A, listed in Section S-26.304 or other approved structural systems.

Exception: When ACI/ASCE 530 is used to design masonry foundation walls, project drawings, typical details and specifications are not required to bear the seal of the architect or engineer responsible for design.

R-304.2 Backfill damage: Foundation walls shall extend at least 8 inches above the finished grade adjacent to the foundation at all points.

Exception: Where masonry veneer is used, foundation walls shall extend a minimum of 4 inches above the finished grade.

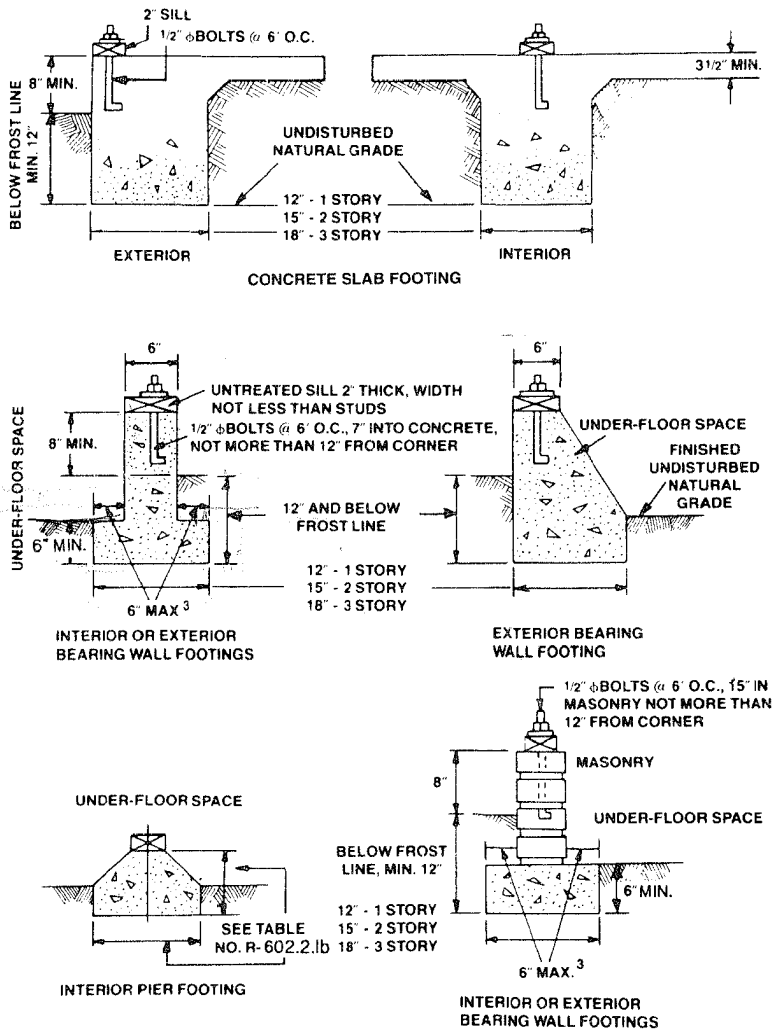
Backfill adjacent to the wall shall not be placed until the wall has sufficient strength or has been sufficiently braced to prevent damage by the backfill.

Foundation walls shall be drained and dampproofed in accordance with Section R-305 and Section R-306, respectively.

R-304.3 Masonry or concrete foundation: Masonry and concrete foundation walls shall be constructed using the following criteria:

1. Where unstable soil or groundwater conditions do not exist and when located in Seismic Zone 0, 1, or 2, as established in Table No. R-201.2, masonry or concrete foundation walls shall be constructed as set forth in Table No. R-304.3a.
2. Where unstable conditions exist when located in Seismic Zone 3 or 4, as established in Table No. R-201.2, foundation walls of masonry or concrete shall be constructed as set forth in Table No. R-304.3b.

Figure No. R-303
MINIMUM FOUNDATION REQUIREMENTS[1,2]



NOTES:

[1]Foundations shall extend not less than 12 inches below the finished natural grade or engineered fill and in no case less than the frost line depth.

[2]Footing sizes are based on soil with an allowable soil pressure of 2,000 pounds per square foot. Footings on soil with a lower allowable soil pressure shall be designed in accordance with accepted engineering practice.

[3]Footing projections shall not exceed the footing thickness.

Table No. R-304.3a

MINIMUM THICKNESS AND ALLOWABLE DEPTH OF UNBALANCED FILL FOR UNREINFORCED MASONRY AND CONCRETE FOUNDATION WALLS [1,4] WHERE UNSTABLE SOIL OR GROUND WATER CONDITIONS DO NOT EXIST IN SEISMIC ZONES NO. 0, 1 OR 2

FOUNDATION WALL CONSTRUCTION	NOMINAL THICKNESS,[3] INCHES	MAXIMUM DEPTH OF UNBALANCED FILL,[1] FEET
Masonry of Hollow Units, Ungrouted	8 10 12	4 5 6
Masonry of Solid Units	6 8 10 12	3 5 6 7
Masonry of Hollow or Solid Units, Fully Grouted	8 10 12	7 8 8
Plain Concrete	6[2] 8 10 12	6 7 8 8
Rubble Stone	Foundation wall of rubble stone shall be at least 16 inches thick. Rough or random rubble shall not be used as foundations for walls exceeding 35 feet in height.	
Masonry of hollow units reinforced vertically with #4 bars and grout at 24 inches on center. Bars located not less than 4 1/2 inches from pressure side of wall.	8	7

[1] Maximum depths of unbalanced fill may be increased with the approval of the building official when soil conditions warrant such increase. Unbalanced fill is the height of outside finish grade above the basement floor or inside grade.

[2] 6-inch plain concrete walls shall be formed on both sides.

[3] The actual thickness shall not be more than 1/2-inch less than the required nominal thickness specified in the table.

[4] The height between lateral supports shall not exceed 8 feet.

TABLE No. R-304.5
PLYWOOD GRADE AND THICKNESS FOR WOOD FOUNDATION CONSTRUCTION
(30 pcf equivalent-fluid weight soil pressure)

HEIGHT OF FILL (inches)	STUD SPACING (inches)	FACE GRAIN ACROSS STUDS[2]			FACE GRAIN PARALLEL TO STUDS		
		Grade[3]	Minimum Thickness[1]	Identification Index	Grade[3]	Minimum Thickness[1 4]	Identification Index
24	12	B	15/32	32/16	A B	15/32 15/32[5]	32/16 32/16
	16	B	15/32	32/16	A B	15/32[5] 19/32[5] (4, 5 ply)	32/16 40/20
36	12	B	15/32	32/16	A B B	15/32 15/32[5] (4, 5 ply) 19/32 (4, 5 ply)	32/16 32/16 40/20
	16	B	15/32[5]	32/16	A B	19/32 23/32	40/20 48/24
48	12	B	15/32	32/16	A B	15/32[5] 19/32[5] (4, 5 ply)	32/16 40/20
	16	B	19/32	40/20	A A	19/32[5] 23/32	40/20 48/24
60	12	B	15/32	32/16	A B B	19/32 19/32[5] (5 ply) 23/32	40/20 40/20 48/24
	16	B	19/32[5]	40/20	A	23/32[5]	48/24
72	12	B	15/32[5]	32/16	A B	19/32 23/32[5]	40/20 48/24
	16	B	23/32[5]	48/24	—	—	—
86	12	B	19/32	40/20	A A	19/32[5] 23/32	40/20 48/24
	16	B	23/32[5]	48/24	—	—	—

(Continued)

(Footnotes for Table No. R-304.5)

[1]Minimum thickness 15/32 inch, except crawl space sheathing may be 3/8 inch for face grain across studs 16 inches on center and maximum 2-foot depth of unequal fill.

[2]Minimum 2-inch blocking between studs required at all horizontal panel joints more than 4 feet below adjacent ground level.

[3]Plywood shall be of the following minimum grades in accordance with DOC PS 1 listed in Section S-26.304:

(i) DOC PS 1, Construction and Industrial Plywood, grades marked:

A. Structural I C-D

B. C-D (Exterior glue)

(ii) Performance-rated all-veneer plywood, grades marked:

A. Structural I

B. C-D (Exterior glue) which meet all DOC PS 1 requirements except thickness and which have been evaluated under approved performance specifications.

(iii) Where a major portion of the wall is exposed above ground and a better appearance is desired, the following DOC PS 1 Exterior grades are suitable:

A. Structural I A-C, Structural I B-C or Structural I C-C (Plugged)

B. A-C Exterior Group I, B-C Exterior Group I, C-C (Plugged) Exterior Group I or MDO Exterior Group I.

[4]When face grain is parallel to studs all veneer plywood panels of the required thickness, grade and identification index may be of any construction permitted under Article 3.2 of NFoPA Technical Report No. 7 listed in Section S-226.304 except as noted in the table for minimum number of plies required.

[5]For this fill height, thickness and grade combination, panels which are continuous over less stud spacings) require blocking 16 inches above the bottom plate. Offset adjacent blocks and fasten through corrosion-resistant nails at each end.

Figure No. R-304.5a
TYPICAL DETAILS FOR WOOD FOUNDATION BASEMENT WALLS

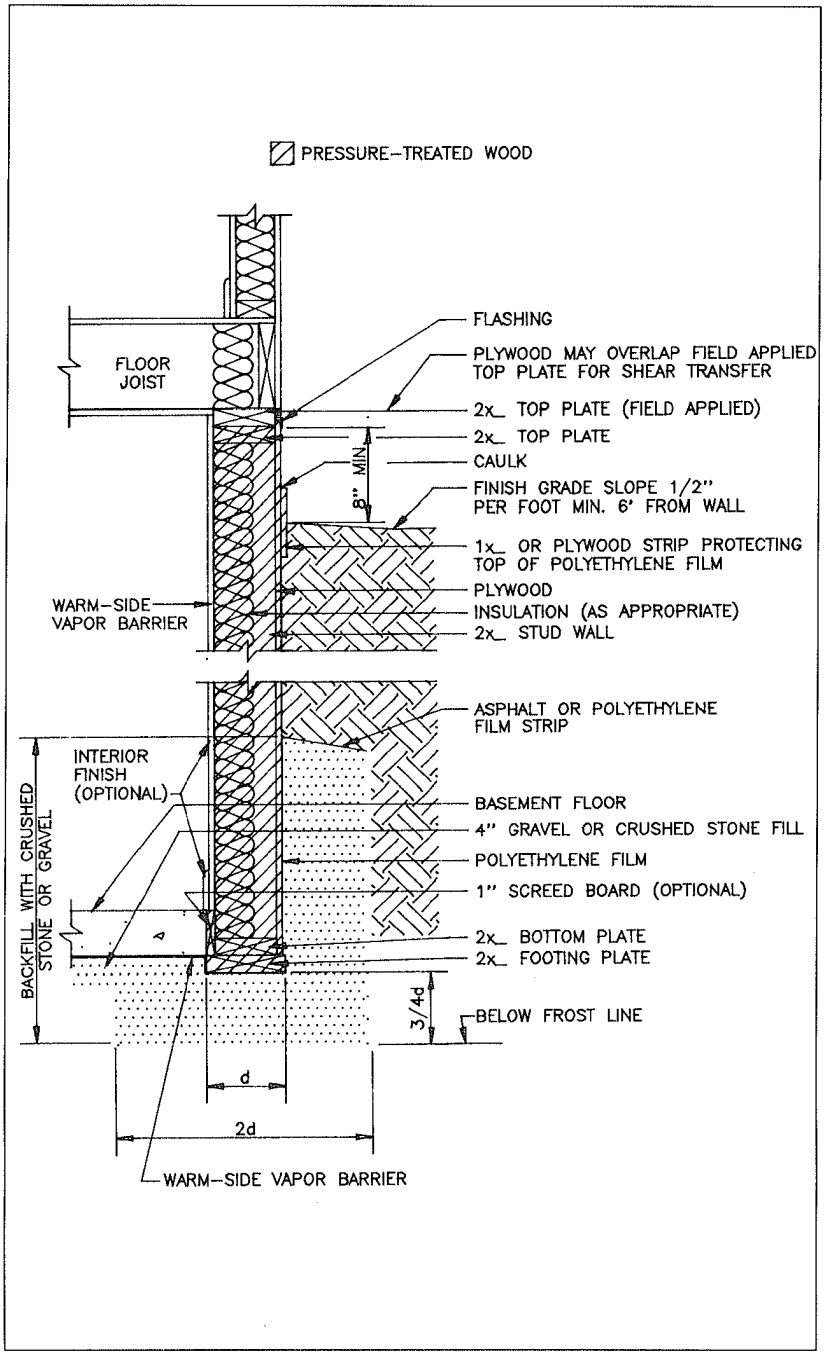
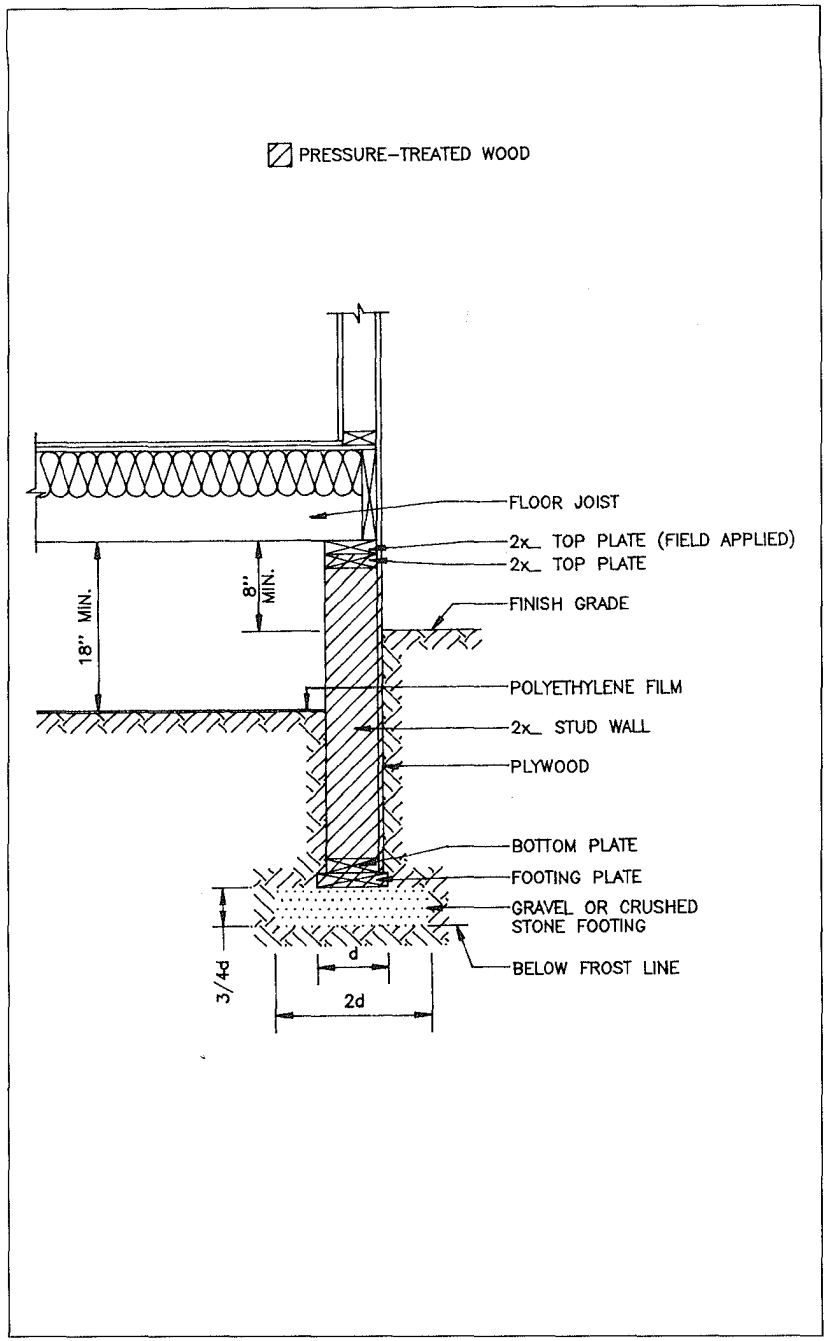


Figure No. R-304.5b
TYPICAL DETAILS FOR WOOD FOUNDATION CRAWL SPACE WALLS



SECTION R-305—FOUNDATION DRAINAGE

R-305.1 Concrete or masonry foundations: Drains shall be provided around all concrete or masonry foundations enclosing habitable or usable spaces located below grade. Drainage tiles, gravel or crushed stone drains, perforated pipe or other approved systems or materials shall be installed at or below the area to be protected and shall discharge by gravity or mechanical means into an approved drainage system. Gravel or crushed stone drains shall extend at least 1 foot beyond the outside edge of the footing and 6 inches above the top of the footing and be covered with an approved filter membrane material. The top of open joints of drain tiles shall be protected with strips of building paper, and the drainage tiles or perforated pipe shall be placed on a minimum of 2 inches of washed gravel or crushed rock at least one sieve size larger than the tile joint opening or perforation and covered with not less than 6 inches of the same material.

Exception: A drainage system is not required when the foundation is installed on well-drained ground or sand-gravel mixture soils according to the Unified Soil Classification System, Group I Soils.

R-305.2 Wood foundations: Wood foundations enclosing habitable or usable spaces located below grade shall be adequately drained in accordance with NFoPA Technical Report No. 7 listed in Section S-26.305 and the following provisions:

A porous layer of gravel, crushed stone or coarse sand shall be placed to a minimum thickness of 4 inches under the basement floor. Provision shall be made for automatic draining of this layer and the gravel or crushed stone wall footings.

A 6-mil-thick polyethylene moisture barrier shall be applied over the porous layer with the basement floor constructed over the polyethylene.

In other than Group I soils, a sump shall be provided to drain the porous layer and footings. The sump shall be at least 24 inches in diameter or 20 inches square, shall extend at least 24 inches below the bottom of the basement floor and shall be capable of positive gravity or mechanical drainage to remove any accumulated water. The drainage system shall discharge into an approved sewer system or to daylight.

SECTION R-306—FOUNDATION DAMPPROOFING

R-306.1 Dampproofing for concrete and masonry foundations: Exterior foundation walls of masonry construction enclosing basements shall be dampproofed by applying not less than 3/8 inch of portland cement parging to the wall from footing to finish grade. The parging shall be covered with a coat of approved bituminous material applied at the recommended rate. Exterior foundation walls of concrete construction enclosing basements shall be dampproofed by applying a coat of approved bituminous material to the wall from the footing to the finish grade at the recommended rate.

Foundation walls of habitable rooms located below grade shall be waterproofed with membranes extending from the edge of the footing to the finish grade line. The membrane shall consist of either 2-ply hot-mopped felts, 6-mil polyvinyl chloride, 55-pound roll roofing or equivalent material. The laps in the waterproofing membrane shall be sealed and firmly affixed to the wall.

Foundation walls may be dampproofed or waterproofed using materials or methods of construction other than covered in this section where approved by the building official.

R-306.2 Dampproofing for wood foundations: Wood foundations enclosing habitable or usable spaces located below grade shall be adequately dampproofed in accordance with NFoPA Technical Report No. 7 listed in Section S-26.306 and the following provisions:

Plywood panel joints in the foundation walls shall be sealed full length with a caulking compound capable of producing a moistureproof seal under the conditions of temperature and moisture content at which it will be applied and used.

A 6-mil-thick polyethylene film shall be applied over the below-grade portion of exterior foundation walls prior to backfilling. Joints in the polyethylene film shall be lapped 6 inches and sealed with adhesive. The top edge of the polyethylene film shall be bonded to the sheathing to form a seal. Film areas at grade level shall be protected from mechanical damage and exposure by a pressure preservatively treated lumber or plywood strip attached to the wall several inches above finish grade level and extending approximately 9 inches below grade. The joint between the strip and the wall shall be caulked full length prior to fastening the strip to the wall. Other coverings appropriate to the architectural treatment may also be used. The polyethylene film shall extend down to the bottom of the wood footing plate but shall not overlap or extend into the gravel or crushed stone footing.

The space between the excavation and the foundation wall shall be backfilled with the same material used for footings, up to a height of 1 foot above the footing for well-drained sites, or one-half the total backfill height for poorly drained sites. The porous fill shall be covered with strips of 30-pound asphalt paper or 6-mil polyethylene to permit water seepage while avoiding infiltration of fine soils.

The remainder of the excavated area shall be backfilled with the same type of soil as was removed during the excavation. As with all foundations, the backfill should be placed in 6- to 8-inch layers and tamped to consolidate the fill and remove voids where water might collect.

Final grading shall provide a downward slope away from the house along all foundation walls. The final grade shall provide a minimum slope of 1/2 inch per foot for a minimum of 6 feet from the house.

Alternate materials or methods for dampproofing below-grade habitable areas other than covered in this section may be approved by the building official.

SECTION R-307—FOUNDATION INSULATION

R-307.1 Protection of exposed foundation insulation: Foundation walls and the edges of slab-on-ground floors with exterior applied insulation shall have an approved protective covering to prevent the degradation of thermal performance from the effects of weathering, sunlight and physical abuse. The protective covering shall cover the exposed insulation and extend to a minimum of 6 inches below grade.

SECTION R-308—COLUMNS

R-308.1 Protection: Column bases shall be protected against decay or corrosion except when approved wood of natural decay resistance or approved pressure preservatively treated wood as set forth in Section R-309 is used.

Exception: Basement posts or columns supported by piers projecting 2 inches above the finish floor and separated therefrom by an approved impervious barrier.

All surfaces (inside and outside) of steel columns shall be given a shop coat of rust-inhibitive paint or the equivalent, except for corrosion-resistant steel and steel treated with coatings to provide corrosion resistance.

R-308.2 Structural requirements: The columns shall be adequately anchored to prevent lateral displacement. Wood columns shall be not less in nominal size than 4 inches by 4 inches and steel columns shall be not less than 3-inch-diameter standard pipe or approved equivalent.

SECTION R-309—PROTECTION AGAINST DECAY

R-309.1 Location required: In areas subject to termite or decay damage as established by Table No. R-201.2, the following locations shall require the use of an approved species and grade of lumber, pressure preservatively treated in accordance with AWPA C1, C2, C3, C4, C9, C15, C18, C20, C22, C23, C24, C27, C28, P1, P2, and P3 listed in Section S-26.308, or decay-resistant heartwood of redwood, black locust, or cedars.

1. Wood joists or the bottom of a wood structural floor when closer than 18 inches or wood girders when closer than 12 inches to exposed ground in crawl spaces or unexcavated areas located within the periphery of the building foundation.
2. All sills which rest on concrete or masonry exterior walls and are less than 8 inches from exposed ground.
3. Sills and sleepers on a concrete or masonry slab which is in direct contact with the ground.
4. The ends of wood girders entering exterior masonry or concrete walls having clearances of less than 1/2 inch on tops, sides and ends.

5. Wood siding, sheathing and wall framing on the exterior of a building having a clearance of less than 6 inches from the ground.
6. Wood structural members supporting moisture-permeable floors or roofs which are exposed to the weather, such as concrete or masonry slabs, unless separated from such floors or roofs by an impervious moisture barrier.
7. Wood furring strips or other wood framing members attached directly to the interior of exterior masonry or concrete walls below grade except when an approved vapor retarder is applied to the interior of the exterior wall.

All wood in contact with the ground and which supports permanent structures intended for human occupancy shall be approved wood suitable for ground contact use, except untreated wood may be used where entirely below ground-water level or continuously submerged in fresh water.

In geographical areas where experience has demonstrated a specific need, approved naturally durable or pressure-treated wood shall be used for those portions of wood members which form the structural supports of buildings, balconies, porches or similar permanent building appurtenances when such members are exposed to the weather without adequate protection from a roof, eave, overhang or other covering which would prevent moisture or water accumulation on the surface or at joints between members. Depending on local experience, such members may include:

1. Horizontal members such as girders, joists and decking.
2. Vertical members such as posts, poles and columns.
3. Both horizontal and vertical members.

Posts, poles and columns supporting permanent structures intended for human occupancy which are embedded in concrete in direct contact with the ground or embedded in concrete exposed to the weather shall be approved pressure-treated wood suitable for ground contact use.

R-309.2 Quality of material: Lumber and plywood required to be pressure preservatively treated in accordance with this code shall bear the quality mark of an approved inspection agency which maintains continuing supervision, testing and inspection over the quality of the product.

The required quality mark on each piece of pressure preservatively treated lumber or plywood shall contain the following information:

1. Identification of the treating plant.
2. Year treated.
3. Type of preservative.
4. The minimum preservative retention.
5. End use for which product was treated.
6. Standard to which product was treated.
7. Identity of the approved inspection agency.
8. The designation "Dry," if applicable.

Exception: When lumber 1 inch or less in thickness and 4 inches or less in width, or 36 inches or less in length, has been bundled, one

mark is required on the face of those pieces which form the exterior surfaces of the bundle.

R-309.3 Fasteners: Fasteners for pressure preservative and fire retardant treated wood shall be of hot-dipped, zinc-coated, galvanized or stainless steel, silicon bronze, or copper. Fasteners for treated wood foundations shall be as required in NFoPA Technical Report No. 7 listed in Section S-26.309.

SECTION R-310—PROTECTION AGAINST TERMITES

R-310.1 Subterranean termite control: In areas favorable to termite damage as established by Table No. R-201.2, methods of protection shall be by chemical soil treatment, pressure-treated wood, naturally termite-resistant wood or physical barriers approved by the building official. Approved combinations of methods may be used.

R-310.2 Chemical soil treatment: The concentration, rate of application and treatment method of the termiticide shall be consistent with and never less than the termiticide label and applied according to recommendations of the USDA Forest Service as cited in Home and Garden Bulletin No. 64, listed in Section S-26.310.

R-310.3 Pressure-treated and naturally resistant wood: Heartwood of redwood and eastern red cedar shall be considered termite resistant. Pressure-treated wood and naturally termite-resistant wood shall not be used as a physical barrier unless a barrier can be inspected for any termite shelter tubes around the inside and outside edges and joints of a barrier.

Field cut ends, notches and drilled holes of pressure-treated wood shall be retreated in the field according to AWPA M4 listed in Section S-26.310.

SECTION R-311—CRAWL SPACE

R-311.1 Ventilation: The space between the bottom of the floor joists and the earth under any building (except such space as is occupied by a basement or cellar) shall be provided with a sufficient number of ventilating openings through foundation walls or exterior walls to ensure ample ventilation. Ventilating openings shall be provided with corrosion-resistant wire mesh, or equivalent, with the least dimension being 1/8 inch. The minimum net area of ventilation openings shall be not less than 1 square foot for each 150 square feet of crawl space area. One such ventilating opening shall be within 3 feet of each corner of said building.

Exceptions:

1. Ventilation openings may be vented to the interior of buildings where warranted by climatic conditions.
2. The total area of ventilation openings may be reduced to 1/1,500 of the under-floor area where the ground surface is treated with an approved vapor barrier material and one such ventilation opening is within 3 feet of each corner of said buildings. The vents may have operable louvers.
3. Ventilation openings may be omitted on one side.

4. Under-floor spaces used as supply plenums for distribution of heated and cooled air shall comply with the requirements of Section M-1102.3.

R-311.2 Access: An access crawl hole 18 inches by 24 inches shall be provided to the under-floor space.

R-311.3 Removal of debris: The under-floor grade shall be cleaned of all vegetation and organic material.

R-311.4 Finished grade: The finished grade of under-floor space may be located at the bottom of the footings; however, where there is evidence that the groundwater table can rise to within 6 inches of the finished grade at the building perimeter or where there is evidence that surface water does not readily drain from the building site, the grade in the under-floor space shall be as high as the outside finished grade, unless an approved drainage system is provided.

Chapter 4
WALL CONSTRUCTION

SECTION R-401— GENERAL

R-401.1 Application: The provisions of this chapter shall control the design and construction of all walls and partitions for all buildings. The use of materials or methods of construction not specified in this chapter accomplishing the purposes intended by this code and approved by the building official in accordance with Section R-108 shall be accepted as complying with this code.

R-401.2 Requirements: The wall construction shall be capable of accommodating all loads imposed according to Section R-201 and transmitting the resulting loads to its supporting structural elements.

Compressible floor-covering materials that compress more than 1/32 inch when subjected to 50 pounds applied over 1 inch square of material and are greater than 1/8 inch in thickness in the uncompressed state shall not extend beneath walls, partitions or columns which are fastened to the floor.

SECTION R-402— DIMENSION LUMBER

R-402.1 Identification: Load-bearing dimension lumber for studs, plates and headers shall conform to applicable standards or grading rules and shall be identified by a grade mark, or certificate of inspection issued by an approved agency. The grade mark or certificate shall provide adequate information to determine the "F_b," the allowable stress in bending, and "E," the modulus of elasticity. Approved end-jointed lumber may be used interchangeably with solid-sawn members of the same species and grade.

R-402.2 Grade: Studs shall be a minimum No. 3, Standard or Stud grade lumber.

> **Exception:** Bearing studs not supporting floors and nonbearing studs may be Utility grade lumber, provided the studs are spaced in accordance with Table No. R-402.3d.

R-402.3 Construction: Exterior walls of wood-frame construction shall be in accordance with Figure Nos. R-402.3a and R-402.3b. Components of exterior walls shall be fastened in accordance with Table No. R-402.3a. Walls of wood frame construction shall be designed and constructed in accordance with the NFoPA "National Design Specification for Wood Construction," listed in Section S-26.402. *

Exterior walls subject to wind pressures of 30 pounds per square foot or greater, as established in Table No. R-201.2, shall be designed in accordance with accepted engineering practice.

In bearing walls, studs which are not more than 10 feet in length shall be spaced not more than is specified in Table No. R-402.3d for the corresponding stud size.

When bearing studs are spaced at 24-inch intervals, and doubled top plates are less than two 2 by 6 or two 3 by 4 members, and supported floor joists, floor trusses or roof trusses are spaced at more than 16-inch intervals, care shall be exercised to ensure locating supported floor joists or trusses within 5 inches of the studs beneath, or, in lieu thereof, solid blocking equal in size to the studs beneath shall be installed to reinforce the double plate above.

Exception: A single top plate may be installed in bearing and exterior walls, provided the plate is adequately tied at joints, corners and intersecting walls by at least the equivalent of 3-inch by 6-inch by 0.036-inch-thick galvanized steel that is nailed to each wall or segment of wall by three 8d nails or equivalent, provided the rafters or joists are centered over the studs with a tolerance of no more than 1 inch. Top plate may be omitted over lintels which are adequately tied to adjacent wall section as previously described or with 1-inch by 4-inch by 12-inch wood members splice nailed to each wall section by three 8d nails or equivalent.

R-402.4 Interior partitions: Interior load-bearing partitions shall be constructed, framed and firestopped as specified for exterior walls. Interior nonbearing partitions may be constructed with 2-inch by 3-inch studs spaced 24 inches on center or 2-inch by 4-inch flat studs spaced 16 inches on center.

Interior nonbearing partitions may be capped with a single top plate.

R-402.5 Drilling and notching— studs: Any stud in an exterior wall or bearing partition may be cut or notched to a depth not exceeding 25 percent of its width. Studs in nonbearing partitions may be notched to a depth not to exceed 40 percent of a single stud width. Any stud may be bored or drilled, provided that the diameter of the resulting hole is no greater than 40 percent of the stud width, the edge of the hole is no closer than 5/8 inch to the edge of the stud, and the hole is not located in the same section as a cut or notch.

Exception: A stud may be bored to a diameter not exceeding 60 percent of its width, provided that such studs located in exterior walls or bearing partitions are doubled and that not more than two successive studs are bored.

Table No. R-402.3a
FASTENER SCHEDULE FOR STRUCTURAL MEMBERS

DESCRIPTION OF BUILDING MATERIALS	NUMBER & TYPE OF FASTENER[1 2 3 5]	SPACING OF FASTENERS
Joist to sill or girder, toe nail	3-8d	—
1" × 6" subfloor or less to each joist, face nail	2-8d 2 staples, 1¾"	— —
Wider than 1" × 6" subfloor to each joist, face nail	3-8d 4 staples, 1¾"	— —
2" subfloor to joist or girder, blind and face nail	2-16d	—
Sole plate to joist or blocking, face nail	16d	16" o.c.
Top or sole plate to stud, end nail	2-16d	—
Stud to sole plate, toe nail	3-8d or 2-16d	—
Double studs, face nail	16d	24" o.c.
Double top plates, face nail	16d	24" o.c.
Top plates, laps and intersections, face nail	2-16d	—
Continued header, two pieces	16d	16" o.c. along each edge
Ceiling joists to plate, toe nail	3-8d	—
Continuous header to stud, toe nail	4-8d	—
Ceiling joist, laps over partitions, face nail	3-16d	—
Ceiling joist to parallel rafters, face nail	3-16d	—
Rafter to plate, toe nail	2-16d	—
1" brace to each stud and plate, face nail	2-8d 2 staples, 1¾"	— —
1" × 6" sheathing to each bearing, face nail	2-8d 2 staples, 1¾"	— —
1" × 8" sheathing to each bearing, face nail	2-8d 3 staples, 1¾"	— —
Wider than 1" × 8" sheathing to each bearing, face nail	3-8d 4 staples, 1¾"	— —
Built-up corner studs	16d	24" o.c.
Built-up girder and beams	16d	32" o.c. at top and bottom and staggered two 20d at ends and at each splice
2" planks	2-16d	At each bearing
Roof rafters to ridge, valley or hip rafters: toe nail face nail	4-16d 3-16d	— —
Rafter ties to rafters, face nail	3-8d	—

(Continued)

Table No. R-402.3b
PLYWOOD WALL SHEATHING—
FACE GRAIN PARALLEL OR PERPENDICULAR TO STUDS[1]

MINIMUM THICKNESS AND CONSTRUCTION	PANEL SPAN RATING	STUD SPACING (Inches)		
		SIDING NAILED TO STUDS	SIDING NAILED TO SHEATHING, SHEATHING PARALLEL TO STUDS	SIDING NAILED TO SHEATHING, SHEATHING PERPENDICULAR TO STUDS
5/16"	12/0, 16/0, 20/0	16	—	16
3/8", 15/32" and 1/2"—3-ply	16/0, 20/0, 24/0, 32/16	24	16	24
15/32" and 1/2"—4- and 5-ply	24/0, 32/16	24	24	24

[1]Table applies to C-D and C-C grades, including Structural I and II.

Table No. R-402.3c
ALLOWABLE SPANS FOR PARTICLEBOARD WALL SHEATHING[1]
(Not exposed to the weather, long dimension of panel parallel or perpendicular to studs)

THICKNESS (Inches)	GRADE	STUD SPACING (Inches)	
		When Siding is Nailed to Studs	When Siding is Nailed to Sheathing
5/16	2-M-W	16	—
3/8		24	16
7/16		24	24
3/8	2-M-1	16	—
1/2	and 2-M-2	16	16

[1] Wall sheathing. The allowable grade, panel thickness and stud spacing are shown in Table No. R-402.3c. The panels may be applied horizontally or vertically. If the panel are applied horizontally, the end joints of the panels shall be offset so that four panel corners will not meet. All panel edges must be supported. Leave a 1/16-inch gap between panels and nail no closer than 3/8 inch from panel edges.

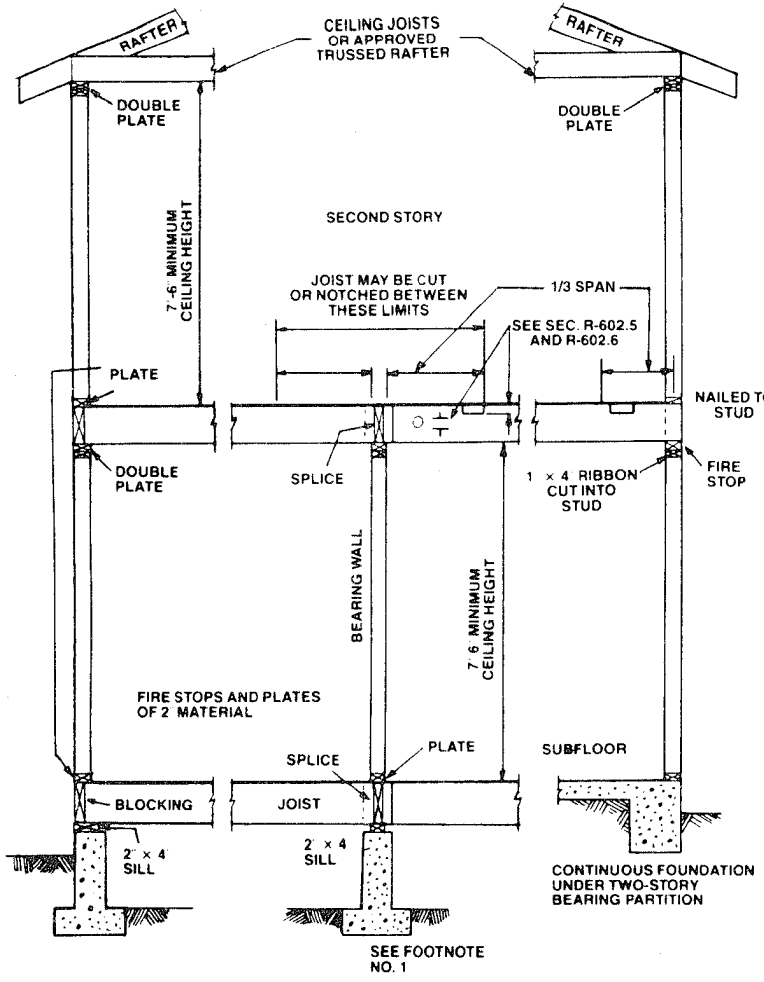
Table No. R-402.3d
MAXIMUM STUD SPACING (INCHES)

STUD SIZE	SUPPORTING ROOF AND CEILING ONLY	SUPPORTING ONE FLOOR ROOF AND CEILING	SUPPORTING TWO FLOORS ROOF AND CEILING	SUPPORTING ONE FLOOR ONLY
2 × 4	24[1]	16	—	24[1]
3 × 4	24[1]	24	16	24
2 × 5	24	24	—	24
2 × 6	24	24	16	24

[1]Shall be reduced to 16 inches if Utility grade studs are used.

Figure No. R-402.3a

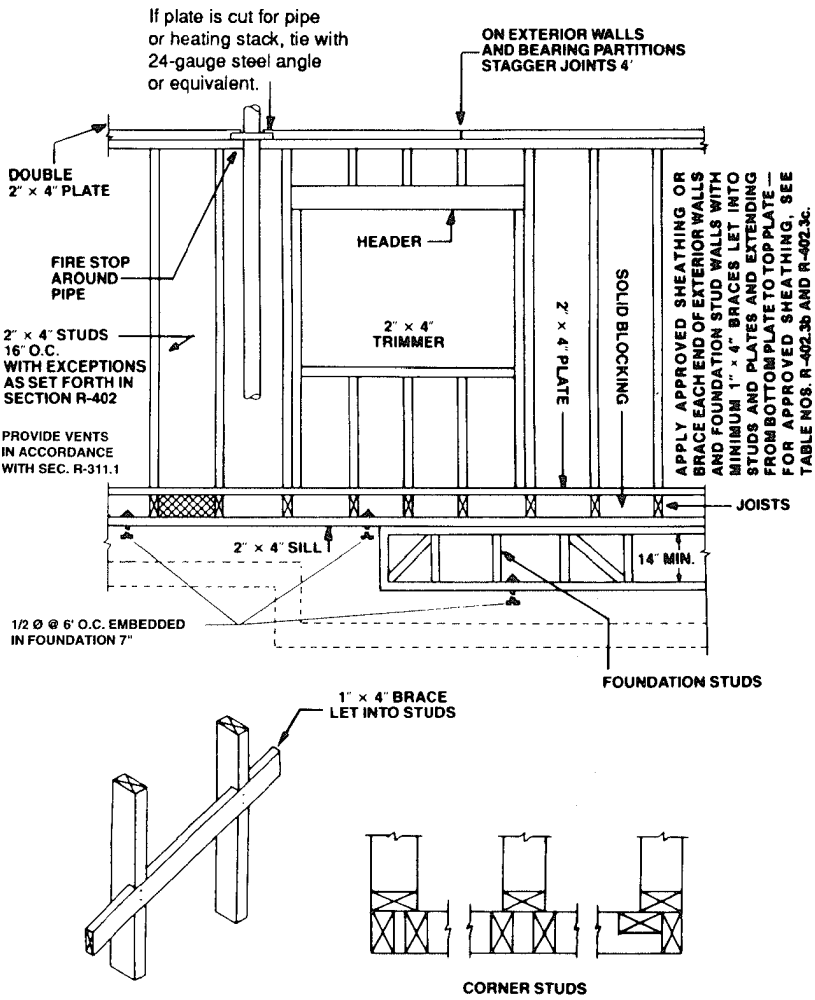
TYPICAL WALL, FLOOR AND ROOF FRAMING



NOTE:
1. See Figure No. R-303 for pier-type footings.

This figure is for illustration purposes only and the written text shall apply.

Figure No. R-402.3b
FRAMING DETAILS



Note:
A third stud and/or partition intersection backing studs may be omitted through the use of wood spacers or backup cleats of 3/8-inch-thick plywood, 1-inch-thick lumber or other approved devices which will serve as an adequate backing for the attachment of facing materials.

This figure is for illustration purposes only and the written text shall apply.

R-402.5.1 Drilling and notching—top plate: Where piping or ductwork is placed in or partly in an exterior wall or interior load-bearing wall, necessitating a cutting of the top plate by more than 50 percent of its width, the plate shall be reinforced with 24 gauge steel angle or other equivalent support spanning the distance between the appropriate studs.

R-402.6 Headers: The allowable spans for nominal 4-inch single headers and 2-inch double headers in bearing walls shall not exceed the spans set forth in Table Nos. R-402.6a through R-402.6f. The tables are not to be used where concentrated loads are supported by the headers.

Nominal 2-inch single headers may be used to span openings in load-bearing walls, provided the headers are of adequate size to support all imposed loads.

Nailed-only plywood-box headers shall be designed in accordance with the NAHB "Construction Guide, Design Tables and Technical Report for Plywood Headers for Residential Construction," listed in Section S-26.402, or by approved engineering practice.

Load-bearing headers are not required in interior or exterior nonbearing walls. A single flat 2-inch by 4-inch member may be used as a header in exterior nonbearing walls for openings up to 8 feet in width if the vertical distance to the parallel nailing surface above is not more than 24 inches. For such nonbearing headers, no cripples or blocking are required above the header.

R-402.7 Firestopping: Firestopping shall be provided to cut off all concealed draft openings (both vertical and horizontal) and to form an effective fire barrier between stories, and between a top story and the roof space. Firestopping shall be provided in wood-frame construction in the following locations:

1. In concealed spaces of stud walls and partitions, including furred spaces, at the ceiling and floor level;
2. At all interconnections between concealed vertical and horizontal spaces such as occur at soffits, drop ceilings, cove ceilings, etc.;
3. In concealed spaces between stair stringers at the top and bottom of the run;
4. At openings around vents, pipes, ducts, chimneys and fireplaces at ceiling and floor level, with noncombustible materials.

Except as provided in Item 4 above, firestopping shall consist of 2-inch nominal lumber, or two thicknesses of 1-inch nominal lumber with broken lap joints, or one thickness of 23/32-inch plywood with joints backed by 23/32-inch plywood, or one thickness of 3/4-inch Type 2-M particleboard with joints backed by 3/4-inch Type 2-M particleboard, or other approved materials.

The integrity of all firestops shall be maintained.

Table No R-402.6a
HEADER DESIGN CHART
(Douglas Fir-Larch, Southern Pine No. 2,
Roof Load = 20LL + 10 DL; Floor Load = 40 LL + 10 DL)
F_b = 1,200 E = 1,600,000 F_v = 90

HEADER SUPPORTING:	HEADER SIZE:	MAXIMUM ALLOWABLE HEADER SPAN (Ft.-In.)								
		DESIGN PROCEDURE								
		Nonstruct. Sheath.			1/2" Insul. Board Sheath.*			1/2" Plywood Sheath.**		
		House Depth (Ft.)			House Depth (Ft.)			House Depth (Ft.)		
		24'	28'	32'	24'	28'	32'	24'	28'	32'
Roof	2-2 × 4	4-7	4-6	4-3	4-11	4-8	4-6	5-7	5-4	5-1
	2-2 × 6	6-8	6-4	5-11	6-11	6-7	6-4	7-7	7-3	7-0
	2-2 × 8	8-3	8-0	7-7	8-6	8-2	7-11	8-11	8-7	8-4
	2-2 × 10	9-10	9-6	9-3	10-0	9-8	9-4	10-4	10-0	9-9
	2-2 × 12	11-4	10-11	10-7	11-5	11-1	10-9	11-10	11-5	11-1
Roof plus one story (Bearing)	2-2 × 4	5-2	4-11	4-9	5-4	5-1	4-10	5-8	5-5	5-2
	2-2 × 6	6-9	6-5	6-0	6-11	6-7	6-3	7-4	7-0	6-8
	2-2 × 8	8-0	7-5	7-0	8-1	7-8	7-3	8-5	8-2	7-9
	2-2 × 10	9-3	8-9	8-3	9-4	9-0	8-5	9-7	9-3	8-11
	2-2 × 12	10-5	10-1	9-7	10-6	10-2	9-9	10-10	10-5	10-1
Roof plus one story (No bearing)	2-2 × 4	4-8	4-5	4-3	4-9	4-6	4-3	5-1	4-10	4-8
	2-2 × 6	5-10	5-5	5-1	6-0	5-7	5-3	6-7	6-2	5-9
	2-2 × 8	6-9	6-3	5-11	7-0	6-6	6-1	7-6	7-0	6-7
	2-2 × 10	8-0	7-5	6-11	8-2	7-7	7-1	8-8	8-1	7-7
	2-2 × 12	9-3	8-7	8-1	9-5	8-9	8-3	9-11	9-3	8-8
Roof plus two stories (Bearing)	2-2 × 4	4-8	4-5	4-3	4-9	4-6	4-3	5-1	4-10	4-8
	2-2 × 6	5-10	5-5	5-1	6-0	5-7	5-3	6-7	6-2	5-9
	2-2 × 8	6-9	6-3	5-11	7-0	6-6	6-1	7-6	7-0	6-7
	2-2 × 10	8-0	7-5	6-11	8-2	7-7	7-1	8-8	8-1	7-7
	2-2 × 12	9-3	8-7	8-1	9-5	8-9	8-3	9-11	9-3	8-8
Roof plus two stories (No bearing)	2-2 × 4	3-11	3-8	3-5	4-1	3-9	3-7	4-5	4-2	4-0
	2-2 × 6	4-8	4-4	4-0	4-10	4-5	4-2	5-3	4-11	4-7
	2-2 × 8	5-5	5-0	4-8	5-7	5-2	4-10	6-0	5-7	5-3
	2-2 × 10	6-4	5-11	5-6	6-6	6-0	5-8	6-11	6-5	6-0
	2-2 × 12	7-5	6-10	6-5	7-6	7-0	6-6	7-11	7-4	6-11

*Sheathing or combined sheathing/siding having a minimum density of 18 pcf.
**Minimum 1/2-inch plywood sheathing or combined sheathing/siding applied between the bottom of the header, the top of the plate and between the center lines of the broken vertical studs at the end of the header and nailed to the header, top plates, cripples and studs-6 inches o.c. at the edges and 12 inches o.c. at intermediate framing.

Note: Linear interpolation for house widths not in table is permitted. For example, assume a 26-foot-wide house with 1/2-inch plywood sheathing roof load 2 x 6 header: allowable header span = 7 feet 6 inches.

Tables based on maximum 1 1/2-foot overhangs and band used at floors.
■symbol represents supporting beam or structural bearing wall below floor.
●symbol represents location of header.

Header spans identified as having "no bearing" construction apply to both interior and exterior load-bearing walls which have tributary areas equal to one-half the house depth. Header spans identified with "bearing" construction apply only to exterior bearing walls with tributary areas equal to one-fourth of the house depth.

Nominal 4-inch size single headers may be substituted for ominal 2-inch headers.

Table No R-402.6b
HEADER DESIGN CHART
(Douglas Fir-Larch, Southern Pine No. 2,
Roof Load = 30LL + 10 DL; Floor Load = 40 LL + 10 DL)
F_b = 1,200 E = 1,600,000 F_v = 90

HEADER SUPPORTING:	HEADER SIZE:	MAXIMUM ALLOWABLE HEADER SPAN (Ft.-In.) DESIGN PROCEDURE								
		Nonstruct. Sheath.			1/2" Insul. Board Sheath.*			1/2" Plywood Sheath.*		
		House Depth (Ft.)			House Depth (Ft.)			House Depth (Ft.)		
		24'	28'	32'	24'	28'	32'	24'	28'	32'
Roof	2-2 × 4	4-2	3-11	3-8	4-5	4-3	4-1	5-1	4-10	4-8
	2-2 × 6	5-10	5-6	5-2	6-3	5-10	5-6	6-11	6-7	6-4
	2-2 × 8	7-6	7-0	6-7	7-10	7-3	6-10	8-4	8-0	7-7
	2-2 × 10	9-2	8-8	8-2	9-3	8-11	8-5	9-8	9-4	9-1
	2-2 × 12	10-6	10-2	9-10	10-8	10-4	10-0	11-0	10-8	10-4
Roof plus one story (Bearing)	2-2 × 4	4-11	4-8	4-6	5-0	4-9	4-7	5-4	5-1	4-11
	2-2 × 6	6-3	5-10	5-6	6-6	6-1	5-8	6-11	6-7	6-3
	2-2 × 8	7-4	6-10	6-5	7-7	7-0	6-7	8-1	7-7	7-1
	2-2 × 10	8-7	8-1	7-6	8-10	8-2	7-8	9-2	8-8	8-2
	2-2 × 12	10-0	9-4	8-9	10-1	9-6	8-11	10-4	9-11	9-5
Roof plus one story (No bearing)	2-2 × 4	4-5	4-3	4-0	4-9	4-4	4-2	4-10	4-8	4-5
	2-2 × 6	5-5	5-1	4-9	5-8	5-3	4-11	6-2	5-9	5-5
	2-2 × 8	6-4	5-11	5-6	6-6	6-1	5-8	7-0	6-6	6-2
	2-2 × 10	7-6	6-11	6-6	7-7	7-1	6-8	8-1	7-6	7-0
	2-2 × 12	8-8	8-1	7-7	8-10	8-2	7-8	9-3	8-8	8-1
Roof plus two stories (Bearing)	2-2 × 4	4-5	4-3	4-0	4-9	4-4	4-2	4-10	4-8	4-5
	2-2 × 6	5-5	5-1	4-9	5-8	5-3	4-11	6-2	5-9	5-5
	2-2 × 8	6-4	5-11	5-6	6-6	6-1	5-8	7-0	6-6	6-2
	2-2 × 10	7-6	6-11	6-6	7-7	7-1	6-8	8-1	7-6	7-1
	2-2 × 12	8-8	8-1	7-7	8-10	8-2	7-8	9-3	8-8	8-1
Roof plus two stories (No bearing)	2-2 × 4	3-9	3-6	3-3	3-11	3-8	3-5	4-3	4-0	3-9
	2-2 × 6	4-5	4-1	3-10	4-7	4-3	4-0	5-1	4-8	4-5
	2-2 × 8	5-2	4-10	4-6	5-4	4-11	4-8	5-9	5-4	5-0
	2-2 × 10	6-1	5-8	5-4	6-3	5-9	5-5	6-7	6-2	5-9
	2-2 × 12	7-1	6-7	6-2	7-2	6-8	6-3	7-7	7-1	6-7

*See notes to Table No. R-402.6a.

Table No. R-402.6c
HEADER DESIGN CHART
(Hem Fir No. 2, Roof Load = 20 LL + 10 DL; Floor Load = 40 LL + 10 DL)
F_b = 1,000 E = 1,400,000 F_v = 75

HEADER SUPPORTING:	HEADER SIZE:	MAXIMUM ALLOWABLE HEADER SPAN (Ft.-In.)								
		DESIGN PROCEDURE								
		Nonstruct. Sheath.			1/2" Insul. Board Sheath.*			1/2" Plywood Sheath.*		
		House Depth (Ft.)			House Depth (Ft.)			House Depth (Ft.)		
		24'	28'	32'	24'	28'	32'	24'	28'	32'
Roof	2-2 × 4	4-5	4-2	3-11	4-8	4-5	4-3	5-4	5-1	4'-10
	2-2 × 6	6-2	5-9	5-5	6-7	6-1	5-9	7-7	7-1	6-8
	2-2 × 8	7-10	7-4	6-11	8-3	7-8	7-3	9-1	8-6	8-0
	2-2 × 10	9-6	9-2	8-8	9-8	9-4	9-1	10-0	9-8	9-5
	2-2 × 12	10-11	10-7	10-3	11-1	10-8	10-5	11-5	11-1	10-9
Roof plus one story (Bearing)	2-2 × 4	4-12	4-9	4-6	5-1	4-10	4-8	5-5	5-2	5-0
	2-2 × 6	6-3	5-10	5-5	6-6	6-1	5-8	7-0	6-8	6-3
	2-2 × 8	7-4	6-10	6-4	7-6	7-0	6-7	8-1	7-7	7-1
	2-2 × 10	8-7	8-0	7-6	8-10	8-2	7-8	9-4	8-8	8-2
	2-2 × 12	10-0	9-4	8-9	10-2	9-6	8-11	10-5	10-0	9-4
Roof plus one story (No bearing)	2-2 × 4	4-5	4-2	3-11	4-7	4-4	4-1	4-10	4-8	4-5
	2-2 × 6	5-4	4-11	4-7	5-6	5-1	4-9	6-1	5-7	5-3
	2-2 × 8	6-2	5-9	5-5	6-4	5-11	5-6	6-10	6-5	6-0
	2-2 × 10	7-3	6-9	6-4	7-5	6-11	6-6	7-11	7-4	6-11
	2-2 × 12	8-5	7-10	7-4	8-7	8-0	7-6	9-1	8-5	7-11
Roof plus two stories (Bearing)	2-2 × 4	4-5	4-2	3-11	4-7	4-4	4-1	4-10	4-8	4-5
	2-2 × 6	5-4	4-11	4-7	5-6	5-1	4-9	6-1	5-7	5-3
	2-2 × 8	6-2	5-9	5-5	6-4	5-11	5-6	6-10	6-5	6-0
	2-2 × 10	7-3	6-9	6-4	7-5	6-11	6-6	7-11	7-4	6-11
	2-2 × 12	8-5	7-10	7-4	8-7	8-0	7-6	9-1	8-5	7-11
Roof plus two stories (No bearing)	2-2 × 4	3-7	3-4	3-1	3-9	3-6	3-3	4-2	3-10	3-7
	2-2 × 6	4-3	3-11	3-8	4-5	4-1	3-10	4-10	4-6	4-2
	2-2 × 8	4-11	4-7	4-3	5-1	4-9	4-5	5-6	5-1	4-9
	2-2 × 10	5-10	5-5	5-1	5-11	5-6	5-2	6-4	5-10	5-6
	2-2 × 12	6-9	6-3	5-10	6-10	6-4	6-0	7-3	6-8	6-3

*See notes to Table No. R-402.6a

Table No. R-402.6d
HEADER DESIGN CHART
(Hem Fir No. 2, Roof Load = 30 LL + 10 DL; Floor Load = 40 LL + 10 DL)
F_b = 1,000 E = 1,400,000 F_v = 75

HEADER SUPPORTING:	HEADER SIZE:	MAXIMUM ALLOWABLE HEADER SPAN (Ft.-In.) DESIGN PROCEDURE Nonstruct. Sheath.1/2" House Depth (Ft.) 24'	28'	32'	Insul. Board Sheath.* House Depth (Ft.) 24'	28'	32'	1/2"Plywood Sheath.** House Depth (Ft.) 24'	28'	32'
Roof	2-2 x 4	3-10	3-7	3-5	4-2	3-11	3-8	4-10	4-7	4-5
	2-2 x 6	5-4	5-0	4-9	5-8	5-4	5-0	6-7	6-2	5-9
	2-2 x 8	6-10	6-4	6-0	7-1	6-8	6-3	7-10	7-4	6-11
	2-2 x 10	8-6	7-11	7-6	8-9	8-2	7-8	9-4	8-9	8-3
	2-2 x 12	10-2	9-6	8-11	10-4	9-9	9-2	10-8	10-3	9-9
Roof plus one story										
(Bearing)	2-2 x 4	4-8	4-5	4-3	4-9	4-7	4-5	5-2	4-11	4-8
	2-2 x 6	5-9	5-3	5-0	5-11	5-6	5-2	6-6	6-1	5-8
	2-2 X 8	6-8	6-3	5-10	6-11	6-5	6-0	7-5	6-11	6-6
	2-2 X 10	7-10	7-4	6-11	8-0	7-6	7-0	8-6	7-11	7-6
	2-2 X 12	9-2	8-6	8-0	9-4	8-8	8-2	9-9	9-1	8-7
Roof plus one story										
(No bearing)	2-2 x 4	4-2	3-11	3-8	4-4	4-1	3-10	4-8	4-5	4-3
	2-2 x 6	5-0	4-7	4-4	5-2	4-9	4-6	5-8	5-3	4-11
	2-2 x 8	5-9	5-5	5-1	6-0	5-7	5-2	6-5	6-0	5-7
	2-2 x 10	6-10	6-4	5-11	6-11	6-6	6-1	7-5	6-10	6-5
	2-2 x 12	7-11	7-4	6-11	8-1	7-6	7-0	8-6	7-11	7-5
Roof plus two stories										
(Bearing)	2-2 x 4	4-2	3-11	3-8	4-4	4-1	3-10	4-8	4-5	4-3
	2-2 x 6	5-0	4-7	4-4	5-2	4-9	4-6	5-8	5-3	4-11
	2-2 x 8	5-9	5-5	5-1	6-0	5-7	5-2	6-5	6-0	5-7
	2-2 x 10	6-10	6-4	5-11	6-11	6-6	6-1	7-5	6-10	6-5
	2-2 x 12	7-11	7-4	6-11	8-1	7-6	7-0	8-6	7-11	7-5
Roof plus two stories										
(No bearing)	2-2 x 4	3-5	3-2	3-0	3-7	3-4	3-1	3-11	3-8	3-5
	2-2 x 6	4-1	3-9	3-6	4-2	3-11	3-8	4-7	4-3	4-0
	2-2 x 8	4-9	4-5	4-1	4-10	4-6	4-3	5-3	4-10	4-7
	2-2 x 10	5-7	5-2	4-10	5-8	5-3	4-11	6-0	5-7	5-3
	2-2 x 12	6-5	6-0	5-7	6-7	6-1	5-9	6-11	6-5	6-0

*See notes to Table No. R-402.6a.

Table No. R-402.6e
HEADER DESIGN CHART
(Spruce-Pine-Fir No. 2, Roof Load = 20 LL + 10 DL; Floor Load = 40 LL + 10 DL)

$F_b = 875$ E = 1,300,000 $F_v = 70$

HEADER SUPPORTING:	HEADER SIZE:	MAXIMUM ALLOWABLE HEADER SPAN (Ft.-In.)								
		DESIGN PROCEDURE								
		Nonstruct. Sheath.			1/2" Insul. Board Sheath.*			1/2" Plywood Sheath.*		
		House Depth (Ft.)			House Depth (Ft.)			House Depth (Ft.)		
		24'	28'	32'	24'	28'	32'	24'	28'	32'
Roof	2-2 × 4	4-2	3-11	3-8	4-5	4-3	4-0	5-2	5-0	4-9
	2-2 × 6	5-10	5-5	5-1	6-2	5-9	5-5	7-1	6-7	6-3
	2-2 × 8	7-4	6-10	6-6	7-8	7-2	6-9	8-6	7-11	7-6
	2-2 × 10	9-2	8-7	8-1	9-5	8-9	8-3	9-10	9-6	8-11
	2-2 × 12	10-9	10-3	9-8	10-10	10-6	9-11	11-3	10-10	10-6
Roof plus one story (Bearing)	2-2 × 4	4-10	4-7	4-4	5-0	4-9	4-6	5-4	5-1	4-10
	2-2 × 6	5-10	5-6	5-2	6-1	5-8	5-4	6-8	6-3	5-10
	2-2 × 8	6-10	6-4	6-0	7-1	6-7	6-2	7-7	7-1	6-8
	2-2 × 10	8-1	7-6	7-1	8-3	7-8	7-2	8-9	8-2	7-8
	2-2 × 12	9-4	8-8	8-2	9-6	8-10	8-4	10-0	9-4	8-9
Roof plus one story (No bearing)	2-2 × 4	4-3	3-11	3-8	4-5	4-1	3-10	4-9	4-6	4-3
	2-2 × 6	5-0	4-7	4-4	5-2	4-9	4-5	5-8	5-3	4-11
	2-2 × 8	5-9	5-4	5-0	6-0	5-6	5-2	6-5	6-0	5-7
	2-2 × 10	6-10	6-4	5-11	6-11	6-5	6-1	7-5	6-10	6-5
	2-2 × 12	7-11	7-4	6-11	8-1	7-6	7-0	8-6	7-11	7-5
Roof plus two stories (Bearing)	2-2 × 4	4-3	3-11	3-8	4-5	4-1	3-10	4-9	4-6	4-3
	2-2 × 6	5-0	4-7	4-4	5-2	4-9	4-5	5-8	5-3	4-11
	2-2 × 8	5-9	5-4	5-0	6-0	5-6	5-2	6-5	6-0	5-7
	2-2 × 10	6-10	6-4	5-11	6-11	6-5	6-1	7-5	6-10	6-5
	2-2 × 12	7-11	7-4	6-11	8-1	7-6	7-0	8-6	7-11	7-5
Roof plus two stories (No bearing)	2-2 × 4	3-4	3-1	2-11	3-6	3-3	3-0	3-10	3-7	3-4
	2-2 × 6	4-0	3-8	3-5	4-1	3-10	3-7	4-6	4-2	3-11
	2-2 × 8	4-7	4-3	4-0	4-9	4-5	4-2	5-1	4-9	4-5
	2-2 × 10	5-5	5-1	4-9	5-7	5-2	4-10	5-11	5-6	5-2
	2-2 × 12	6-4	5-10	5-6	6-5	6-0	5-7	6-9	6-3	5-11

*See notes to Table No. R-402.6a

Table No. R-402.6f
HEADER DESIGN CHART
(Spruce-Pine-Fir No. 2, Roof Load = 30 LL + 10 DL; Floor Load = 40 LL + 10 DL)

F_b = 875 E = 1,300,000 F_v = 70

HEADER SUPPORTING:	HEADER SIZE:	MAXIMUM ALLOWABLE HEADER SPAN (Ft.-In.)								
		DESIGN PROCEDURE								
		Nonstruct. Sheath.			1/2" Insul. Board Sheath.*			1/2" Plywood Sheath.*		
		House Depth (Ft.)			House Depth (Ft.)			House Depth (Ft.)		
		24'	28'	32'	24'	28'	32'	24'	28'	32'
Roof	2-2 × 4	3-7	3-4	3-2	3-11	3-8	3-5	4-10	4-6	4-3
	2-2 × 6	5-0	4-8	4-5	5-4	5-0	4-8	6-2	5-9	5-5
	2-2 × 8	6-5	5-11	5-7	6-8	6-3	5-11	7-4	6-11	6-6
	2-2 × 10	8-0	7-5	7-0	8-2	7-7	7-2	8-10	8-3	7-9
	2-2 × 12	9-6	8-11	8-5	9-9	9-1	8-7	10-5	9-8	9-2
Roof plus one story (Bearing)	2-2 × 4	4-7	4-3	4-0	4-8	4-5	4-2	5-0	4-9	4-7
	2-2 × 6	5-4	5-0	4-8	5-6	5-2	4-10	6-1	5-8	5-4
	2-2 × 8	6-3	5-10	5-6	6-5	6-0	5-8	6-11	6-5	6-1
	2-2 × 10	7-4	6-10	6-5	7-6	7-0	6-7	8-0	7-5	7-0
	2-2 × 12	8-6	7-11	7-6	8-8	8-1	7-7	9-2	8-6	8-0
Roof plus one story (No bearing)	2-2 × 4	3-11	3-8	3-5	4-1	3-10	3-7	4-6	4-3	3-11
	2-2 × 6	4-8	4-4	4-1	4-10	4-6	4-2	5-3	4-11	4-7
	2-2 × 8	5-5	5-0	4-9	5-7	5-2	4-10	6-0	5-7	5-3
	2-2 × 10	6-5	5-11	5-7	6-6	6-1	5-8	6-11	6-5	6-0
	2-2 × 12	7-5	6-10	6-5	7-6	7-0	6-7	7-11	7-4	6-11
Roof plus two stories (Bearing)	2-2 × 4	3-11	3-8	3-5	4-1	3-10	3-7	4-6	4-3	3-11
	2-2 × 6	4-8	4-4	4-1	4-10	4-6	4-2	5-3	4-11	4-7
	2-2 × 8	5-5	5-0	4-9	5-7	5-2	4-10	6-0	5-7	5-3
	2-2 × 10	6-5	5-11	5-7	6-6	6-1	5-8	6-11	6-5	6-0
	2-2 × 12	7-5	6-10	6-5	7-6	7-0	6-7	7-11	7-4	6-11
Roof plus two stories (No bearing)	2-2 × 4	3-3	3-0	2-10	3-4	3-1	2-11	3-8	3-5	3-3
	2-2 × 6	3-10	3-6	3-4	3-11	3-8	3-5	4-4	4-0	3-9
	2-2 × 8	4-5	4-1	3-10	4-6	4-3	4-0	4-11	4-6	4-3
	2-2 × 10	5-2	4-10	4-6	5-4	4-11	4-7	5-8	5-3	4-11
	2-2 × 12	6-0	5-7	5-3	6-2	5-9	5-4	6-6	6-0	5-8

*See notes to Table No. R-402.6a

R-402.8 Draftstopping: Draftstopping shall be provided in all floor/ceiling assemblies under the following circumstances:

1. Ceiling is suspended under the floor framing; or
2. Floor framing is constructed of truss-type or open-web perforated members.

In floor/ceiling assemblies the space between the ceiling membranes and floor shall be divided into two or more approximately equal areas with no area greater than 1,000 square feet. Draftstopping shall be provided parallel to the main framing members.

Ventilation of concealed roof spaces shall be maintained in accordance with Section R-707.

Draftstopping materials shall be not less than 1/2-inch gypsum board, 3/8-inch plywood, 3/8-inch Type 2-M-W particleboard, or other approved materials adequately supported.

The integrity of all draftstops shall be maintained.

R-402.9 Cripple walls: Foundation cripple walls shall be framed of studs not less in size than the studding above with a minimum length of 14 inches, or shall be framed of solid blocking. When exceeding 4 feet in height, such walls shall be framed of studs having the size required for an additional story.

Such walls having a stud height exceeding 14 inches shall be considered to be first story walls for the purpose of determining the bracing required by Section R-402.10. Solid blocking may be used to brace cripple walls having a stud height of 14 inches or less.

R-402.10 Wall bracing: Exterior and foundation wall panels of frame construction shall be braced with approved structural sheathing, 1-inch by 4-inch let-in braces, or approved metal strap devices installed in accordance with the manufacturer's specifications. Structural sheathing and 1-inch by 4-inch let-in braces shall be installed in accordance with Table No. R-402.10 and fastened in accordance with Table No. R-402.3a.

Exterior walls shall be effectively braced with let-in bracing, plywood in accordance with Table No. R-402.3b, particleboard in accordance with Table No. R-402.3c or other approved material. If let-in bracing is used, it shall be let into the top and bottom plates and the intervening studs, placed at not more than 60 nor less than 45° from the horizontal and attached to the framing in conformance with Table No. 402.3a.

Table No. R-402.10
WALL BRACING

SEISMIC ZONE	CONDITION[1]	TYPE OF BRACE	AMOUNT OF BRACING[2 3]
0, 1 and 2	One Story. Top of two or three story. First story of two story Second story of three story.	1-by 4-inch let-in bracing or structural sheathing.	Located at each end and at least every 25 feet of wall length.
	First story of three story.	Structural sheathing.	Minimum 48-inch-wide panels. Located as required for let-in bracing.

Table No. R-402.10 (Continued)
WALL BRACING

SEISMIC ZONE	CONDITION[1]	TYPE OF BRACE	AMOUNT OF BRACING[2 3]
3 and 4	One Story. Top of two or three story.	1-by 4-inch let-in bracing or structural sheathing.	Located at each end and at least every 25 feet of wall length.
	First story of two story. Second story of three story.	Structural sheathing.	25 percent of wall length to be sheathed.
	First story of three story.	Structural sheathing.	40 percent of wall length to be sheathed.

[1]Foundations wall panels braced same as story above.

[2]Where structural sheathing is used, each braced panel must be at least 48 inches in width.

[3]Structural sheathing and let-in bracing shall be located at each end or as near thereto as possible.

SECTION R-403— METAL

Metal structural elements in walls and partitions may be either hot-rolled structural shapes or bar sections or members cold formed to shape from sheet, strip or plate, or a fabricated combination thereof. Members shall be straight and free of any defects which would significantly affect their structural performance.

Structural elements in walls and partitions shall be constructed of materials and designed in accordance with AA SAS30, the AISI "Specification for the Design of Cold-Formed Steel Structural Members" or the AISC "Specification for the Design, Fabrication and Erection of Structural Steel for Buildings," listed in Section S-26.403.

SECTION R-404— GENERAL MASONRY CONSTRUCTION

R-404.1 Thickness of masonry: The nominal thickness of masonry walls shall conform to the requirements of R-404.1.1 through R-404.1.4

R-404.1.1 Minimum thickness: The minimum thickness of masonry bearing walls more than one story high shall be 8 inches. Solid masonry walls of one story dwellings and garages shall not be less than 6 inches in thickness when not greater than 9 feet in height, provided that when gable construction is used, an additional 6 feet is permitted to the peak of the gable. Masonry walls shall be laterally supported in either the horizontal or vertical direction at intervals as required by Section R-404.7.

R-404.1.2 Rubble stone walls: The minimum thickness of rough or random or coursed rubble stone walls shall be 16 inches.

R-404.1.3 Change in thickness: Where walls of masonry of hollow units or masonry bonded hollow walls are decreased in thickness, a course of solid masonry shall be constructed between the wall below and the thinner wall above, or special units or construction shall be used to transmit the loads from face shells or wythes above to those below.

R-404.1.4 Parapet walls: Unreinforced solid masonry parapet walls shall be not less than 8 inches in thickness and their height shall not exceed four times their thickness. Unreinforced hollow unit masonry parapet walls shall not be less than 8 inches in thickness, and their height shall not exceed three times their thickness.

R-404.2 Corbeled masonry: Solid masonry units shall be used for corbeling. The maximum corbeled projection beyond the face of the wall shall be not more than one-half of the wall thickness or one-half the wythe thickness for hollow walls; the maximum projection of one unit shall neither exceed one-half the height of the unit nor one-third its thickness at right angles to the wall. The top course of corbels shall be a header course when the corbeled masonry is used to support floor or roof framing members as shown in Figure No. R-404.9 for anchorage requirements.

Cavity wall or masonry veneer construction may be supported on an 8-inch foundation wall, provided the 8-inch wall is corbeled with solid masonry to the width of the wall system above. The total horizontal projection of the corbel shall not exceed 2 inches with individual corbels projecting not more than one-third the thickness of the unit nor one-half the height of the unit. The top course of all corbels shall be a header course.

R-404.3 Allowable stresses: Masonry construction shall be designed and constructed such that the allowable stresses prescribed herein are not exceeded. In determining the stresses in masonry, the effects of all loads and conditions of loading and the influence of all forces affecting the design and strength of the several parts shall be taken into account.

R-404.3.1 Unreinforced masonry: The compressive stresses in unreinforced masonry, including partially reinforced masonry, shall not exceed the values given in Table No. R-404.3.1.

Exception: Unreinforced masonry designed and constructed in accordance with BIA "Building Code Requirements for Engineered Brick Masonry" and ACI/ASCE 530 except Appendix A, listed in Section S-26.404.

When ACI/ASCE 530 is used to design unreinforced masonry, project drawings, typical details and specifications are not required to bear the seal of the architect or engineer responsible for design.

R-404.3.2 Reinforced masonry: The allowable stresses in reinforced masonry shall be as prescribed in BIA "Building Code Requirements for Engineered Brick Masonry," and ACI/ASCE 530 except Appendix A, Section S-26.404.

Exception: When ACI/ASCE 530 is used to design reinforced masonry, project drawings, typical details and specifications are not required to bear the seal of the architect or engineer responsible for design.

R-404.3.3 Combined units: In walls or other structural members composed of different kinds or grades of units, materials or mortars, the maximum stress shall not exceed the allowable stress for the weakest of

Table 404.3.1
ALLOWABLE COMPRESSIVE STRESSES FOR EMPIRICAL DESIGN OF MASONRY

CONSTRUCTION; COMPRESSIVE STRENGTH OF UNIT, GROSS AREA	ALLOWABLE COMPRESSIVE STRESSES[2] GROSS CROSS-SECTIONAL AREA[4]	
	Type M or S Mortar	Type N Mortar
Solid masonry of brick and other solid units of clay or shale; sand-lime or concrete brick:		
8,000 + psi	350	300
4,500 psi	225	200
2,500 psi	160	140
1,500 psi	115	100
Grouted[1] masonry, of clay or shale; sand-lime or concrete:		
4,500+ psi	225	200
2,500 psi	160	140
1,500 psi	115	100
Solid masonry of solid concrete masonry units:		
3,000+ psi	225	200
2,000 psi	160	140
1,200 psi	115	100
Masonry of hollow load-bearing units:		
2,000+ psi	140	120
1,500 psi	115	100
1,000 psi	75	70
700 psi	60	55
Hollow walls (cavity or masonry bonded[3]) solid units:		
2,500+ psi	160	140
1,500 psi	115	100
Hollow units	75	70
Stone ashlar masonry:		
Granite	720	640
Limestone or marble	450	400
Sandstone or cast stone	360	320
Rubble Stone Masonry		
Coarse, rought or random	120	100

[1]See Section R-408.

[2]Linear interpolation shall be used for determining allowable stresses for masonry units having compressive strengths which are intermediate between those given in the table.

[3]Where floor and roof loads are carried upon one wythe, the gross cross-sectional area is that of the wythe under load; if both wythes are loaded, the gross cross-sectional area is that of the wall minus the area of the cavity between the wythes. Walls bonded with metal ties shall be considered as cavity walls unless the collar joints are filled with mortar or grout.

[4]Gross cross-sectional area shall be calculated on the actual rather than nominal dimensions.

the combination of units, materials and mortars of which the member is composed. The net thickness of any facing unit which is used to resist stress shall not be less than 1 1/2 inches.

R-404.4 Piers: The unsupported height of masonry piers shall not exceed ten times their least dimension. When structural clay tile or hollow concrete masonry units are used for isolated piers to support beams and girders, the cellular spaces shall be filled solidly with concrete or Type M or S mortar, except that unfilled hollow piers may be used if their unsupported height is not more than four times their least dimension. When hollow masonry units are solidly filled with concrete or Type M, S or N mortar, the allowable compressive stress may be increased as provided in Table No. R-404.3.1.

Hollow piers shall be capped with 4 inches of solid masonry or concrete or shall have cavities of the top course filled with concrete or grout or other methods approved by the building official.

R-404.5 Chases: Chases and recesses in masonry walls shall not be deeper than one-third the wall thickness, and the maximum length of a horizontal chase or horizontal projection shall not exceed 4 feet, and shall have at least 8 inches of masonry in back of the chases and recesses and between adjacent chases or recesses and the jambs of openings. Chases and recesses shall not be cut in walls of hollow masonry units or in hollow walls, but when permitted may be built in. Chases and recesses in masonry walls shall be designed and constructed so as not to reduce the required strength or required fire-resistance of the wall and in no case shall a chase or recess be permitted within the required area of a pier.

Exception: In residential buildings constructed of 8-inch masonry walls, recesses below window openings may extend from floor to sill and be the width of the opening above, and in no case shall the depth of the recess exceed 4 inches.

R-404.6 Stack bond: In unreinforced masonry where masonry units are laid in stack bond, longitudinal reinforcement consisting of not less than two continuous wires each with a minimum aggregate cross-sectional area of 0.017 square inches shall be provided in horizontal bed joints spaced not more than 16 inches on center vertically.

R-404.7 Lateral Support: Masonry walls shall be laterally supported in either the horizontal or the vertical direction at intervals not exceeding those given in Table R-404.7.

Lateral support shall be provided by cross walls, pilasters, buttresses, or structural frame members when the limiting distance is taken horizontally, or by floors, or roofs acting as diaphragms or structural frame members when the limiting distance is taken vertically.

Table No. R-404.7
WALL LATERAL SUPPORT REQUIREMENTS

CONSTRUCTION	Maximum Wall Length to Thickness, [1,2] or Wall Height to Thickness
Bearings walls	
Solid or solid grouted	20
All other	18
Nonbearing walls	
Exterior	18
Interior	36

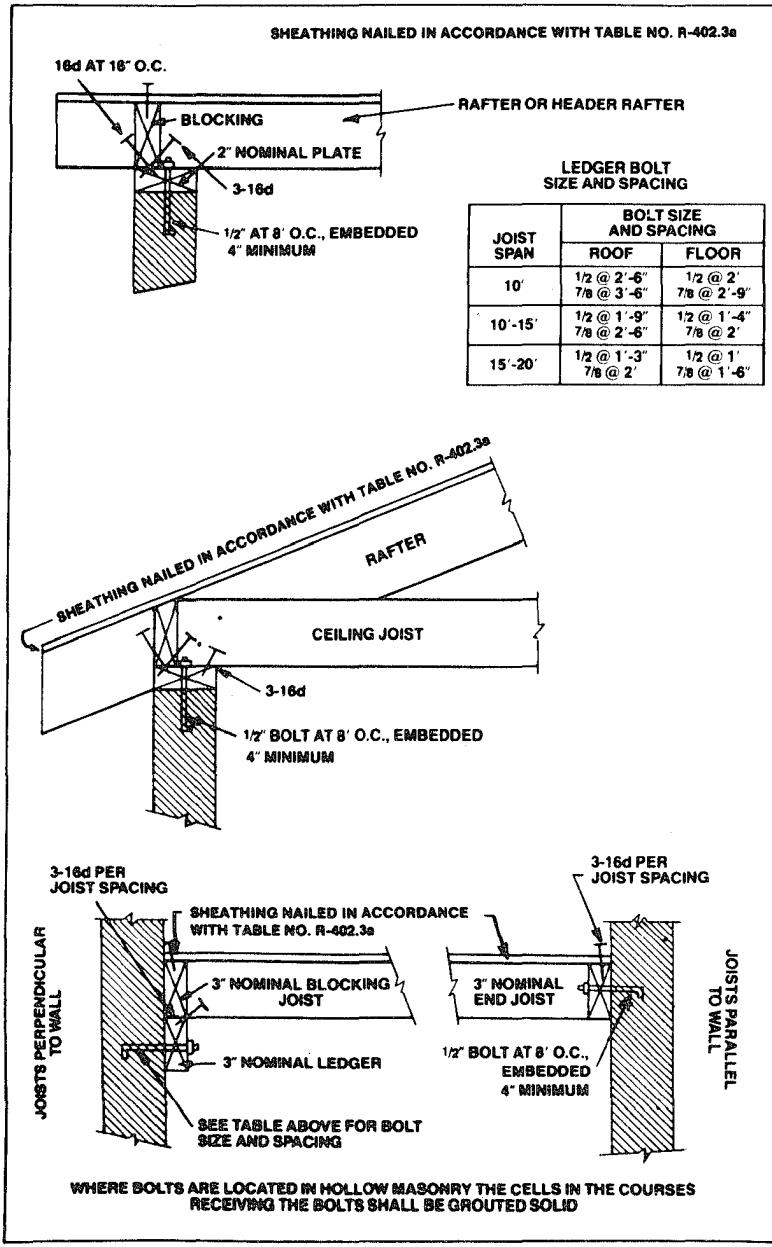
[1] Except for cavity walls and cantilever walls, the thickness of a wall shall be its nominal thickness measured perpendicular to the face of the wall. For cavity walls, the thickness shall be determined as the sum of the nominal thickness of the individual wythes. For cantilever walls, except for parapets, the ratio of height to nominal thickness shall not exceed 6 for solid masonry or 4 for hollow masonry. For parapets see Section R-404.1.4.

[2] An additional unsupported height of 6 feet is permitted for gable end walls.

R-404.8 Lintels: Masonry over openings shall be supported by steel lintels, reinforced concrete or masonry lintels or masonry arches, designed to support load imposed. Lintels and arches shall be constructed of materials and designed in accordance with the AISC "Specification for the Design, Fabrication and Erection of Structural Steel Buildings," BIA Technical Notes 17H, 31A, or 31B, NCMA TR 91, NCMA TEK 25A or NCMA TEK 81, listed in Section S-26.404.

R-404.9 Anchorage: Masonry walls shall be anchored to floor and roof systems in accordance with the details shown in Figure No. R-404.9, R-404.10a or R-404.10b. Footings may be considered as points of lateral support.

Figure No. R-404.9
ANCHORAGE REQUIREMENTS FOR MASONRY WALLS LOCATED IN SEISMIC ZONE NO. 0, 1 OR 2 AND WHERE WIND LOADS ARE LESS THAN 30 psf



LEDGER BOLT SIZE AND SPACING

JOIST SPAN	BOLT SIZE AND SPACING	
	ROOF	FLOOR
10'	1/2 @ 2'-6" 7/8 @ 3'-6"	1/2 @ 2' 7/8 @ 2'-9"
10'-15'	1/2 @ 1'-9" 7/8 @ 2'-6"	1/2 @ 1'-4" 7/8 @ 2'
15'-20'	1/2 @ 1'-3" 7/8 @ 2'	1/2 @ 1' 7/8 @ 1'-6"

(Continued)

Figure No. R-404.9 (Continued)

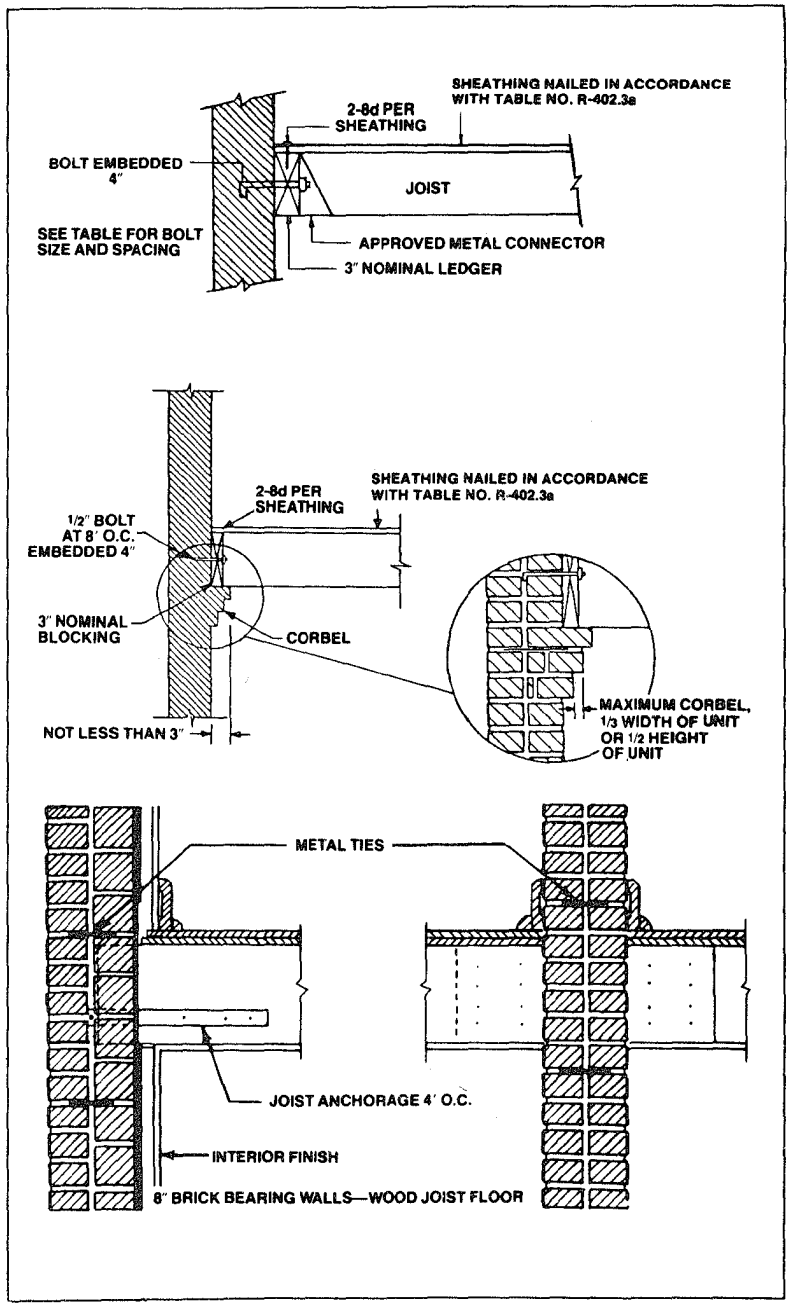


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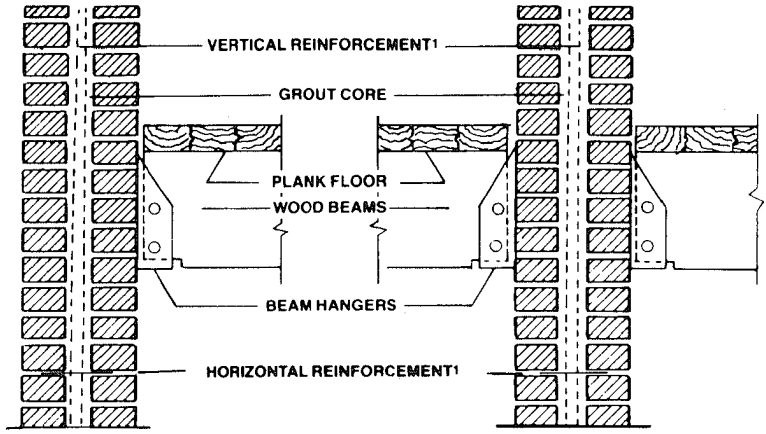
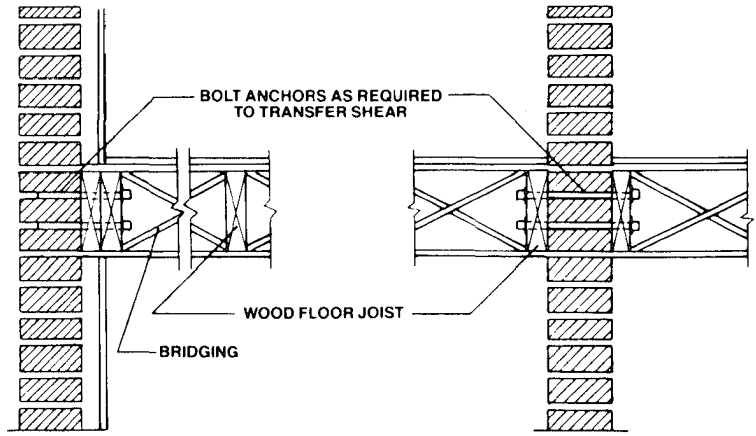
Figure No. R-404.9 (Continued)



1. Horizontal and vertical reinforcement will vary with design requirements.

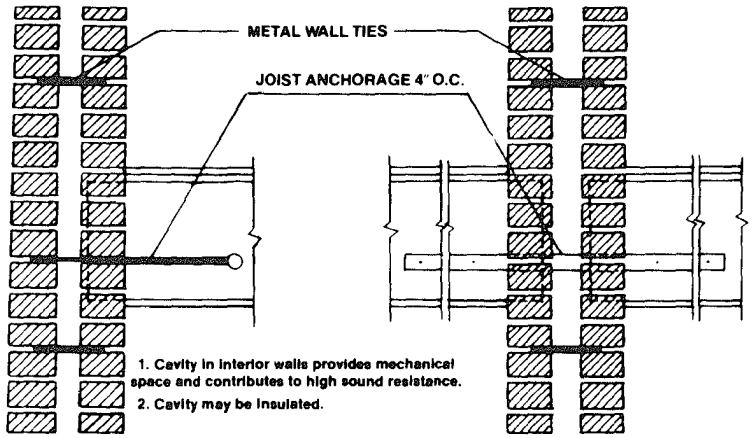
10" RBM BEARING WALLS—PLANK AND BEAM TIMBER FLOOR



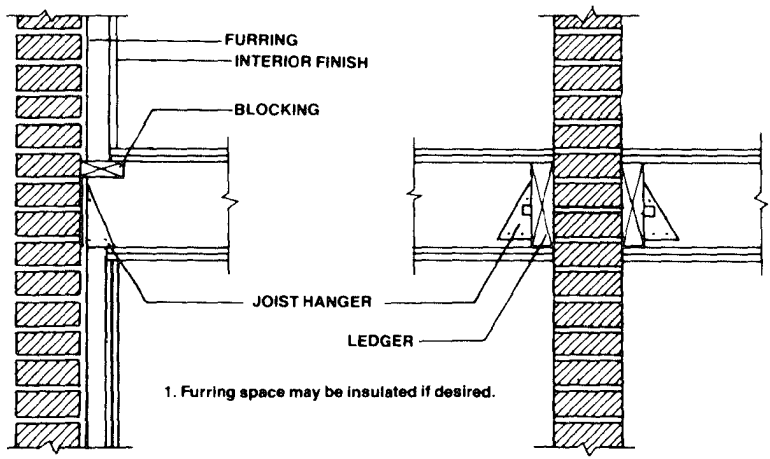
6" BRICK SHEAR WALLS—WOOD JOIST FLOOR

(Continued)

Figure No. R-404.9 (Continued)



10" BRICK CAVITY BEARING WALLS—
WOOD JOIST FLOOR



6" BRICK BEARING WALLS—WOOD JOIST FLOOR

R-404.10 Reinforcement: Masonry walls subject to wind loads of 30 pounds per square foot or greater, or located in Seismic Zone No. 3 or 4 as established in Table No. R-201.2, shall be constructed in accordance with the requirements of this chapter and Figure Nos. R-404.10a and R-404.10b. In addition, the minimum area of reinforcement shall be not less than 0.002 times the gross cross-sectional area of the wall, not more than two-thirds of which may be used in either direction. No required vertical reinforcement shall be less than 3/8 inch in diameter. Principal wall steel shall have a maximum spacing of 4 feet on center.

* **R-404.11 Protection for reinforcement:** All bars shall be completely embedded in mortar or grout. Joint reinforcement embedded in horizontal mortar joints shall have not less than 5/8-inch mortar coverage from the exposed face. All other reinforcement shall have a minimum coverage of one bar diameter over all bars, but not less than 3/4 inch except where exposed to weather or soil, in which cases the minimum coverage shall be 2 inches.

R-404.12 Beam supports: Beams, girders or other concentrated loads supported by a wall or column shall have a bearing of at least 3 inches in length measured parallel to the beam upon solid masonry not less than 4 inches in thickness, or upon a metal bearing plate of adequate design and dimensions to distribute the load safely, or upon a continuous reinforced masonry member projecting not less than 4 inches from the face of the wall.

Joists shall have a bearing of not less than 11/2 inches except as provided above, and shall be supported in accordance with Figure No. R-404.9.

R-404.13 Metal accessories: Joint reinforcement, anchors, ties and wire fabric shall conform to the following ASTM standards listed in Section S-26.404: ASTM A82 for joint reinforcement, wire anchors and ties; ASTM A36 for plate, headed and bent-bar anchors; ASTM A510 for corrugated sheet metal anchors and ties; ASTM B227 for copper-clad steel wire ties; or ASTM A167 for stainless steel hardware.

R-404.13.1 Corrosion protection: Minimum corrosion protection of joint reinforcement, anchors ties and wire fabric for use in masonry wall construction shall conform to Table No. R-404.13.1

Figure NO. R-404.10a
REQUIREMENTS FOR REINFORCED GROUTED MASONRY CONSTRUCTION IN SEISMIC ZONE NO. 3 OR 4 OR WHERE WIND LOADS ARE 30 psf OR GREATER

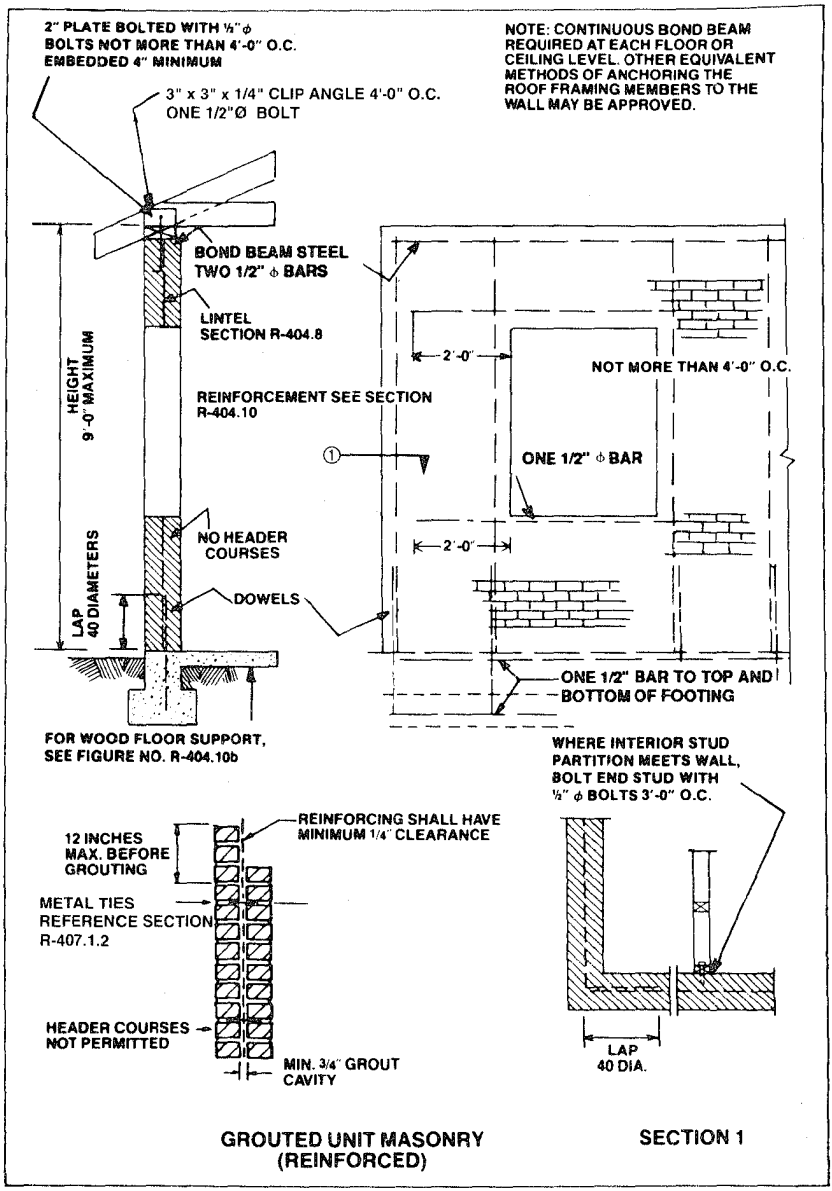
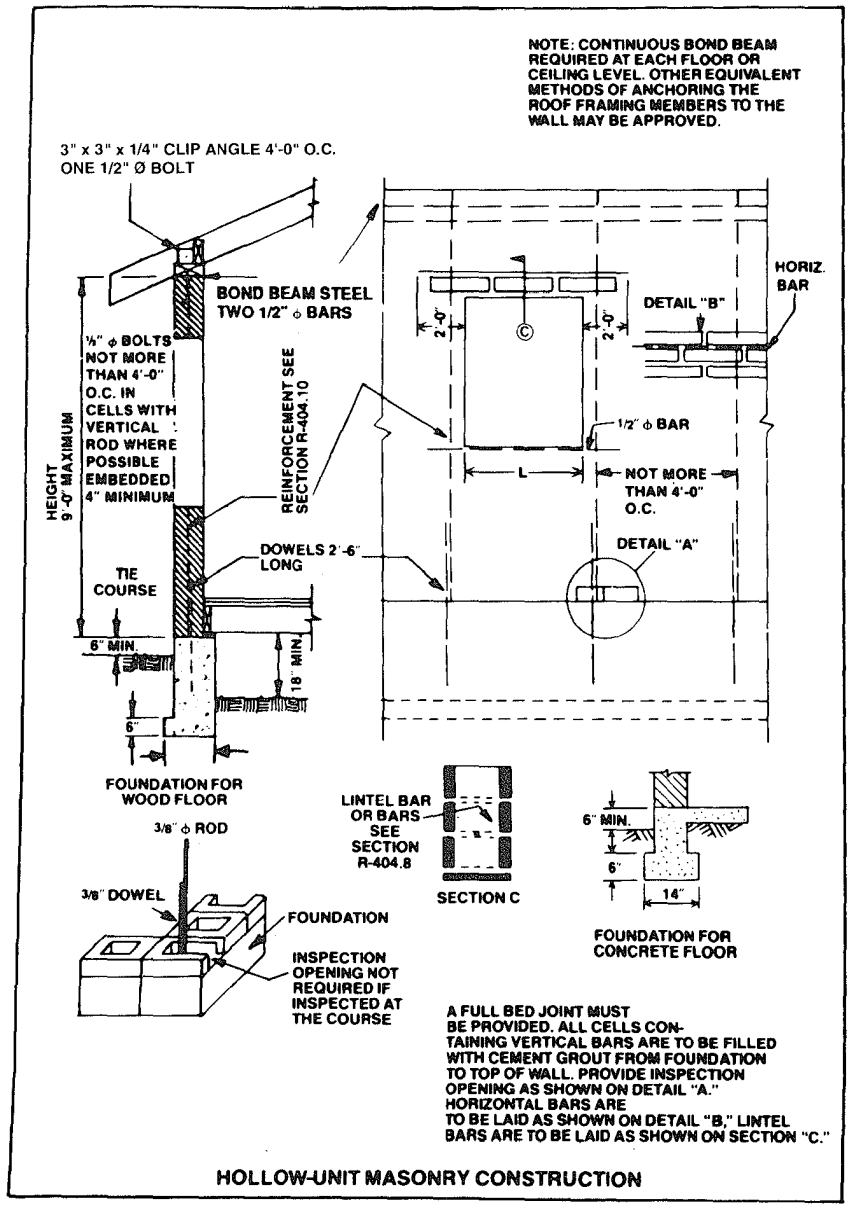


Figure NO. R-404.10b
REQUIREMENTS FOR REINFORCED HOLLOW-UNIT MASONRY CONSTRUCTION IN SEISMIC ZONE NO. 3 OR 4 OR WHERE WIND LOADS ARE 30 psf OR GREATER



HOLLOW-UNIT MASONRY CONSTRUCTION

Table No. R-404.13.1
MINIMUM CORROSION PROTECTION

Masonry Metal Accessory	Standard (As listed in Section S-26.404)
Joint reinforcement, interior walls	ASTM A641, Class 1
Wire ties or anchors in exterior walls completely embedded in mortar or grout	ASTM A641, Class 3
Wire ties or anchors in exterior walls not completely embedded in mortar or grout	ASTM A153, Class B-2
Joint reinforcement in exterior walls or interior walls exposed to moist environment	ASTM A153, Class B-2
Sheet metal ties or anchors exposed to weather	ASTM A153, Class B-2
Sheet metal ties or anchors completely embedded in mortar or grout	ASTM A525, Class G-60
Stainless steel hardware for any exposure	ASTM A167, Type 304

SECTION R-405—UNIT MASONRY

R-405.1 Placing mortar and masonry units

R-405.1.1 Bed and head joints: Unless otherwise required or indicated on the project drawings, head and bed joints shall be 3/8 inch thick, except that the thickness of the bed joint of the starting course placed over foundations shall not be less than 1/4 inch and not more than 3/4 inch.

Mortar joint thickness shall be within the following tolerances from the specified dimensions:

bed joint ..... ±1/8 inch

head joint ..... -1/4 inch, +3/8 inch

collar joints ..... -1/4 inch, +3/8 inch

R-405.1.2 Hollow units: Hollow units shall be placed such that:

1. Face shells of bed joints are fully mortared.
2. Webs are fully mortared in all courses of piers, columns and pilasters, in the starting course on foundations, where adjacent cells or cavities are to be grouted and when otherwise required.
3. Head joints are mortared a minimum distance from each face equal to the face shell thickness of the unit.

R-405.1.3 Solid units: Unless otherwise required or indicated on the project drawings, place solid units as follows:

1. In fully mortared bed and head joints,
2. Completely butter the ends of the units. Head joints are not to be filled by slushing with mortar,
3. Construct head joints by shoving mortar tight against the adjoining unit, and
4. Do not furrow bed joints deep enough to produce voids.

R-405.1.4 All units: Place units while the mortar is soft and plastic. Any unit disturbed to the extent that initial bond is broken after initial positioning shall be removed and relaid in fresh mortar.

R-405.2 Installation of wall ties: The installation of wall ties shall be as follows:

1. The ends of wall ties shall be embedded in mortar joints. Wall tie ends shall engage outer face shells of hollow units by at least 1/2 inch. Wire wall ties shall be embedded at least 1 1/2 inches into the mortar bed of solid masonry units or solid grouted hollow units.
2. Wall ties shall not be bent after being embedded in grout or mortar.

SECTION R-406—ANCHORAGE

R-406.1 General: Masonry elements shall be anchored in accordance with R-406.2 and R-406.3.

R-406.2 Intersecting walls: Masonry walls depending upon one another for lateral support shall be anchored or bonded at locations where they meet or intersect by one of the following methods indicated in Sections R-406.2.1 through R-406.2.4.

R-406.2.1 Bonding Pattern: Fifty percent of the units at the intersection shall be laid in an overlapping masonry bonding pattern, with alternate units having a bearing of not less than 3 inches on the unit below.

R-406.2.2 Joint reinforcement: Walls shall be anchored by joint reinforcement spaced at a maximum distance of 8 inches. Longitudinal reinforcement shall be at least 9 gauge and shall extend at least 30 inches in each direction at the intersection.

R-406.2.3 Interior nonload bearing walls: Interior nonload bearing walls shall be anchored at their intersection, at vertical intervals of not more than 16 inches with joint reinforcement or 1/4 inch galvanized mesh hardware cloth.

R-406.2.4 Steel Connectors: Walls shall be anchored by steel connectors having a minimum section of 1/4 inch by 1 1/2 inches with ends bent up at least 2 inches, or with cross pins to form anchorage. Anchors shall be at least 24 inches long with a maximum spacing of 4 feet.

R-406.2.5 Ties, joint reinforcement, anchors: Other metal ties, joint reinforcement or anchors, if used, shall be spaced to provide equivalent area of anchorage to that required by this section.

R-406.3 Anchorage to structural framing: Floor and roof diaphragms and other structural framing providing lateral support to masonry walls located in Seismic Zones No. 0, 1, or 2 shall be connected to the masonry in accordance with R-406.3.1, R-406.3.2 and R-406.3.3

R-406.3.1 Wood floor joists: Wood floor joists bearing on masonry walls shall be anchored to the wall at intervals not to exceed 6 ft by metal strap anchors or 1/2 inch diameter bolts installed as specified for roof structures in R-406.3.2, or by other approved connectors.

R-406.3.2 Roof structures: Roof structures shall be anchored to masonry walls with metal strap anchors, 1/2-inch bolts, or other approved anchors spaced not more than 6 ft on center. Bolts shall extend and be embedded at least 15 inches into the masonry, or be hooked or welded to bond beam reinforcement placed not less than 6 inches from the top of the wall.

R-406.3.3 Other structural framing: Where masonry walls are dependent upon other structural framing for lateral support they shall be anchored to the structural members with metal anchors. Metal anchors shall consist of 1/2-inch bolts spaced at 4 foot on center embedded 4 inches into the masonry, or their equivalent area may be used in an alternate spacing.

SECTION R-407— MULTIPLE WYTHE MASONRY

R-407.1 General: The facing and backing of multiple wythe masonry walls shall be bonded in accordance with Section R-407.1.1, R-407.1.2 or R-407.1.3. In cavity walls, neither the facing nor the backing shall be less than 3 inches nominal in thickness and the cavity shall not be more than 4 inches nominal in width. The backing shall be at least as thick as the facing.

Exception: Cavities may exceed the 4-inch nominal dimension provided tie size and tie spacing have been established by calculation.

R-407.1.1 Bonding with masonry headers:

1. Solid units: Where the facing and backing (adjacent wythes) of solid masonry construction are bonded by means of masonry headers, no less than 4 percent of the wall surface of each face shall be composed of headers extending not less than 3 inches into the backing. The distance between adjacent full-length headers shall not exceed 24 inches either vertically or horizontally. In walls in which a single header does not extend through the wall, headers from the opposite sides shall overlap at least 3 inches, or headers from opposite sides shall be covered with another header course overlapping the header below at least 3 inches.
2. Hollow units: Where two or more hollow units are used to make up the thickness of a wall, the stretcher courses shall be bonded at vertical intervals not exceeding 34 inches by lapping at least 3 inches over the unit below, or by lapping at vertical intervals not exceeding 17 inches with units which are at least 50 percent greater in thickness than the units below.

R-407.1.2 Bonding with wall ties or joint reinforcement:

1. Bonding with wall ties, except as required by paragraph two, where the facing and backing (adjacent wythes) of masonry walls are bonded with 3/16 inch diameter wall ties or metal wire of equivalent stiffness embedded in the horizontal mortar joints, there shall be at least one metal tie for each 4 1/2 ft^2 of wall area. Ties in alternate courses shall be staggered. The maximum

vertical distance between ties shall not exceed 24 inches, and the maximum horizontal distance shall not exceed 36 inches. Rods or ties bent to rectangular shape shall be used with hollow masonry units laid with the cells vertically. In other walls the ends of ties shall be bent to 90° angles to provide hooks no less than 2 inches long. Additional bonding ties shall be provided at all openings, spaced not more than 3 ft apart around the perimeter and within 12 inches of the opening.

2. Bonding with adjustable wall ties: Where the facing and backing (adjacent wythes) of masonry are bonded with adjustable wall ties, there shall be at least one tie for each 2 2/3 ft^2 of wall area. Neither the vertical nor horizontal spacing of the adjustable wall ties shall exceed 24 inches. The maximum vertical offset of bed joints from one wythe to the other shall be 1 1/4 inches. The maximum clearance between connecting parts of the ties shall be 1/16 inch. When pintle legs are used, ties shall have at least two 3/16 inch diameter legs.
3. Bonding with prefabricated joint reinforcement: Where the facing and backing (adjacent wythes) of masonry are bonded with prefabricated joint reinforcement, there shall be at lest one cross wire serving as a tie for each 2 2/3 ft^2 of wall area. The vertical spacing of the joint reinforcement shall not exceed 16 inches. Cross wires on prefabricated joint reinforcement shall be not smaller than No. 9 gauge. The longitudinal wires shall be embedded in the mortar.

R-407.1.3 Bonding with natural or cast stone:

1. Ashlar masonry: In ashlar masonry, bonder units, uniformly distributed, shall be provided to the extent of not less than 10% of the wall area. Such bonder units shall extend not less than 4 inches into the backing wall.
2. Rubble stone masonry: Rubble stone masonry 24 inches or less in thickness shall have bonder units with a maximum spacing of 3 ft vertically and 3 ft horizontally, and if the masonry is of greater thickness than 24 inches, shall have one bonder unit for each 6ft^2 of wall surface on both sides.

R-407.2 Masonry bonding pattern

R-407.2.1 Masonry laid in running bond: In each wythe of masonry laid in running bond, head joints in successive courses shall be offset by not less than one-fourth the unit length, or the masonry walls shall be reinforced longitudinally as required in Section R-407.2.2.

R-407.2.2 Masonry laid in stack bond: Where unit masonry is laid with less head joint offset than in Section R-407.2.1, the minimum area of horizontal reinforcement placed in mortar bed joints or in bond beams spaced not more than 48 inches apart, shall be 0.0007 times the vertical cross-sectional area of the wall.

SECTION R-408— GROUTED MASONRY

R-408.1 General: Grouted masonry is a form of construction made with masonry units in which the interior spaces are filled with grout, except that cores of solid masonry units and end spaces of stretcher units need not be grouted. At the time of laying, all masonry units shall be free of excessive dust and dirt.

R-408.2 Mortar and grout: Only Type M or Type S mortar mix consisting of portland cement, hydrated lime and sand in accordance with ASTM C270 listed in Section S-26.408 shall be used to construct masonry wythes. Grout shall consist of cementitious material and aggregate in accordance with ASTM C476 listed in Section S-26.408. Fine grout shall be used when the interior vertical space to receive grout does not exceed 2 inches in thickness. Interior vertical spaces exceeding 2 inches in thickness shall use coarse or fine grout. Type M or Type S mortar to which sufficient water has been added to produce pouring consistency can be used as grout.

R-408.3 Bonding of backup wythe: Where all interior vertical spaces are filled with grout in double-wythe construction, masonry headers shall not be permitted. Metal wall ties shall be used in accordance with Section R-407.1.2 to prevent spreading of the wythes and to maintain the vertical alignment of the wall. Wall ties shall be installed in accordance with Section R-407.1.2, when the backup wythe in double wythe construction is fully grouted.

R-408.4 Grouting requirements: Maximum pour heights and the minimum dimensions of spaces provided for grout placement shall conform to Table R-408.4. If the work is stopped for one hour or longer, the horizontal construction joints shall be formed by stopping all tiers at the same elevation and with the grout 1 inch below the top.

Table No. R-408.4
GROUT SPACE DIMENSIONS AND POUR HEIGHTS

Grout Type	Grout pour maximum height (feet)	Minimum width of grout spaces[1,2] (inches)	Minimum grout [2,3] space dimensions for grouting cells of hollow units (inches x inches)
Fine	1	3/4	1 1/2 x 2
	5	2	2 x 3
	12	2 1/2	2 1/2 x 3
	24	3	3 x 3
Coarse	1	1 1/2	1 1/2 x 3
	5	2	2 1/2 x 3
	12	2 1/2	3 x 3
	24	3	3 x 4

1 For grouting between masonry wythes.

2 Grout space dimension is the clear dimension between any masonry protrusion and shall be increased by the horizontal projection of the diameters of the horizontal bars within the cross section of the grout space.

3 Area of vertical reinforcement shall not exceed 6% of the area of the grout space.

*

R-408.4.1 Grout space (cleaning): Provision shall be made for cleaning grout space. Mortar projections which project more than 1/2 inch into grout space and any other foreign matter shall be moved from grout space prior to inspection and grouting.

* **R-408.4.2 Grout barriers:** Vertical grout barriers or dams shall be built of solid masonry across the grout space the entire height of the wall to control the flow of the grout horizontally. Grout barriers shall not be more than 25 feet apart.

R-408.4.3 Grout placement: Grout shall be a plastic mix suitable for pumping without segregation of the constituents and shall be mixed thoroughly. Grout shall be placed by pumping or by an approved alternate method and shall be placed before any initial set occurs and in no case more than one and one-half hours after water has been added.

Grouting shall be done in a continuous pour, in lifts not exceeding 4 feet. It shall be consolidated by puddling or mechanical vibrating during placing and reconsolidated after excess moisture has been absorbed but before plasticity is lost. The grouting of any section of a wall between control barriers shall be completed in one day with no interruptions greater than one hour.

Grout shall not be pumped through aluminum pipes.

R-408.4.4 Inspection: Special inspection during grouting shall be provided where required by the building official.

SECTION R-409— REINFORCED GROUTED MASONRY

R-409.1 General: Reinforced grouted masonry shall conform to all of the requirements for grouted masonry specified in Section R-408 and also the requirements of this section.

R-409.2 Construction: The thickness of grout or mortar between masonry units and reinforcement shall be not less than 1/4 inch, except that 1/4-inch bars may be laid in horizontal mortar joints at least 1/2 inch thick, and steel wire reinforcement may be laid in horizontal mortar joints at least twice the thickness of the wire diameter.

SECTION R-410— REINFORCED HOLLOW-UNIT MASONRY

R-410.1 General: Reinforced hollow-unit masonry is the type of construction made with hollow masonry units in which certain cells are continuously filled with mortar or grout, and in which reinforcement is embedded.

R-410.2 Mortar and grout: Only Type M or Type S mortar mix consisting of portland cement, hydrated lime and sand in accordance with ASTM C270 listed in Section S-26.410 shall be used to construct walls of hollow masonry units. Grout shall consist of cementitious material and aggregate in accordance with ASTM C476 listed in Section S-26.410, or Type M or Type S mortar to which sufficient water has been added to produce pouring consistency.

R-410.3 Construction: Requirements for construction shall be as follows:

1. All reinforced hollow-unit masonry shall be built to preserve the unobstructed vertical continuity of the cells to be filled. Walls and cross webs forming such cells to be filled shall be full-bedded in mortar to prevent leakage of grout. All head (or end) joints shall be solidly filled with mortar for a distance in from the face of the wall or unit not less than the thickness of the longitudinal face shells. Bond shall be provided by lapping units in successive vertical courses or by equivalent mechanical anchorage.
2. Vertical cells to be filled shall have vertical alignment sufficient to maintain a clear, unobstructed continuous vertical cell measuring not less than 2 inches by 3 inches.
3. Cleanout openings shall be provided at the bottom of all cells to be filled at each pour of grout where such pour is in excess of 4 feet in height. Any overhanging mortar or other obstruction or debris shall be removed from the insides of such cell walls. The cleanouts shall be sealed before grouting and after inspection.
4. Vertical reinforcement shall be held in position at top and bottom and at intervals not exceeding 192 diameters of the reinforcement.
5. All cells containing reinforcement shall be filled solidly with grout. Grout shall be poured in lifts of 8-foot maximum height. All grout shall be consolidated at time of pouring by puddling or vibrating and then reconsolidated by again puddling later, before plasticity is lost.

   When total grout pour exceeds 8 feet in height, the grout shall be placed in lifts not exceeding 4 feet each and special inspection during grouting shall be required. Minimum cell dimension shall be 3 inches.
6. When the grouting is stopped for one hour or longer, horizontal construction joints shall be formed by stopping the pour of grout not less than 1/2 inch below the top of the uppermost units grouted. Horizontal steel shall be fully embedded by grout in an uninterrupted pour.

SECTION R-411— WINDOWS

Windows shall be tested and certified to indicate compliance with the requirements of the following specifications listed in Section S-26.411:

Aluminum: AAMA (ANSI) 101
Wood: ANSI/NWWDA I.S. 2
Polyvinyl Chloride: ASTM D4099

Exceptions

1. Regardless of the type or requirements of the windows set forth in the aforementioned specifications, no window may be selected whose air infiltration exceeds 0.50 cfm per linear foot of crack

when tested in accordance with ASTM E283 listed in Section S-26.411 at a pressure differential of 1.56 psf.

2. When selecting windows in accordance with the aforementioned specifications, the design loading shall not exceed 66 2/3 percent of the uniform structural test loading set forth in the specification.

SECTION R-412—SLIDING GLASS DOORS

Sliding glass doors shall be tested and certified to indicate compliance with the requirements of the following specifications listed in Section S-26.412:

Aluminum: AAMA (ANSI) 101

Wood: ANSI/NWWDA I.S.3

Exceptions

1. Regardless of the type or requirements of the sliding glass doors set forth in the aforementioned specifications, no sliding glass door may be selected whose air infiltration exceeds 0.50 cfm per square foot of door area when tested in accordance with ASTM E283 listed in Section S-26.412 at a pressure differential of 1.56 psf.
2. When selecting sliding glass doors in accordance with the aforementioned specifications, the design loading shall not exceed 66 2/3 percent of the uniform structural test loading set forth in the specification.

SECTION R-413—PLYWOOD

R-413.1 Identification and grade: Plywood shall conform to DOC PS1, APA PRP-108, HPMA (ANSI) HP, APA E30, APA Y510 and HPMA HP-SG, listed in Section S-26.413 and shall be so identified by a grade mark or certificate of inspection issued by an approved agency. Plywood shall comply with the grades specified in Table No. R-402.3b.

R-413.2 Allowable spans: The maximum allowable spans for plywood wall sheathing shall not exceed the values set forth in Table R-402.3b.

R-413.3 Installation: Plywood wall sheathing shall be attached to framing in accordance with Table No. R-402.3a.

SECTION R-414—PARTICLEBOARD

R-414.1 Identification and grade: Particleboard shall conform to ANSI A208.1 listed in Section S-26.414 and shall be so identified by a grade mark or certificate of inspection issued by an approved agency. Particleboard shall comply with the grades specified in Table No. R-402.3c.

Chapter 5
WALL COVERING

SECTION R-501 — GENERAL

R-501.1 Application: The provisions of this chapter shall control the design and construction of the interior and exterior wall covering for all buildings. The use of materials or methods of construction not specified in this chapter accomplishing the purposes intended by this code and approved by the building official in accordance with Section R-108 shall be accepted as complying with this code.

R-501.2 Installation: Products sensitive to adverse weather shall not be installed until adequate weather protection for the installation is provided. Exterior sheathing shall be dry before applying exterior cover.

SECTION R-502 — INTERIOR COVERING

R-502.1 General: Interior coverings shall be installed in accordance with this chapter and Table Nos. R-502.3a, R-502.3b, R-502.5, R-503.3a and R-503.3b.

R-502.2 Vertical assemblies: Vertical support for lath or gypsum wallboard shall be not less than 2 inches nominal in least dimension. Wood stripping for furring shall not be less than 2 inches nominal thickness in the least dimension except that furring strips not less than 1-inch by 2-inch nominal dimension may be used over solid backing.

R-502.3 Interior: Where wood-framed walls and partitions are covered in the interior with portland cement plaster or tile or similar material and subject to water splash, the framing shall be protected with an approved moisture barrier. Vapor barriers shall not be used behind water-resistant gypsum backing board.

Gypsum board may be applied at right angles or parallel to framing members, except gypsum lath shall be applied at right angles with end joints staggered.

Support spacing for gypsum and metal lath shall conform with Table No. R-502.3a, and fastener spacing shall conform with Table No. R-502.3b.

R-502.4 Interior plaster: Plastering with gypsum plaster or portland cement plaster shall conform to ASTM C5, C28, C35, C37, C59, C61, C587, C588, C631, C841, C842, C847, C926 and C933 listed in Section S-26.502 and shall be not less than two coats when applied over other bases permitted by this section, except that veneer plaster may be applied in one coat not to exceed 3/16 -inch thickness.

Table No. R-502.3a
MAXIMUM SPACING OF SUPPORTS FOR LATH

TYPE OF LATH		MINIMUM WEIGHT (Per Square Yard) GAUGE AND MESH SIZE	VERTICAL (In Inches)			HORIZONTAL (In Inches)	
				Metal			
			Wood	Solid Plaster Partitions	Other	Wood or Concrete	Metal
Expanded metal lath (diamond mesh)		2.5 3.4	16 16	16 16	12 16	— 16	— 13 1/2
Flat rib expanded metal lath		2.75 3.4	16 19	16 24	16 19	16 19	12 19
Stucco mesh expanded metal lath		1.8 and 3.6	16[2]	—	—	—	—
3/8" rib expanded metal lath		3.4 4.0	24 24	24 24	24 24	24 24	24 24
Sheet lath		4.5	24	—	24	24	24
3/4" rib expanded metal lath		5.4	—	—	—	36[3]	36[3]
Wire lath	Welded	1.95 pounds, No. 11 gauge, 2" × 2"	24	24	24	24	24
		1.4 pounds, No. 16 gauge, 2" × 2"	16	16	16	16	16
		1.4 pounds, No. 18 gauge, 1" × 1"[4]	16	—	—	—	—
	Woven	1.4 pounds, No. 17 gauge, 1 1/2" hexagonal[4]	16	—	—	—	—
		1.4 pounds, No. 18 gauge, 1" hexagonal[4]	16	—	—	—	—
3/8" Gypsum lath (perforated)			16	—	16	16	16
3/8" Gypsum lath (plain)			16	—	16	16	16
1/2" Gypsum lath (perforated)			16	—	16	16	16
1/2" Gypsum lath (plain)			24	—	24	24	24

[1]Metal lath and wire lath as reinforcement for portland cement plaster shall be furred out away from vertical supports at least 1/4 inch. Self-furring lath meets furring requirements.

[2]Wire backing required on open vertical frame construction except under expanded metal lath and paperback wire lath.

[3]Contact or furred ceilings only. May not be used in suspended ceilings.

[4]Stucco netting, not to be used as a base for gypsum plaster.

Table No. R-502.3b
MAXIMUM SPACING OF FASTENERS FOR SUPPORT OF LATH

TYPE OF LATH	TYPE OF FASTENER	NAILS Maximum Spacing (in inches) Vertical (In Inches)	NAILS Maximum Spacing (in inches) Horizontal (In Inches)	STAPLES[1] (Round or Flattened Wire) Leg[6]	Wire Gauge No. (In Inches)	Minimum Crown Width (In Inches)	Maximum Spacing Vertical	Maximum Spacing Horizontal
Diamond mesh, expanded metal lath and flat rib metal lath	4d blued box (clinched)[1] 1" No. 11 Ga., 7/16" head, barbed 1 1/2" No. 11 Ga., 7/16", barbed	6 6 6	— — 6	7/8	16	7/16	6	6
3/8" rib metal lath and sheet lath	1 1/2" No. 11 Ga., 7/16" head, barbed	6	6	1 1/4	16	7/16	6	6
3/4" rib metal lath	4d Common 2" No. 11 Ga., 7/16" head, barbed	At ribs —	— At ribs	1 3/4 —	16 —	7/16 —	At ribs —	At ribs —
Wire lath[4]	4d blued box (clinched)[3] 1" No. 11 Ga., 7/16" head, barbed 1 1/2" No. 11 Ga., 7/16" head, barbed 1 1/4" No. 12 Ga., 3/8" head, furring	6 6 6 6	— — 6 —	7/8	16	7/16	6	6
3/8" gypsum lath[3]	1 1/8" No. 13 Ga., 19/64" head, blued	5	5	7/8	16	7/16	5	5
1/2" gypsum lath[3]	1 1/4" No. 13 Ga., 19/64" head, blued	5[5] 4[6]	5[5] 4[6]	1 1/8	16	7/16	4	4

[1]With divergent points and semiflattened ground wire for gypsum lath.

[2]When lath and stripping are stapled simultaneously, increase leg length of staple 1/8 inch.

[3]For interior only

[4]Attach self-furring wire fabric lath to supports at furring device.

[5]Perforated lath.

[6]Plain lath.

R-502.5 Gypsum wallboard: All gypsum wallboard shall conform to ASTM C36, C474, and C475 listed in Section S-26.502 and shall be installed in accordance with ASTM C557 and GA-216 listed in Section S-26.502 and the provisions of this section. Gypsum wallboard shall not be installed until weather protection is provided.

All edges and ends of gypsum wallboard shall occur on the framing members, except those edges and ends which are perpendicular to the framing members.

Support spacing and the size and spacing of fasteners shall comply with Table No. R-502.5.

R-502.6 Shower and bath spaces: Shower and bath areas, floors and walls shall be finished with a smooth, hard and nonabsorbent surface in accordance with ANSI A108.1, A108.4, A108.5, A108.6, A118.1, A118.3, A136.1 and A137.1 listed in Section S-26.502 to a height of not less than 6 feet above the floor.

If gypsum board is utilized as the base or backer board for adhesive application of ceramic tile or other nonabsorbent finish materials, the gypsum board shall be of a type manufactured for this use. All cut or exposed edges, including those at wall intersections, shall be sealed as recommended by the manufacturer.

R-502.7 Other finishes: Wood veneer or hardboard paneling not less than 1/4 -inch nominal thickness (13/64 -inch actual) shall conform to HPMA (ANSI) HP listed in Section S-26.502 and may be installed directly to studs with maximum 16 inches on center spacing; wood veneer or hardboard paneling less than 1/4 -inch nominal thickness must have not less than 3/8 -inch gypsum board backer, unless the qualifying tests were made with the material suspended from the noncombustible backing, and stud spacing may not exceed 16 inches on center.

Wood shakes and shingles shall conform to CSSB "Grading and Packing Rules for Certi-Split Red Cedar Shakes," "Grading Rules for Certi-Sawn Taper-Sawn Red Cedar Shakes" and "Grading and Packing Rules for Certigrade Red Cedar Shingles" listed in Section S-26.502 and shall be applied in accordance with the CSSB "Design and Application Manual for Exterior and Interior Walls" listed in Section S-26.502.

R-502.8 Finishes and materials: Interior finishes and materials shall conform to requirements of Section R-217.

SECTION R-503—EXTERIOR COVERING

R-503.1 General: All exterior walls shall be covered with approved materials designed and installed to provide a barrier against the weather and insects to enable environmental control of the interior spaces. The exterior coverings contained in this section shall be installed in the specified manner unless otherwise approved.

R-503.2 Exterior lath: All lath and lath attachments shall be of corrosion-resistant materials and shall conform to Table Nos. R-502.3a and R-502.3b.

Table No. R-502.5
APPLICATION AND MINIMUM THICKNESS OF GYPSUM WALLBOARD

THICKNESS OF GYPSUM WALLBOARD (inch)	PLANE OF FRAMING SURFACE	LONG DIMENSION OF GYPSUM WALLBOARD SHEETS IN RELATION TO DIRECTION OF FRAMING MEMBERS	MAXIMUM SPACING OF FRAMING MEMBERS (center-to-center, in inches)	MAXIMUM SPACING OF FASTENERS (center-to-center, in inches)		NAILS[1]—TO WOOD
				Nails[1,2]	Screws[3]	
Fastening required without adhesive application.						
3/8	Horizontal[4]	Perpendicular	16	7	12	No. 13 gauge 1 1/2" long, 19/64" head; 0.098" diameter, 1 1/2" long, annular-ringed; 4d cooler nail
	Vertical	Either direction	16	8	12	
1/2	Horizontal	Either direction	16	7	12	No. 13 gauge 1 3/8" long 19/64" head; 0.098" diameter, 1 1/4" long, annular-ringed; 5d cooler nail
	Horizontal	Perpendicular	24	7	12	
	Vertical	Either direction	24	8	12	
5/8	Horizontal	Either direction	16	7	12	No. 13 gauge, 1 5/8" long, 19/64" head; 0.098" diameter, 1 3/8" long, annular-ringed; 6d cooler nail
	Horizontal	Perpendicular	24	7	12	
	Vertical	Either direction	24	8	12	
With adhesive application.						
3/8	Horizontal[4]	Perpendicular	16	16	16	Same as above for 3/8"
	Vertical	Either direction	16	16	24	
1/2 or 5/8	Horizontal	Either direction	16	16	16	As required for 1/2" and 5/8" gypsum wallboard, see above
		Perpendicular	24	12	16	
	Vertical	Either direction	24	24	24	
2—3/8 layers	Horizontal	Perpendicular	24	16	16	Base ply nailed as required for 1/2" gypsum wallboard and face ply placed with adhesive
	Vertical	Either direction	24	24	24	

[1]Where the metal framing has a clinching design formed to receive the nails by two edges of metal, the nails shall be not less than 5/8 inch longer than the wallboard thickness and shall have ringed shanks. Where the metal framing has a nailing groove formed to receive the nails, the nails shall have barbed shanks or be 5D, No. 13 1/2 gauge, 1 5/8 inches long, 15/64-inch head for 1/2-inch gypsum wallboard; 6d, No. 13 gauge, 1 7/8 inches long, 15/64-inch head for 5/8-inch gypsum wallboard.

[2]Two nails spaced not less than 2 inches apart, nor more than 2 1/2 inches apart, and pairs of nails spaced not more than 12 inches center to center may be used.

[3]Screw shall be Type S or W per ASTM C1002 listed in Section S-26.502 and long enough to penetrate wood framing not less than 5/8 inch and metal framing not less than 1/4 inch.

[4]Three-eighths-inch single-ply gypsum board shall not be installed if water-based spray-textured finish is applied nor to support insulation above a ceiling.

Backing for vertical surfaces shall consist of sheathing or of not less than No. 18 U.S. gauge steel wire stretched taut horizontally and spaced not more than 6 inches apart vertically.

Where lath on vertical surfaces extends between rafters or other similar projecting members, solid backing shall be installed to provide support for lath and attachments.

Gypsum lath shall not be used, except that on horizontal supports of ceilings or roof soffits it may be used as backing for metal lath or wire lath and portland cement plaster.

Backing is not required under expanded metal lath or paperbacked wire lath.

R-503.3 Exterior plaster: Plastering with portland cement plaster, conforming to ASTM C926 listed in Section S-26.503, shall be not less than three coats when applied over metal lath or wire lath and shall be not less than two coats when applied over masonry, concrete or gypsum backing. If plaster surface is completely covered by veneer or other facing material or is completely concealed, plaster application need be only two coats, provided the total thickness is as set forth in Table No. R-503.3a.

On wood-frame construction with an on-grade concrete floor slab system, exterior plaster shall be applied in such a manner as to cover, but not to extend below, the lath, paper and screed.

Only approved plasticity agents and approved amounts thereof may be added to portland cement. When plastic cement is used, no additional lime or plasticizers shall be added. Hydrated lime or the equivalent amount of lime putty used as a plasticizer, may be added to standard portland cement in an amount not to exceed 20 percent by weight of the portland cement.

The proportion of aggregate to cementitious materials shall be as set forth in Table Nos. R-503.3b and R-503.3c.

R-503.4 Masonry veneer, general: All masonry veneer shall be installed in accordance with this chapter, Figure No. R-503.4 and Table No. R-503.6. Exterior masonry veneer shall not be attached to wood at any point more than 25 feet above the adjacent ground elevation in Seismic Zone No. 3 or 4 nor more than 35 feet in Seismic Zone No. 0, 1 or 2. Masonry veneers and veneers of concrete or stone may be supported by wood foundations in accordance with NFoPA Technical Report No. 7 listed in Section S-26.503. Veneers used as interior wall finishes may be supported on wood floors which are designed to support the loads imposed.

R-503.4.1 Lintels: Masonry veneer shall not support any vertical load other than the dead load of the veneer above. Veneer above openings shall be supported upon lintels of noncombustible materials and the allowable span shall not exceed the values set forth in Table No. R-503.4.1. The lintels shall have a length of bearing of not less than 4 inches.

Table No. R-503.3a
THICKNESS OF PLASTER

PLASTER BASE	FINISHED THICKNESS OF PLASTER FROM FACE OF LATH, MASONRY, CONCRETE	
	Gypsum Plaster	Portland Cement Mortar
Expanded metal lath	5/8" minimum[1]	5/8" minimum[1]
Wire lath	5/8" minimum[1]	3/4" minimum (interior)[2] 7/8" minimum (exterior)[2]
Gypsum lath	1/2" minimum	—
Masonry walls[3]	1/2" minimum	1/2" minimum
Monolithic concrete walls[3,4]	5/8" maximum	7/8" maximum
Monolithic concrete ceilings[3,4]	3/8" maximum[5]	1/2" maximum
Gypsum veneer base[6]	1/16" minimum	—

[1]When measured from back plane of expanded metal lath, exclusive of ribs, or self-furring lath, plaster thickness shall be 3/4 inch minimum.

[2]When measured from face of support or backing.

[3]Because masonry and concrete surfaces may vary in plane, thickness of plaster need not be uniform.

[4]When applied over a liquid bonding agent, finish coat may be applied directly to concrete surface.

[5]Approved acoustical plaster may be applied directly to concrete or over base coat plaster, beyond the maximum plaster thickness shown.

[6]Attachment shall be in accordance with Table No. R-502.5.

Table No. R-503.3b
GYPSUM PLASTER PROPORTIONS[1]

NUMBER	COAT	PLASTER BASE OR LATH	MAXIMUM VOLUME AGGREGATE PER 100 POUNDS NEAT PLASTER[2] (Cubic Feet)	
			Damp Loose Sand[1]	Perlite or Vermiculite[3]
Two-coat work	Base coat	Gypsum lath	2 1/2	2
	Base coat	Masonry	3	3
Three-coat work	First coat	Lath	2[4]	2
	Second coat	Lath	3[4]	2[5]
	First and second coats	Masonry	3	3

[1]Wood-fibered gypsum plaster may be mixed in the proportions of 100 pounds of gypsum to not more than 1 cubic foot of sand where applied on masonry or concrete.

[2]When determining the amount of aggregate in set plaster, a tolerance of 10 percent shall be allowed.

[3]Combinations of sand and lightweight aggregate may be used, provided the volume and weight relationship of the combined aggregate to gypsum plaster is maintained.

[4]If used for both first and second coats, the volume of aggregate may be 2 1/2 cubic feet.

[5]Where plaster is 1 inch or more in total thickness the proportions for the second coat may be increased to 3 cubic feet.

Table No. R-503.3c
PORTLAND CEMENT PLASTER

MAXIMUM VOLUME AGGREGATE PER VOLUME CEMENTITIOUS MATERIAL[1]						
COAT	Portland Cement Plaster[2] Maximum Volume Aggregate per Volume Cement	PORTLAND CEMENT-LIME PLASTER[3] Maximum Volume Lime per Volume Cement	Maximum Volume Sand per Volume Cement and Lime	Approximate Minimum Thickness[4] Curing	MINIMUM PERIOD MOIST COATS	MINIMUM INTERVAL BETWEEN
First	4	3/4	4	3/8[5]	48[6] Hours	48[7] Hours
Second	5	3/4	5	First and second coats	48 Hours	7 Days[8]
Finished	3[9]	—	3[9]	1/8"	—	—[8]

[1]When determining the amount of aggregate in set plaster, a tolerance of 10 percent may be allowed.

[2]From 10 to 20 pounds of dry hydrated lime (or an equivalent amount of lime putty) may be added as a plasticizing agent to each sack of Type I and Type II standard portland cement in base coat plaster.

[3]No additions of plasticizing agents shall be made.

[4]See Table No. R-503.3a.

[5]Measured from face of support or backing to crest of scored plaster.

[6]Twenty-four-hour minimum period for moist curing of interior portland cement plaster.

[7]Twenty-four-hour minimum interval between coats of interior portland cement plaster.

[8]Finish coat plaster may be applied to interior portland cement base coats after a 48-hour period.

[9]For finish coat, plaster up to an equal part of dry hydrated lime by weight (or an equivalent volume of lime putty) may be added to Type I, Type II and Type III standard portland cement.

Table No. R-503.4.1
ALLOWABLE SPANS FOR LINTELS SUPPORTING MASONRY VENEER

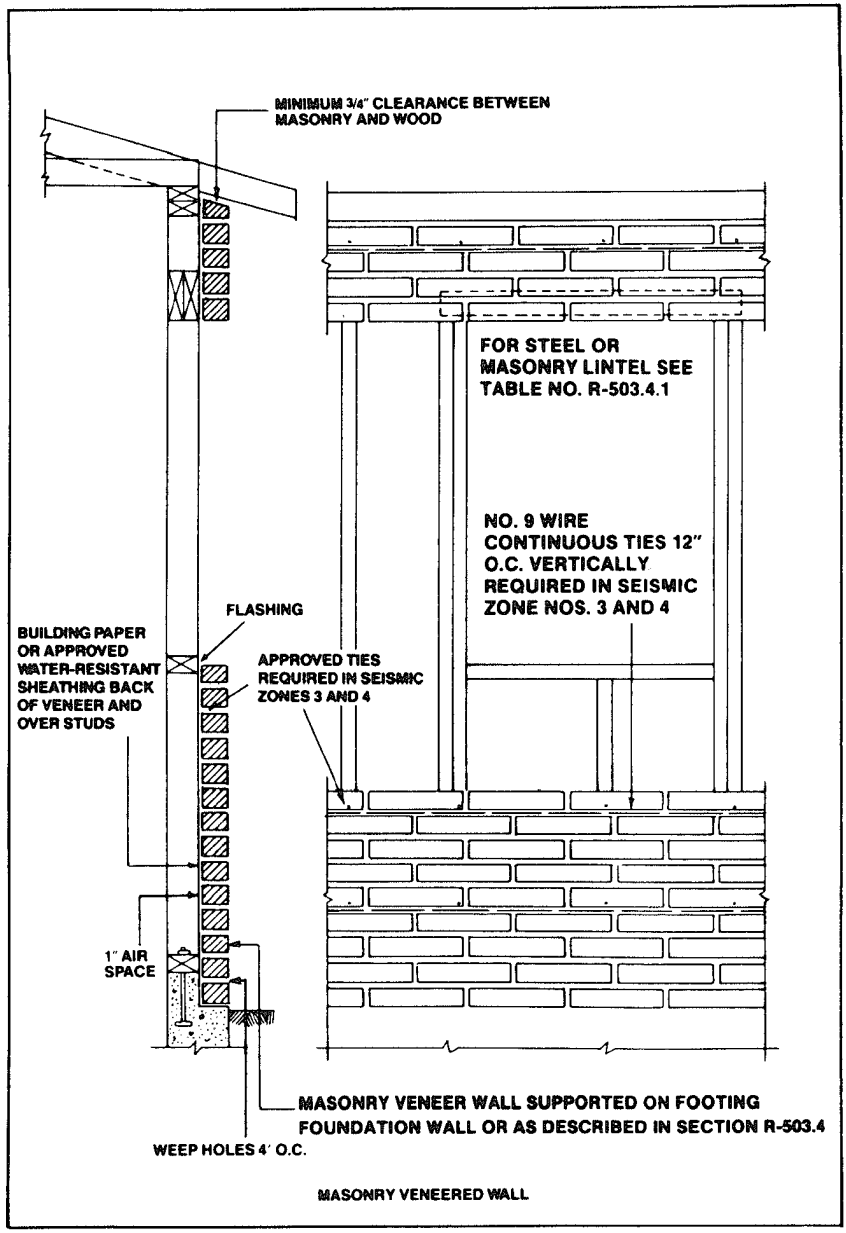
SIZE OF STEEL ANGLE[1] [3]	NO STORY ABOVE	ONE STORY ABOVE	TWO STORIES ABOVE	NO. OF 1/2" OR EQUIVALENT REINFORCING BARS[2]
3 × 3 × 1/4	6'-0"	3'-6"	3'-0"	1
4 × 3 × 1/4	8'-0"	5'-0"	3'-0"	1
6 × 3 1/2 × 1/4	14'-0"	8'-0"	3'-6"	2
2-6 × 3 1/2 × 1/4	20'-0"	11'-0"	5'-0"	4

[1]Long leg of the angle shall be placed in a vertical position.

[2]Depth of reinforced lintels shall be not less than 8 inches and all cells of hollow masonry lintels shall be grouted solid. Reinforcing bars shall extend not less than 8 inches into the support.

[3]Steel members indicated are adequate typical examples; other steel members meeting structural design requirements may be used.

Figure No. R-503.4
MASONRY VENEERED
WALL DETAIL



R-503.4.2 Attachment: Masonry veneer shall be attached to the supporting wall with corrosion-resistant metal ties.

Veneer ties, if strand wire, shall not be less in thickness than No. 9 U.S. gauge wire and shall have a hook embedded in the mortar joint, or if sheet metal, not less than No. 22 U.S. gauge by 7/8-inch corrugated. Each tie shall be spaced not more than 24 inches on center horizontally and shall support not more than 3 1/4 square feet of wall area.

Exception: In Seismic Zone No. 3 or 4 and in wind area of more than 30 pounds per square foot, each tie shall support not more than 2 square feet of wall area.

In Seismic Zone No. 3 or 4, anchor ties of No. 9 gauge or equivalent shall be provided in horizontal joint reinforcement wire. The joint reinforcement shall be continuous with butt splices between ties permitted.

When applied over stud construction, the studs shall be spaced a maximum of 16 inches on centers and approved paper shall first be applied over the sheathing or wires between studs, except as otherwise provided in Section R-503.8, and mortar shall be slushed into the 1-inch space between facing and paper.

As an alternate, an air space of at least 1 inch may be maintained between the backing and the veneer, in which case temporary spot bedding may be used away from the ties to align the veneer. Spot bedding at the ties shall be of cement mortar entirely surrounding the ties.

In lieu of such wire ties, an approved method of grouting the veneer to a paperbacked reinforcement attached directly to the studs may be used.

R-503.5 Weather protection: Exterior walls shall be covered with a weather-resistant siding and/or membrane. Wood shakes and shingles shall conform to CSSB "Grading and Packing Rules for Certi-Split Red Cedar Shakes," "Grading Rules for Certi-Sawn Taper-Sawn Red Cedar Shakes" and "Grading and Packing Rules for Red Cedar Shingles" listed in Section S-26.503.

R-503.6 Weather-resistant siding: The weather-resistant covering shall be installed in a manner to restrict the entrance of moisture and weather and shall be attached in accordance with Table No. R-503.6.

R-503.6.1 Cellular space protection: Where cellular spaces are not provided with interior corrosion-resistant vapor retarders in accordance with Section R-220, other approved means shall be used to avoid condensation and leakage of moisture.

R-503.7 Weather-resistant membrane and sheathing paper: Asphalt-saturated felt free from holes and breaks and weighing not less than 14 pounds per 100 square feet or other approved weather-resistant membrane shall be applied over studs or sheathing of all exterior walls as required by Table No. R-503.6. Such felt or membrane shall be applied horizontally, with the upper layer lapped over the lower layer not less than 2 inches. Where vertical joints occur, felt shall be lapped not less than 6 inches.

Such felt or membrane may be omitted:

1. In detached accessory buildings.
2. Under panel siding with shiplap joints or battens.
3. Under exterior wall finish materials as permitted in Table No. R-503.6, except stucco finish.
4. Under paperbacked stucco lath where method of attachment does not puncture paper.
5. Over water-repellent sheathing materials.

R-503.8 Flashing: Approved corrosion-resistive flashing shall be provided at top and sides of all exterior window and door openings in such a manner as to be leakproof, except that self-flashing windows having a continuous lap of not less than 1 1/8 inches over the sheathing material around the perimeter of the opening, including corners, do not require additional flashing; jamb flashing may also be omitted when specifically approved by the building official. Similar flashings shall be installed at the intersection of chimneys or other masonry construction with frame or stucco walls, with projecting lips on both sides under stucco copings; under and at the ends of masonry, wood or metal copings and sills; continuously above all projecting wood trim; where exterior porches, decks or stairs attach to a wall or floor assembly of wood-frame construction; at wall and roof intersections; under built-in gutters; at junction of chimneys and roofs; in all roof valleys and around all roof openings.

R-503.9 Plywood application: Exterior plywood joints shall occur over framing members, unless wood or plywood sheathing is used or joints are lapped horizontally a minimum of 1 1/2 inches or otherwise made waterproof to the satisfaction of the building official.

R-503.10 Attachment: All wall coverings shall be securely fastened in accordance with Table No. R-503.6 or with other approved aluminum, copper, zinc, zinc-coated or other approved corrosion-resistive fasteners.

Shingles and other weather coverings shall be attached with approximate standard shingle nails or other approved pneumatically, mechanically driven fasteners to furring strips securely nailed to studs, or with approved mechanically-bonding nails.

Wood Shingles or shakes shall be applied in accordance with the CSSB "Design and Application Manual for Exterior and Interior Walls" listed in Section S-26.503. Wood shingles or shakes attached with approved corrosion-resistive annular grooved nails may be applied over fiberboard shingle backer and approved nail-base-type fiberboard sheathing not less than 1/2-inch nominal thickness in accordance with Table No. R-503.6.

Table No. R-503.6
WEATHER-RESISTANT SIDING ATTACHMENT AND MINIMUM THICKNESS

SIDING MATERIAL		NOMINAL THICKNESS[1] (Inches)	JOINT TREATMENT	WEATHER-RESISTANT MEMBRANE REQUIRED	TYPE OF SUPPORTS FOR THE SIDING MATERIAL AND FASTENERS[2,3,4] Wood, Plywood or Particleboard Sheathing	Fiberboard Sheathing Into Stud	Gypsum Sheathing into Stud	Direct to Studs	Number or Spacing or Fasteners
Horizontal aluminum[5,6]	Without insulation	.019[7]	Lap	No	.120 nail-1 1/2"	.120 nail-2"	.120 nail-2"	Not allowed	Same as stud spacing
		.024	Lap	No	.120 nail 1 1/2" long	.120 nail 2" long	.120 nail 2" long	Not allowed	
	With insulation	.019	Lap	No	.120 nail-1 1/2"	.120 nail-2 1/2"	.120 nail-2 1/2"	.120 nail-1 1/2"	
Brick veneer Clay tile veneer Concrete veneer		2 1/4 to 1 2	Sec. 503	Yes	See Sec. R-503 and Figure No. R-503.4				
Horizontal fiberboard[11]		1/2	Sec. 503	No	.099 nail 2" Staple-1 3/4"	.113 nail-2 3/4" Staple-2 1/2"	.113 nail-2 1/2" Staple-2 1/4"	.099-nail 2" Staple 1 3/4"	Same as stud spacing
Hardboard[14] Board and batten-vertical		1/4	(9)	(9)	.099-nail 2"	.099 nail-2 1/2"	.099 nail-2"	.099 nail-1 3/4"	6" panel edges 8" inter. sup.
Hardboard[14] Lap-siding-horizontal		7/16	(9)	(9)	.099 nail-2"	.099 nail-2 1/2"	.099 nail-2 1/4"	.099 nail-2"	Same as stud spacing 2 per bearing
Vertical panel siding		7/16	(9)	(9)	.099 nail-2"	.099 nail-2 1/2"	.099 nail-2"	.080 nail-1 3/4"	6" panel edges 12" inter. sup.
Steel[11]		29 ga.	Lap	No	.113 nail-1 3/4" Staple-1 3/4"	.113 nail-2 3/4" Staple-2 1/2"	.113 nail-2 1/2" Staple-2 1/4"	Not allowed	Same as stud spacing
Stone veneer		2	Sec. 503	Yes	See Sec. R-503 and Figure No. R-503.4				

(Continued)

Table No. R-503.6 (Continued)

Particleboard panels	3/8	(9)	(9)	.113 nail-2" Staple-1 3/8"	.113 nail-2" Staple 2 1/4"	.113 nail-2" Staple 2"	Not allowed	6" on edges 8" inter. sup.
	5/8	(9)	(9)	.113 nail-2" Staple-1 7/8"	.113 nail-2 1/2" Staple-2 1/2"	.113 nail-2 1/2" Staple-2 1/4"	.113 nail-2" Staple-1 5/8"	6" on edges 8" inter. sup.
Plywood panels[12] (Exterior grade)	3/8	(9)	(9)	.099 nail-2" Staple-1 3/8"	.113 nail-2 1/2" Staple-2 1/4"	.099 nail-2" Staple-2"	.099 nail-2" Staple-1 3/8"	6" on edges 12" inter. sup.
Wood[13] Rustic, drop Shiplap	3/8 Minimum 19/32 Average	Lap	No	Fastener penetration into stud—1"			.113 nail-2 1/2" Staple 2"	Face nailing up to 6" widths, 1 nail per bearing; 8" widths and over, 2 nails per bearing
Bevel	7/16	Lap	No					
Butt tipp	3/16	Lap	No					
Shakes[8]	3/8	Lap	Yes	.0915 nail-2"		Staple 2"		
Shingles[8]	3/8	Lap	Yes	16" and 18" shingles		.076 nail-1 1/4" Staple-1 1/4"		2-fasteners per shingle or shake
				24" shingles		.080 nail-1 1/2" Staple 1 1/2"		

[1]Based on stud spacing of 16 inches o.c. Where studs are spaced 24 inches, siding may be applied to sheathing approved for that spacing.

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

[3]Staples shall have a minimum crown width of 7/16-inch O.D. and be manufactured of minimum No. 16 gauge wire.

[4]Nails or staples must be aluminum, galvanized, or rust-preventive coated and shall be driven into the studs for fiberboard or gypsum backing.

[5]Aluminum nails or other nails complying with AAMA 1402 listed in Section S-26-503 shall be used to attach aluminum siding.

[6]As an alternate to the values of Table R-503.6, aluminum siding complying with AAMA 1402 listed in Section S-26.503 may be used.

[7]Aluminum (.019 inch) may be unbacked only when the maximum panel width is 10 inches and the maximum flat area is 8 inches. The tolerance for aluminum siding shall be ±0.002 inch of the nominal dimension.

[8]Shingles and shakes applied over regular density fiberboard or gypsum sheathing shall be fastened to horizontal wood nailers or fiberboard shingle backer.

[9]If boards are applied over sheathing or weather-resistant membrane, joints need not be treated. Otherwise vertical joints must occur at studs and be covered with battens or be lapped.

[10]All attachments shall be coated with a corrosion-resistive coating.

[11]Shall be of approved type.

[12]Three-eighths-inch plywood may be applied directly to studs spaced 16 inches on center. One-half-inch plywood may be applied directly to studs spaced 24 inches on center.

[13]Wood board sidings applied vertically shall be nailed to horizontal nailing strips or blocking set 24 inches o.c. Nails shall penetrate 1 1/2 inches into studs, studs and wood sheathing combined, or blocking. A weather-resistant membrane shall be installed weatherboard fashion under the vertical siding unless the siding boards are lapped or battens are used.

[14]Hardboard siding shall comply with AHA A135.6 listed in section S-26.503.

Chapter 6
FLOORS

SECTION R-601—GENERAL

R-601.1 Application: The provisions of this chapter shall control the design and construction of the floors for all buildings. The use of materials or methods of construction not specified in this chapter accomplishing the purposes intended by this code and approved by the building official in accordance with Section R-108 shall be accepted as complying with this code.

R-601.2 Requirements: Floors of wood construction shall be designed and constructed in accordance with the NFoPA "National Design Specification for Wood Construction," HPMA (ANSI) LHF, the "Canadian Dimension Lumber Data Book" and the "Southern Pine Maximum Spans for Joists and Rafters," listed in Section S-26.601 and in accordance with Figure No. R-601.2 and be capable of accommodating all loads imposed according to Section R-201 and transmitting the resulting loads to its supporting structural elements.

SECTION R-602—DIMENSION LUMBER

R-602.1 Identification and grade: Load-bearing dimension lumber for joists, beams and girders shall conform to applicable standards or grading rules and shall be so identified by a grade mark or certificate of inspection issued by an approved agency. The grade mark or certificate shall provide adequate information to determine F_b, the allowable stress in bending, and E, the modulus of elasticity.

Preservatively treated dimensional lumber shall be identified by the quality mark of an approved agency.

Blocking shall be a minimum of Utility grade lumber. Subflooring may be a minimum of Utility grade lumber or No. 4 Common grade boards.

Approved end-jointed lumber may be used interchangeably with solid-sawn members of the same species and grade.

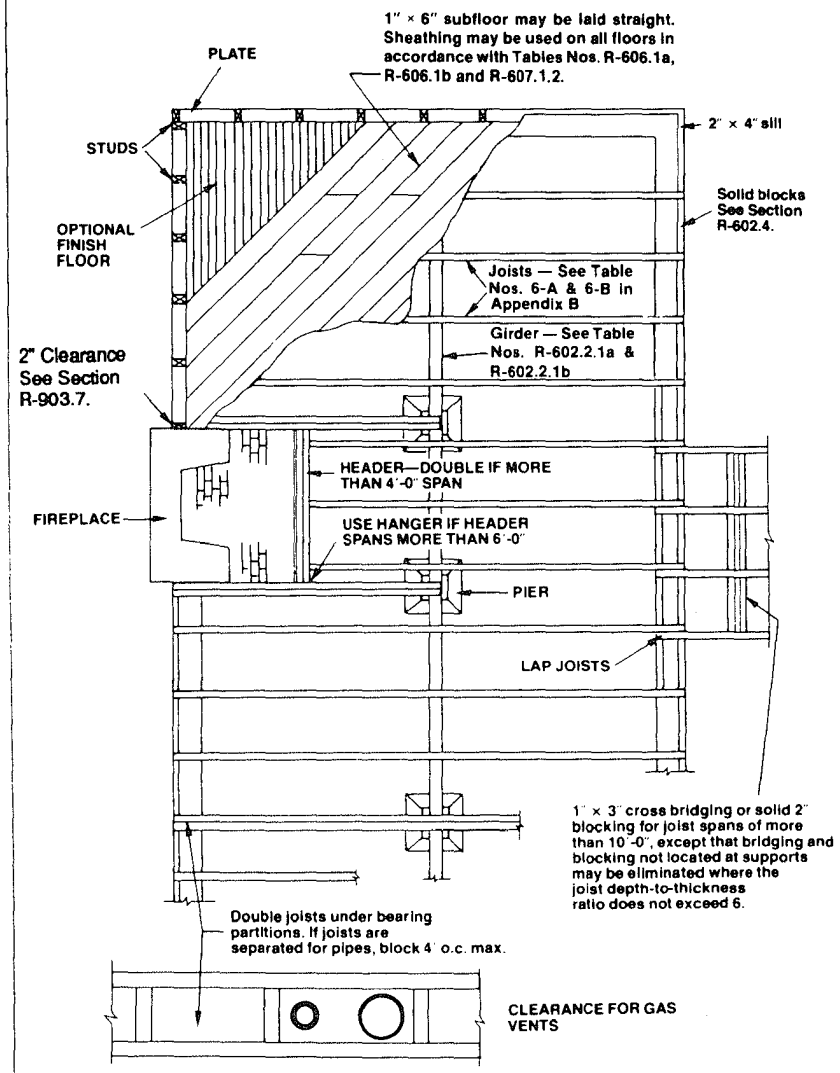
R-602.2 Allowable spans

R-602.2.1 Joists, beams and girders: The clear span of floor joists shall not exceed the values set forth in Table Nos. 6-A and 6-B in Appendix B. The modulus of elasticity, E, and the actual stress in bending, F_b, shown in the tables shall not exceed the values specified in Table Nos. 6/7A and 6/7B in Appendix B. The values for F_b, specified as "repetitive member use" may be used when floor joists are spaced not more than 24 inches on center.

Floor joists that are spliced at a point other than over a structural bearing element shall be designed in accordance with NAHB "Design Tables—Fabrication Guide," "Off-Center Spliced Floor Joists" listed in Section S-26.602 or by approved engineering practice.

The allowable spans of girders shall not exceed the values set forth in Table Nos. R-602.2.1a and No. R-602.2.1b.

Figure No. R-601.2
FLOOR CONSTRUCTION



This figure is for illustration purposes only and the written text shall apply.

Table No. R-602.2.1a
ALLOWABLE SPAN FOR GIRDERS SUPPORTING ONE FLOOR ONLY[3]

SIZE OF WOOD GIRDER[1]		FLOOR LIVE LOAD (psf)	SPACING OF GIRDERS[2] "S"				
			4'	6'	8'	10'	16'
4" × 4"	—	30	5'-6"	4'-6"	3'-6"	3'-0"	2'-6"
		40	5'-0"	4'-0"	3'-6"	3'-0"	2'-6"
4" × 6"	—	30	8'-0"	6'-6"	5'-6"	5'-0"	4'-6"
		40	7'-6"	6'-0"	5'-6"	4'-6"	4'-0"
4" × 8"	6" × 6"	30	11'-0"	9'-0"	8'-0"	7'-0"	5'-6"
		40	10'-0"	8'-6"	7'-6"	6'-6"	5'-0"
4" × 10"	6" × 8"	30	14'-0"	11'-6"	10'-0"	8'-6"	6'-0"
		40	13'-0"	10'-6"	9'-6"	8'-6"	5'-6"
4" × 12"	6" × 10"	30	16'-6"	14'-0"	12'-0"	11'-0"	9'-0"
		40	16'-0"	12'-6"	11'-0"	10'-0"	8'-0"

[1]Spans are based on No. 2 grade lumber.

[2]The spacing "S" is the tributary load to the girder. It is found by adding the unsupported spans of the floor joists on each side which are supported by the girder and dividing by 2.

[3]Spans and girder sizes may be computed independently of the above table when designed in accordance with accepted engineering practice and substantiating data are provided and submitted as required.

R-602.2.2 Floor sheathing: The allowable spans for floor sheathing used as subflooring shall conform to the requirements set forth in Table Nos. R-602.2.2, R-606.1a, R-606.1b, and R-607.1.2.

Table No. R-602.2.2
MINIMUM THICKNESS OF FLOOR SHEATHING

JOIST SPACING (Inches)	MINIMUM NET THICKNESS (Inches)	
	Perpendicular to Joist	Diagonal to Joist
24	11/16	3/4
16	5/8	5/8

R-602.3 Bearing: The ends of each joist, beam or girder shall have not less than 1 1/2 inches of bearing on wood or metal and not less than 3 inches on masonry except where supported on a 1-inch by 4-inch ribbon strip and nailed to the adjacent stud or by the use of approved joist hangers.

Floor systems having joists framing from opposite sides over a bearing support shall be tied together by lapping joists a minimum of 3 inches or with a wood or metal splice, or by continuity of floor sheathing overlapping the ends of joists at least 3 inches, or by other approved methods.

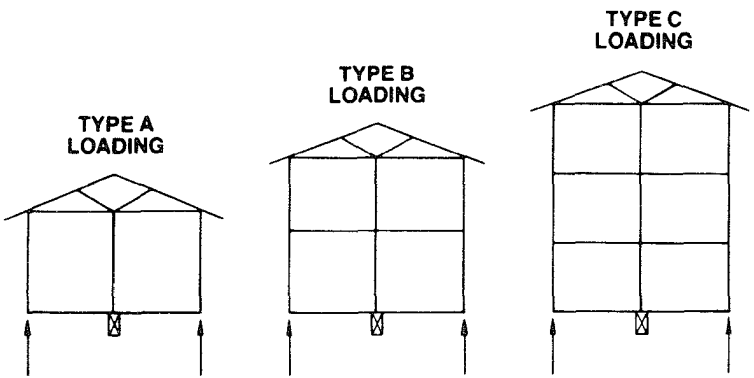
Joists framing into the side of a wood girder shall be supported by approved framing anchors or on ledger strips not less than nominal 2 inches by 2 inches.

Table No. R-602.2.1b
ALLOWABLE SPAN FOR GIRDERS AND REQUIRED SIZE OF COLUMNS AND FOOTINGS TO SUPPORT ROOFS, INTERIOR BEARING PARTITIONS AND FLOORS

SIZE OF GIRDER REQUIRED		SPACING OF GIRDER[2] "S"	TYPE OF LOADING[3]			SIZE OF COLUMNS REQUIRED[4]		SIZE OF PLAIN CONCRETE FOOTING REQUIRED[4]
Wood[1]			A	B	C	Steel	Wood	
4″ × 12″	6″ × 10″	10′ 15′ 20′	5′-6″ 4′-0″ —	— — —	— — —	3″ Steel pipe[5]	4″ × 4″	2′ × 2′ × 8″
(7)	6″ × 12″	10′ 15′ 20′	8′-6″ 6′-0″ 4′-6″	5′-0″ 4′-0″ —	— — —			
(7)	(7)	10′ 15′ 20′	12′-0″ 10′-0″ 8′-0″	9′-0″ 8′-0″ 7′-0″	8′-0″ 7′-0″ 6′-0″		6″ × 6″	4′ × 4′ × 16″[6]
(7)	(7)	10′ 15′ 20′	16′-0″ 13′-6″ 12′-0″	12′-6″ 10′-6″ 9′-6″	11′-0″ 10′-0″ 8′-0″		8″ × 8″	4′-3″ × 4′-3″ × 17″[6]
(7)	(7)	10′ 15′ 20′	20′-0″ 17′-0″ 15′-0″	16′-0″ 13′-6″ 12′-0″	13′-6″ 11′-6″ 10′-0″			

(Continued)

Table No. R-602.2.1b (Continued)



[1]Spans for wood girders are based on No. 2 grade lumber. No. 3 grade may be used with appropriate design.

[2]The spacing "S" is the tributary load in the girder. It is found by adding the unsupported spans of the floor joists on each side which are supported by the girder and dividing by 2.

[3]Figures under "type of loading" columns are the allowable girder spans.

[4]Required size of columns is based on girder support from two sides. Size of footing is based on allowable soil pressure of 2,000 pounds per square foot.

[5]Standard weight.

[6]Footing thickness is based on the use of plain concrete with a specified compressive strength of not less than 2,500 pounds per square inch at 28 days. If approved, the footing thickness may be reduced based on an engineering design utilizing higher-strength concrete and/or reinforcement.

[7]Girder will require an approved design.

R-602.4 Lateral support and bridging: Joists shall be supported laterally at the ends at each support by full-depth solid blocking except where the ends of joists are nailed or bolted to a header, band or rim joist or to an adjoining stud. Solid blocking shall be not less than 2 inches in thickness.

Joists having a depth-to-thickness ratio exceeding 6 to 1 based on nominal dimensions shall be supported laterally by solid blocking, diagonal bridging (wood or metal) or a 1- by 3-inch bridging nailed to the bottom of the joist at intervals not exceeding 10 feet.

R-602.5 Cutting and notching: Notches in the top or bottom of joists shall not exceed one-sixth the depth of the joist and shall not be located in the middle third of the span. Where joists are notched on the ends, the notch shall not exceed one-fourth the joist depth. Cantilevered portions less than 4 inches wide shall not be notched unless the reduced section properties and lumber defects are considered in the design. When it is necessary to provide a space for pipes, ducts or vents, the double joists required to support bearing partitions which run parallel to the floor joists shall be spaced apart to accommodate the pipes, ducts or vents, and blocked at 4 feet on center.

R-602.6 Bored holes: Holes bored in joists shall not be within 2 inches of the top and bottom of joists and their diameter shall not exceed one-third the depth of the joist.

R-602.7 Floor framing: Floor framing shall be nailed in accordance with Table No. R-402.3a. Where posts and beam or girder construction is used to support floor framing, positive connections shall be provided to ensure against uplift and lateral displacement.

End joints in lumber used as subflooring shall occur over supports unless end-matched lumber is used, in which case each piece shall bear on at least two joists. Subflooring may be omitted when joist spacing does not exceed 16 inches and a 1-inch nominal tongue-and-groove wood strip flooring is applied perpendicular to the joists.

Joists under bearing partitions shall be doubled or a beam of equivalent size shall be provided. Double joists which are separated to permit the installation of piping or vents shall be solid blocked at a maximum spacing of 4 feet on center.

R-602.8 Headers: Openings in floor framing shall be framed with a header and doubled trimmer joists. For openings not exceeding 4 feet, the header joist may be the same size as the floor joist. When the header joist span exceeds 4 feet, the header joist shall be doubled and be of sufficient cross-section to support the floor joist framing into the header. Approved hangers shall be used for the header joist to trimmer joists connections when the header joists span exceeds 6 feet.

R-602.9 Floor trusses: Wood floor trusses shall be designed in accordance with approved engineering practice. The design of metal plate connected wood trusses shall comply with TPI QST, TPI PCT and TPI "Design Specification for Metal Plate Connected Wood Trusses" listed in

Section S-26.602. Trusses shall be braced and installed in accordance with their appropriate engineered design. In the absence of specific bracing requirements, trusses shall be braced in accordance with TPI BWT listed in Section S-26.602. Truss members shall not be drilled, cut, notched or altered in any manner unless so designed.

SECTION R-603—CONCRETE FLOORS (ON GROUND)

R-603.1 General: Concrete slab-on-ground floors shall be constructed in accordance with Figure No. R-303. The specified compressive strength of concrete at 28 days shall be not less than 2,500 pounds per square inch except where weather exposure requires greater strength and air-entrained concrete, as set forth in Table No. R-302.2.

Slabs shall be constructed with control joints having a depth of at least one-fourth the slab thickness, and joints shall be spaced at intervals not more than 30 feet in each direction and slabs not rectangular in shape shall have control joints across the slab at points of offset, if offset exceeds 10 feet.

Exception: Control joints are not required or may exceed 30-foot intervals where welded wire fabric or equivalent is provided in accordance with Table No. R-603.1. The welded wire fabric or equivalent material shall be placed at mid-depth of the slab or 2 inches from the top surface for slabs more than 4 inches in thickness.

Table No. R-603.1
CRACK CONTROL REINFORCEMENT FOR SLABS

MAXIMUM DIMENSION OF SLAB OR DISTANCE BETWEEN CONTROL JOINTS (Feet)[1]						WWF[2] WIRE SPACING (Inches)	WWF[2] WIRE SIZE DESIGNATION
SLAB THICKNESS (inches)							
3.5	4.0	4.5	5.0	5.5	6.0		
42	36	32	29	26	24	6x6	W1.4 x W1.4
59	52	46	42	38	35	6x6	W2.0 x W2.0
86	75	67	60	55	50	6x6	W2.9 x W2.9

1 Values in table are based on reinforcement with a yield strength of 65,000 psi. If reinforcement with a different yield strength is used, the slab dimension shown in the table shall be adjusted by multiplying by the yield strength of the steel to be used and dividing by 65,000.

2 Welded wire fabric.

R-603.2 Site preparation: The area within the foundation walls shall have all vegetation, top soil and foreign material removed, and the fill material shall be free of vegetation and foreign material.

R-603.2.1 Fill: The fill shall be compacted to assure uniform support of the slab, and except where approved, the fill depths shall not exceed 24 inches for clean sand or gravel and 8 inches for earth.

R-603.2.2 Base: A 4-inch-thick base course consisting of clean graded sand, gravel, crushed stone or crushed blast-furnace slag passing a 2-inch sieve and retained on a 1/4-inch sieve shall be placed on the prepared subgrade when the slab is below grade. An approved vapor barrier with joints lapped not less than 6 inches shall be placed between the concrete floor slab and the base course or the prepared subgrade where no base course exists.

Exception: The vapor barrier may be omitted:

1. From detached garages, utility buildings and other unheated accessory structures;
2. From driveways, walks, patios and other flatwork not likely to be enclosed and heated at a later date; or
3. Where approved by the building official, based upon local site conditions.

SECTION R-604—TREATED-WOOD FLOORS (ON GROUND)

R-604.1 General: Treated-wood basement floors and floors on ground shall be designed to withstand axial forces and bending moments resulting from lateral soil pressures at the base of the exterior walls and floor live and dead loads. Floor framing shall be designed to meet joist deflection requirements in accordance with Section R-201.

Unless special provision is made to resist sliding caused by unbalanced lateral soil loads, wood basement floors shall be limited to applications where the differential depth of fill on opposite exterior foundation walls is 2 feet or less.

Joists in wood basement floors shall bear tightly against the narrow face of studs in the foundation wall or directly against a band joist which bears on the studs. Plywood subfloor shall be continuous over lapped joists or over butt joints between in-line joists. Sufficient blocking shall be provided between joists to transfer lateral forces at the base of the end walls into the floor system.

Where required, resistance to uplift or restraint against buckling shall be provided by interior bearing walls or properly designed stub walls anchored in the supporting soil below.

R-604.2 Site preparation: The area within the foundation walls shall have all vegetation, topsoil and foreign material removed, and any fill material which is added shall be free of vegetation and foreign material. The fill shall be compacted to assure uniform support of the treated-wood floor sleepers.

R-604.2.1 Base: A minimum 4-inch-thick granular base of gravel having a maximum size of 3/4 inch or crushed stone having a maximum size of 1/2 inch shall be placed over the compacted earth.

R-604.2.2 Moisture barrier: Polyethylene sheeting of minimum 6-mil thickness shall be placed over the granular base. Joints shall be lapped 6 inches and left unsealed. The polyethylene membrane shall be placed over the treated-wood sleepers and shall not extend beneath the footing plates of the exterior walls.

R-604.3 Materials: All framing materials, including sleepers, joists, blocking and plywood subflooring, shall be pressure preservatively treated and dried after treatment in accordance with AWPA C22 listed in Section S-26.604. All fasteners shall meet the requirements of NFoPA Technical Report No. 7 listed in Section S-26.604.

SECTION R-605—METAL

Steel and aluminum structural elements shall be constructed of materials and designed in accordance with the AISC "Specification for the Design, Fabrication and Erection of Structural Steel for Buildings" and AA SAS30, respectively, listed in Section S-26.605. Steel elements may be hot-rolled or cold-formed structural steel. Members shall be straight and free of any defects which would affect their performance.

SECTION R-606—PLYWOOD

R-606.1 Identification and grade: Plywood used for structural purposes shall conform to APA E30, APA PRP-108, APA Y510, DOC PS1, HPMA (ANSI) HP, and HPMA HP-SG listed in Section S-26.606 and shall be so identified by a grade mark or certificate of inspection issued by an approved agency.

Where used as structural subflooring, plywood shall be of one of the grades specified in Table No. R-606.1a. When used as combination subflooring-underlayment, the grade shall be as specified in Table No. R-606.1b.

R-606.2 Allowable spans: The maximum allowable span for plywood used as subflooring shall be set forth in Table No. R-606.1a. The maximum span for plywood combination subfloor-underlayment shall be as set forth in Table No. R-606.1b.

R-606.3 Installation: Plywood subfloor and plywood combination subfloor-underlayment shall be attached to framing in accordance with Table No. R-402.3a.

SECTION R-607—PARTICLEBOARD

R-607.1 Identification and grade: Particleboard shall conform to ANSI A208.1 listed in Section S-26.607 and shall be so identified by a grade mark or certificate of inspection issued by an approved agency.

R-607.1.1 Floor underlayment: Particleboard floor underlayment shall conform to Type 1-M-1 or sanded Type 2-M-W and shall not be less than 1/4 inch in thickness.

R-607.1.2 Subfloor and combined subfloor-underlayment: Particleboard subfloor and combined subfloor-underlayment shall conform to 2-M-3 and shall not exceed the maximum allowable spans as specified in Table No. R-607.1.2.

Table No. R-606.1a
ALLOWABLE SPANS FOR PLYWOOD FLOOR AND ROOF SHEATHING CONTINUOUS OVER TWO OR MORE SPANS AND FACE GRAIN PERPENDICULAR TO SUPPORTS[1]

PANEL SPAN RATING[3]	PANEL THICKNESS (Inches)	ROOF[2] MAXIMUM SPAN (In Inches) Edges Blocked[7]	ROOF[2] MAXIMUM SPAN (In Inches) Edges Unblocked	ROOF[2] LOAD CAPACITY (In lbs. per square foot) Total Load	ROOF[2] LOAD CAPACITY (In lbs. per square foot) Live Load	FLOOR MAXIMUM SPAN[4] (Inches)
12/0	5/16	12		135	130	0
16/0	5/16, 3/8	16		80	65	0
20/0	5/16,3/8	20		70	55	0
24/0	3/8	24	20	60	45	0
24/0	15/32, 1/2	24	24	60	45	0
32/16	15/32, 1/2, 5/8	32	28	50	35	16[6]
40/20	19/32, 5/8, 3/4	40	32	40[5]	35[5]	20[6,8]
48/24	23/32, 3/4, 7/8	48	36	40[5]	35[5]	24

1 These values apply to C-D and C-C grades only. Spans shall be limited to values shown because of possible effect of concentrated loads.

2 Uniform load deflection limitation: 1/180 of span under live load plus dead load, 1/240 under live load only.

3 Span rating appears on all panels in the construction grades listed in Footnote 1. The numerator and denominator represent the allowable spans for roofs and floors, respectively, for blocked panels.

4 Plywood edge shall have approved tongue-and-groove joints or shall be supported with blocking unless 1/4-inch-minimum-thickness underlayment or 1 1/2 inches of approved cellular or lightweight concrete is placed over the subfloor, or finished floor is 3/4-inch wood strip. Allowable uniform load based on deflection of 1/360 of span is 165 pounds per square foot.

5 For roof live load of 40 pounds per square foot or total load of 55 pounds per square foot, decrease spans by 13 percent or use panel with next greater span rating.

6 May be 24 inches if 3/4-inch wood strip flooring is installed at right angles to joists.

7 Edges may be blocked with lumber or other approved type of edge support.

8 May be 24 inches where a minimum of 1 1/2 inches of approved cellular or lightweight concrete is placed over the subfloor.

Table No. R-606.1b
ALLOWABLE SPANS FOR PLYWOOD COMBINATION SUBFLOOR-UNDERLAYMENT[1] PLYWOOD CONTINUOUS OVER TWO OR MORE SPANS AND FACE GRAIN PERPENDICULAR TO SUPPORTS

IDENTIFICATION	SPACING OF JOIST 16	20	24	48
Species Group[2]				
1	1/2	5/8	3/4	—
2,3	5/8	3/4	7/8	—
4	3/4	7/8	1	—
Span Rating[3]	16 o.c.	20 o.c.	24 o.c.	48 o.c.

1 Unsupported edges shall be tongue-and-groove or blocked except where 1/4-inch-thick underlayment or 3/4-inch finish floor is used. Allowable uniform load based on deflection of 1/360 of span is 125 pounds per square foot, except panels with a span rating of 48 o.c. are limited to 65 pounds per square foot total load at maximum span.

2 Applicable to all grades of sanded Exterior-type plywood.

3 Applicable to Underlayment grade and C-C Plugged.

Table No. R-607.1.2
ALLOWABLE SPANS FOR PARTICLEBOARD SUBFLOOR AND COMBINED SUBFLOOR-UNDERLAYMENT[1,4]

GRADE	THICKNESS (Inches)	MAXIMUM SPACING OF SUPPORTS (inches)[2,3]	
		SUBFLOOR	COMBINATION SUBFLOOR-UNDERLAYMENT
2-M-W	1/2	16	—
	5/8	20	16
	3/4	24	24
2-M-3	3/4	20	20

1 All panels are continuous over two or more spans and the tongue-and-groove panels are installed with the long dimension perpendicular to supports.
2 Uniform deflection limitation: 1/360 of the span under 100 psf minimum load.
3 Edges shall have tongue-and-groove joints or shall be supported with blocking unless 1/4-inch minimum thickness underlayment is installed or finish floor is 25/32-inch wood strip.
4 The allowable grade, panel thickness and support spacings are shown in Table No. R-607.1.2. The panels may be applied parallel or perpendicular to joists and shall be continuous over two or more spans. If the panels are applied perpendicular to the supports, the end joints of the panels shall be offset so that four panel corners will not meet. Cutouts for items such as plumbing and electrical shall be oversized to avoid a forced fit. A 1/2-inch gap must be provided between the panel and concrete and masonry walls. Tongue-and-groove panels will have marks indicating "this side down." Leave a 1/16-inch gap between all panel edges when used as a subfloor. When used as a combined subfloor-underlayment, leave a 1/16-inch gap on Type 2-M-3 panels but lightly butt the edges of Type 2-M-W panels. Nail panels no closer than 3/8 inch from edges. Sand panel edges flat if swelling results from adverse moisture conditions during construction. If the panels are to be installed under nontextile resilient flooring, they shall be covered with 1/4-inch-minimum-thickness underlayment.

R-607.2 Installation: Particleboard underlayment shall be installed in accordance with the recommendations of the manufacturer. Particleboard subfloor and combination subfloor-underlayment shall be installed in accordance with Table No. R-607.1.2 and attached to framing in accordance with Table No. R-402.3a.

Chapter 7
ROOF-CEILING CONSTRUCTION

SECTION R-701—GENERAL

R-701.1 Application: The provisions of this chapter shall control the design and construction of the roof-ceiling system for all buildings. Roofs shall be constructed in accordance with Figure Nos. R-404.9, R-404.10a, R-404.10b, and R-702.3 and nailed in accordance with Table No. R-402.3a. The use of materials or methods of construction not specified in this chapter accomplishing the purposes intended with this code and approved by the building official in accordance with this code and approved by the building official in accordance with Section R-108 shall be accepted as complying with this code.

R-701.2 Requirements: Roof-ceilings of wood construction shall be designed and constructed in accordance with the NFoPA *National Design Specification for Wood Construction,* the *Canadian Dimension Lumber Data Book,* or the *Southern Pine Maximum Spans for Joists and Rafters,* listed in Section S-26.701 and shall be capable of accommodating all loads imposed according to Section R-201 and shall transmit the resulting loads to its supporting structural elements.

R-701.3 Roof drainage: In areas where expansive or collapsible soils are known to exist, all dwellings shall have a controlled method of water disposal from roofs that will collect and discharge all roof drainage to the ground surface at least 5 feet from foundation walls or to an approved drainage system.

SECTION R-702—DIMENSION LUMBER

R-702.1 Identification and grade: Load-bearing dimension lumber for rafters, trusses and ceiling joists shall conform to applicable standards or grading rules and be identified by a grade mark or certificate of inspection issued by an approved agency. The grade mark or certificate shall provide adequate information to determine F_b, the allowable stress in bending, and E, the modulus of elasticity. Approved end-jointed lumber may be used interchangeably with solid-sawn members of the same species and grade. Blocking shall be a minimum of Utility grade lumber.

The allowable unit stresses for fire-retardant-treated lumber, including fastener values, shall be developed from an approved method of investigation which considers the effects of anticipated temperature and humidity to which the fire-retardant lumber will be subjected, the type of treatment and redrying process. The fire-retardant-treated lumber shall be graded by an approved agency.

R-702.2 Framing details: Rafters shall be nailed to ceiling joists to form a continuous tie between exterior walls where joists are parallel to the rafters. Where not parallel, rafters shall be tied with a rafter tie, located as near the plate as practical. Rafter ties shall be spaced not more than 4 feet

on center. Rafters shall be framed to ridge board or to each other with gusset plate as a tie. Ridge board shall be at least 1-inch nominal thickness and not less in depth than the cut end of the rafter. At all valleys and hips there shall be a valley or hip rafter not less than 2-inch nominal thickness and not less in depth than the cut end of the rafter. Hip and valley rafters shall be supported at the ridge by a brace to a bearing partition or be designed to carry and distribute the specific load at that point.

Ends of ceiling joists shall be lapped a minimum of 3 inches or butted over bearing partitions or beam and toenailed to the bearing member. When ceiling joists are used to provide resistance to rafter thrust, lapped joists shall be nailed together and butted joists shall be tied together in a manner to resist such thrust.

R-702.3 Allowable spans: The unsupported spans for rafters and ceiling joists shall not exceed the values set forth in Table Nos. 7-A through 7-S in Appendix B and Table No. R-702.3.

When the roof pitch is less than 3 in 12, members supporting rafters and ceiling joists, such as ridge beams, hips and valleys, shall be designed as beams.

R-702.4 Bearing: The ends of each rafter or ceiling joist shall have not less than 1 1/2 inches of bearing on wood or metal and not less than 3 inches on masonry.

If the finished ceiling material is installed on the ceiling prior to the attachment of the ceiling to the walls, such as in construction at a factory, a compression strip of the same thickness as the finish ceiling material shall be installed directly above the top plate of bearing walls if the compressive strength of the finish ceiling material is less than the loads it will be required to withstand. The compression strip shall cover the entire length of such top plate and shall be at least one-half the width of the top plate. It shall be of material capable of transmitting the loads transferred through it.

R-702.5 Cutting and notching: Notching at the ends of the rafter or ceiling joists shall not exceed one-fourth the depth. Notches in the top or bottom of the joists shall not exceed one-sixth the depth and shall not be located in the middle one-third of the span, except that a notch not exceeding one-third of the depth is permitted in the top of the rafter or ceiling joist not further from the face of the support than the depth of the member. The tension side of lumber 4 inches wide or greater shall not be notched except at the ends of the members. Cantilevered portions less than 4 inches wide shall not be notched unless the reduced section properties and lumber defects are considered in the design.

R-702.6 Bored holes: Holes bored in rafters or ceiling joists shall not be within 2 inches of the top and bottom and their diameter shall not exceed one-third the depth of the member.

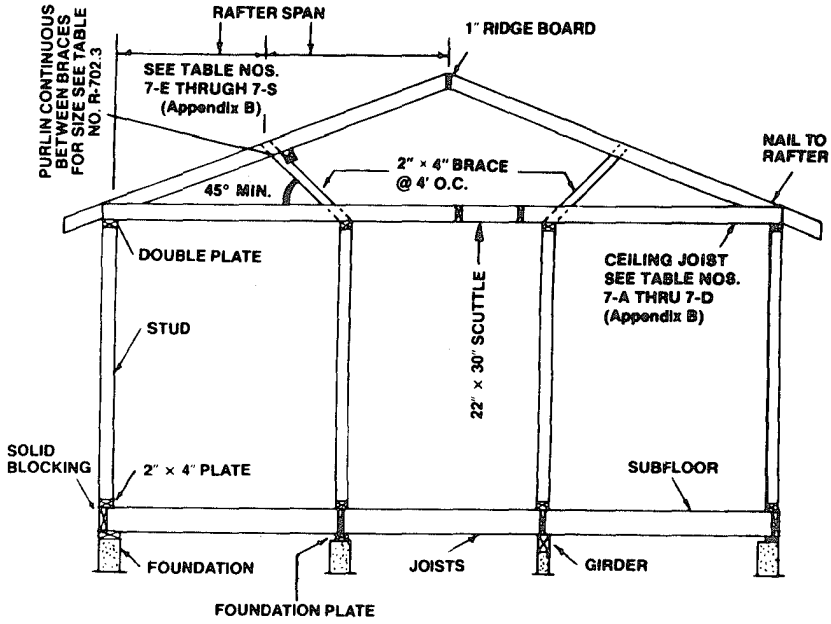
R-702.7 Lateral support and bridging: Rafters and ceiling joists shall be provided with lateral support at points of bearing to prevent rotation.

Table No. R-702.3
ALLOWABLE RAFTER SPAN BASED ON SIZE OF ROOF PURLIN (SHOWN IN FIGURE NO. R-702.3)

SIZE OF ROOF PURLIN BRACED AT 4'O.C.	MAXIMUM ALLOWABLE RAFTER SPAN [1]	
	30 Lbs. Per Sq. Ft. L.L. & D.L.	40 Lbs. Per Sq. Ft. L.L. & D.L.
2"x 4"	5' - 0"	3' - 6"
2" x 6"	11' - 6"	8'- 6"

[1]Maximum rafter span is maximum distance between exterior or interior wall support and purlin, between ridge member and purlin or between purlins.

Figure No. R-702.3
FRAMING DETAILS



Notes:

[1]Where ceiling joist run perpendicular to the rafters, rafter ties shall be nailed to the rafters near the plate line spaced not more than 4 feet o.c.

[2]This figure is for illustration purposes only and written text shall apply.

Rafters and ceiling joists having a depth-to-thickness ratio exceeding 6 to 1 based on nominal dimensions shall be supported laterally by solid blocking, diagonal bridging (wood or metal) or a 1-inch by 3-inch bridging nailed to the rafter or ceiling joist at intervals not exceeding 10 feet.

R-702.8 Headers: Roof-ceiling framing around openings shall be provided with headers. The allowable spans for headers in bearing walls shall not exceed the values set forth in Table Nos. R-402.6a through R-402.6f.

R-702.9 Trusses: Wood trusses shall be designed in accordance with approved engineering practice. Truss components may be joined by nails, glue, timber connectors or other approved fastening devices. The design of metal plate connected wood trusses shall comply with TPI QST, TPI PCT and TPI "Design Specification for Metal Plate Connected Wood Trusses" listed in Section S-26.702. Trusses shall be braced according to their appropriate engineered design. In the absence of specific bracing requirements, trusses shall be braced in accordance with TPI BWT listed in Section S-26.702. Truss members shall not be cut or altered unless so designed.

R-702.10 Roof Tie-Down: Roof assemblies subject to wind uplift pressures of 20 lbs per sq ft or greater, as established in Table No. R-201.2, shall be designed in accordance with accepted engineering practice, or rafter or truss ties shall be provided in accordance with Table No. R-702.10 or shall be designed in accordance with ASCE 7, listed in Section S-26.702. Roof assemblies subject to wind uplift pressures greater than 50 lbs per sq ft shall be designed in accordance with ASCE 7, listed in Section S-26.702.

Table No. R-702.10
MINIMUM STRENGTH FOR RAFTER OR TRUSS TIES TO RESIST WIND UPLIFT(lbs)

ROOF UPLIFT DESIGN WIND LOAD (PSF)	TOTAL BUILDING WIDTH INCLUDING OVERHANG (FT)				
	24	28	32	36	40
20	126	147	168	189	211
25	217	253	289	325	361
30	307	358	409	460	511
35	397	463	529	595	662
40	487	568	650	731	812
45	577	674	770	866	962
50	668	779	890	1002	1113

[1]The Design Wind Load map and table in Appendix A shall be used for guidance in determining roof uplifts loads.

[2]Strength values are based on 24-inch tie spacing with ties at each end of all trusses or rafters. For spacing other than 24-inch, strength values shall be adjusted accordingly.

[3]Tie strength requirements are adjusted to account for wind effects. If ties are rated to include stress increases for wind loading, multiply the table values by 1.33.

[4]Interpolation is permitted between roof uplift design wind load values and between building widths.

[5]Where truss or rafter ties are used conventional nailing is still required.

SECTION R-703—PLYWOOD

R-703.1 Identification and grade: Plywood shall conform to applicable standards or grading rules and be identified by grade mark or certificate of inspection issued by an approved agency. Plywood shall comply with the grades specified in Table No. R-606.1a.

All plywood, when designed to be exposed in outdoor applications, shall be of an exterior type, except that plywood roof sheathing exposed to the underside may be of interior type bonded with exterior glue.

The allowable unit stresses for fire-retardant-treated plywood, including fastener values, shall be developed from an approved method of investigation which considers the effects of anticipated temperature and humidity to which the fire-retardant plywood will be subjected, the type of treatment and redrying process. The fire-retardant-treated plywood shall be graded by an approved agency.

R-703.2 Allowable spans: The maximum allowable spans for plywood roof sheathing shall not exceed the values set forth in Table No. R-606.1a.

R-703.3 Installation: Plywood roof sheathing shall be installed with joints staggered or nonstaggered, in accordance with Table No. R-606.1a.

SECTION R-704—PARTICLEBOARD

R-704.1 Identification and grade: Particleboard roof sheathing shall conform to Type 2-M-W as set forth in ANSI A208.1 listed in Section S-26.704 and shall be so identified by a grade mark or certificate of inspection issued by an approved agency.

R-704.2 Allowable spans: The allowable loads and spans for particleboard roof sheathing shall not exceed the values set forth in Table No. R-704.2.

R-704.3 Installation: Particleboard roof sheathing shall be installed in accordance with Table No. R-704.2.

Table No. R-704.2
ALLOWABLE LOADS FOR PARTICLEBOARD ROOF SHEATHING[1, 2, 4]

GRADE	THICKNESS (Inches)	MAXIMUM ON-CENTER SPACING	LIVE LOAD (Lbs. Per Sq. Ft.)	TOTAL LOAD (Lbs. Per Sq. Ft.)
2-M-W	3/8[3]	16	45	65
	7/16	16	105	105
	7/16[3]	24	30	40
	1/2	16	110	150
	1/2	24	40	55

[1]Panels are continuous over two or more spans.

[2]Uniform load deflection limitations: 1/180 of the span under live load plus dead load and 1/240 of the span under live load only.

[3]Edges shall be tongue and groove or supported with blocking or edge clips.

[4]The panels may be applied parallel or perpendicular to the span of the rafters or joists and shall be continuous over two or more spans. If the panels are applied perpendicular to roof supports, the end joints of the panels shall be offset so that four panel corners will not meet. Cutouts for items such as plumbing and electrical shall be oversized to avoid a forced fit. A 1/2-inch gap must be provided between the panel and concrete and masonry walls. Leave a 1/16-inch gap between panels and nail no closer than 3/8 inch from panel edge.

SECTION R-705 — METAL

R-705.1 Steel elements: Steel structural elements in roof-ceiling construction may be either hot-rolled structural steel shapes or members cold formed to shape from steel strip or plate or a fabricated combination thereof. Members shall be straight and free of any defects which would significantly affect their structural performance. Steel structural members in roof-ceiling construction shall be designed in accordance with the AISC "Specification for the Design", "Fabrication and Erection of Structural Steel for Buildings" listed in Section S-26.705.

R-705.2 Aluminum elements: Aluminum structural elements in roof-ceiling systems shall be constructed of materials and designed in accordance with AA SAS30 listed in Section S-26.705.

SECTION R-706 — CEILING FINISHES

Ceilings shall be installed in accordance with the requirements in Chapter 5.

SECTION R-707 — ATTIC VENTILATION

When determined necessary by the building official due to atmospheric or climatic conditions, enclosed attics and enclosed rafter spaces formed where ceilings are applied directly to the underside of roof rafters shall have cross ventilation for each separate space by ventilating openings protected against the entrance of rain or snow. Ventilating openings shall be provided with corrosion resistant wire mesh, or equivalent, with the least dimension being 1/8 inch.

Exception: turbine ventilators

The net free ventilating area shall be not less than 1 to 150 of the area of the space ventilated except that the area may be 1 to 300, provided at least 50 percent of the required ventilating area is provided by ventilators located in the upper portion of the space to be ventilated at least 3 feet above eave or cornice vents with the balance of the required ventilation provided by eave or cornice vents. The net free cross-ventilation area may be not less than 1 to 300 of the area of the space ventilated when the vapor barrier having a transmission rate not exceeding 1 perm is installed on the warm side of the ceiling.

SECTION R-708 — ATTIC ACCESS

A readily accessible attic access framed opening not less than 22 inches by 30 inches shall be provided to any attic area having a clear height of over 30 inches.

Chapter 8
ROOF COVERINGS

SECTION R-801—GENERAL

R-801.1 Application: The provisions of this chapter shall control the design and construction of roof coverings for all buildings. The use of materials or methods not specified in this chapter accomplishing the purposes intended by this code and approved by the building official in accordance with Section R-108 shall be accepted as complying with this code.

R-801.2 Requirements: The roof covering shall be capable of accommodating the loads indicated in Section R-201 and provide a barrier against the weather to protect its supporting elements and the structure beneath. Fasteners shall be in accordance with Table Nos. R-803.4 and R-808.2a. *

R-801.3 Roofing covering materials: Roofs shall be covered with materials as set forth in Sections R-803 through R-810. Roof covering materials shall conform to ASTM A239, A361, B134, B209, B211, B250, C406, and D312; the CSSB "Grading and Packing Rules for Certi-Split Red Cedar Shakes," "Grading and Packing Rules for Certigrade Red Cedar Shakes," and "Grading Rules for Certi-Sawn Taper-Sawn Red Cedar Shingles;" UL 55A and AA ASM 35 listed in Section S-26.801. Classified roofing shall conform to UL 790 listed in Section S-26.801 and shall be installed in areas designated by law as requiring their use or when the edge of the roof is less than 3 feet from a property line. The roofing materials set forth in Sections R-804 through R-807 and concrete slabs may be accepted as Class A roofing.

SECTION R-802—DECK PREPARATION

Roofing shall be applied only when the supporting roof construction is clean and dry.

When a single ply of underlayment is required, it shall be laid parallel to the eaves with a 2-inch top lap and 4-inch end lap nailed sufficiently to hold in place.

When two layers of underlayment are required, they shall be laid shingle fashion parallel to the eaves with 19-inch top lap and 12-inch end lap, with end laps located at least 6 feet from end laps in the preceding course, and blind nailed sufficiently to hold in place.

SECTION R-803—ASPHALT SHINGLES

R-803.1 General: Asphalt shingles shall be applied only to solidly sheathed roofs. Asphalt shingles shall be applied according to manufacturer's printed instructions and this code.

R-803.2 Slopes of 4 inches in 12 inches or greater: Asphalt shingle roofs shall have an underlayment of not less than one ply of No. 15 felt, applied as required in Section R-802 and Table No. R-803.4.

R-803.3 Slopes less than 4 inches in 12 inches but not less than 2 inches in 12 inches: Nominally double-coverage asphalt shingles may be installed on slopes as low as 2 inches in 12 inches, provided the shingles are approved self-sealing shingles or are hand sealed and are installed with an underlayment consisting of two layers of No. 15 felt, applied as required in Section R-802 and Table No. R-803.4. In areas where the January average daily temperature is 25 degrees F. or less, or where there is a possibility of ice forming along the eaves and causing a backup of water, the two layers of felt shall be cemented together in addition to the required nailing, from the eaves up the roof to overlie a point 24 inches inside the interior wall line of the building.

Asphalt shingles shall not be used on roofs with slopes less than 2 inches in 12 inches.

R-803.4 Fasteners: Asphalt shingles shall be fastened according to manufacturer's printed instructions and Table No. R-803.4.

R-803.5 Valley flashing: Roof valleys shall be flashed by one of the methods described below. Asphalt shingles shall be applied according to manufacturer's printed instructions.

Open roof valleys may be provided of not less than No. 28 gauge galvanized corrosion-resistant sheet metal and shall extend at least 8 inches from the center line each way. Sections of flashing shall be jointed to provide an adequate water lock.

Woven or closed valleys may be constructed by centering 36-inch-wide roll roofing material not less than No. 50 in the valley over the underlayment.

Roof valley flashing may be of laced composition shingles, applied in an approved manner, with an underlay of not less than 30-pound felt extending 10 inches from the center line each way, or shall be of two layers of 90-pound mineral-surfaced cap sheet cemented together with the bottom layer not less than 12 inches wide laid face down and the top layer not less than 24 inches wide laid face up.

R-803.6 Wall flashing: Flashing against vertical sidewall shall be by the step-flashing method according to asphalt shingle manufacturer's printed instructions.

R-803.7 Other flashing: Flashings against vertical front wall, as well as soil stack, vent pipe and chimney flashing, shall be applied according to asphalt shingle manufacturer's printed instructions.

R-803.8 Hips and ridges: Hip and ridge shingles shall be fastened according to manufacturer's printed instructions and Table No. R-803.4. Hip and ridge weather exposure shall not exceed that permitted for the field of the roof.

Table No. R-803.4
ASPHALT SHINGLE APPLICATION

ROOF SLOPE	NOT PERMITTED BELOW 2:12	
	2:12 to less than 4:12	4:12 and over
DECK REQUIREMENT	Asphalt shingles shall be fastened to solidly sheathed roofs. Sheathing shall conform to Table Nos. R-606.1a & R-704.2.	
UNDERLAYMENT Temperate climate	Asphalt strip shingles may be installed on slopes as low as 2 inches in 12 inches, provided the shingles are approved self-sealing or are hand-sealed and are installed with an underlayment consisting of two layers of nonperforated Type 15 felt applied shingle fashion. Starting with an 18-inch-wide sheet and a 36-inch-wide sheet over it at the eaves, each subsequent sheet shall be lapped 19 inches horizontally.	One layer nonperforated Type 15 felt lapped 2 inches horizontally and 4 inches vertically to shed water.
Severe climate: In areas subject to wind-driven snow or roof ice buildup.	Same as for temperate climate, and additionally the two layers shall be solid cemented together with approved cementing material between the plies extending from the eave up the roof to a line 24 inches inside the exterior wall line of the building.	Same as for temperate climate, except that one layer No. 40 coated roofing or coated glass base sheet shall be applied from the eaves to a line 12 inches inside the exterior wall line with all laps cemented together.
ATTACHMENT Type of fasteners	Corrosion-resistant nails, minimum 12-gauge 3/8-inch head, or approved corrosion-resistant staples, minimum 16-gauge 15/16-inch crown width. Fasteners shall be long enough to penetrate into the sheathing 3/4 inch or through the thickness of the sheathing, whichever is less.	
No. of fasteners[1]	4 per 36-40-inch strip 2 per 9-18-inch shingle	
Exposure Field of roof Hips and ridges	Per manufacturer's instructions included with packages of shingles. Hip and ridge weather exposures shall not exceed those permitted for the field of the roof.	
Method	Per manufacturer's instructions included with packages of shingles.	
FLASHINGS Valleys Other flashings	Per Section R-803.5 Per Sections R-803.6 and R-803.7	

[1]Figures shown are for normal application. For special conditions such as mansard application and where roofs are in special wind regions, shingles shall be attached per manufacturer's instructions.

SECTION R-804 — SLATE SHINGLES

R-804.1 General: Slate shingles shall be applied in an approved manner and securely fastened with corrosion-resistant nails or corrosion-resistant nails and wire.

R-804.2 Underlayment: Slate shingle roofs shall have an underlayment of not less than two layers of No. 15 felt or one layer of No. 30 felt, applied as required in Section R-802. Nails for shingle tiles shall be not less than No. 14 gauge copper or No. 14 gauge corrosion-resistant metal and shall be long enough to penetrate into the sheathing 3/4 inch or through the thickness of the sheathing, whichever is less.

R-804.3 Valleys: Roof valley flashing shall be provided of not less than No. 28 gauge galvanized corrosion-resistant sheet metal and shall extend at least 11 inches from the center line each way and shall have a splash diverter rib not less than 1 inch high at the flow line formed as part of the flashing. Sections of flashing shall have an end lap of not less than 6 inches and be provided with an adequate water lock.

*

SECTION R-805 — METAL

R-805.1 General: Flat sheets or shingles shall be applied only to solid sheathed roofs. Metal roofing shall be applied in an approved manner.

R-805.2 Slope: Metal shingles shall not be installed on a roof having a slope less than 3 inches in 12 inches unless approved by the building official.

R-805.3 Underlayment: Metal shingles shall be applied over an underlayment of not less than No. 30 felt, applied as required in Section R-802.

SECTION R-806 — TILE, CLAY OR CONCRETE SHINGLES

R-806.1 Attachment: All roof tile shall be securely fastened with corrosion-resistant nails or corrosion-resistant nails and wire, or other approved means.

R-806.2 Roof slope: Tile shall not be installed on a roof having a slope of less than 3 inches in 12 inches unless approved by the building official.

Tile with projection anchor lugs at the bottom of the tile shall be held in position by means of 1-inch by 2-inch wood stripping, treated to resist moisture deterioration, nailed to the roof sheathing over the underlayment or other approved means.

R-806.3 Underlayment: Tile roofs shall have an underlayment of not less than two layers of No. 15 felt or one layer of No. 30 felt, applied as required in Section R-802.

Nailing and valley flashing shall be the same as required for slate shingles.

SECTION R-807 — BUILT-UP ROOFING

R-807.1 Decking: Built-up roofing shall be applied only to solid surface roof decks.

R-807.2 Underlayment: An underlayment of one layer sheathing paper is required under built-up roofing assemblies when the roof deck is constructed of sheathing boards. Underlayment is to be applied as specified in Section R-802.

R-807.3 Base ply: On nailable decks, a base ply is to be fastened to the deck in accordance with manufacturer's published specifications and Table No. R-803.4.

On nonnailable decks, poured-in-place concrete or precast concrete, a base ply required by manufacturer's specification shall be cemented or spot mopped to a primed deck as required by the type of deck material, using not less than 20 pounds per square of hot asphalt for solid mopping, or not less than 10 pounds per square for spot mopping, or not less than 1 1/2 gallons per square of cold bituminous compound, or 25 pounds per square of coal-tar pitch, in accordance with manufacturer's published specifications. If a base ply is not used, a minimum of three roofing plies applied shingle fashion shall be solidly cemented to the primed deck and cemented together, using no less cementing material than that specified for a solidly cemented base ply.

On insulated decks, a vapor retarder shall be installed between the deck and the insulation where the average January temperature is below 45°F. or where excessive moisture conditions are anticipated within the building. Insulation shall be of a rigid type suitable for application of a roof covering. The insulation must be properly attached using Type II or Type III asphalt or mechanical fasteners in accordance with ASTM D312 listed in Section S-26.807 and installed in accordance with the manufacturer's published ply specifications. The insulation may be taped if required. A base ply required by manufacturer's specification shall be solidly cemented to the insulation, using no less cementing material than that specified for a solidly cemented base ply to a primed nonnailable deck. If a base ply is not used, a minimum of three roofing plies applied shingle fashion shall be solidly cemented to the insulation and cemented together, using no less cementing material than that specified for a solidly cemented base ply.

R-807.4 Membrane over base ply: A minimum of two successive layers of roofing plies shall be solidly cemented shingle fashion to the base ply, using no less cementing material than that specified for a solidly cemented base ply.

R-807.5 Surfacing: The built-up roofing assembly shall be surfaced by one of the methods described below.

Mineral aggregate surfaced roofs shall be surfaced with not less than 60 pounds of hot asphalt or 75 pounds of coal-tar pitch in which is embedded not less than 400 pounds of gravel or 300 pounds of crushed slag per roofing square.

Mineral-surfaced cap sheets shall be cemented to the roofing plies using no less cementing material than specified for between the plies.

SECTION R-808—WOOD SHINGLES

R-808.1 Sheathing requirements: Wood shingles shall be applied to roofs with solid or spaced sheathing. Spaced sheathing shall be spaced not to exceed 4 inches clear nor more than the width of the sheathing board. Spaced sheathing shall be not less than 1-inch by 3-inch nominal dimensions.

R-808.2 Installation: Wood shingles shall be applied in accordance with the CSSB "Cedar Shake and Shingle Bureau Design and Application Manual for New Roof Construction" listed in Section S-26.808. Shingles shall be laid with a side lap of not less than 1 1/2 inches. Joints in adjacent courses shall be offset a minimum of 1 1/2 inches and no two joints in alternate courses shall be in direct alignment. Spacing between shingles shall be not less than 1/4 inch nor more than 3/8 inch. Wood shingles shall be fastened to the sheathing in accordance with Table No. R-808.2a.

Shingles shall not be installed on a roof having a slope less than 3 inches in 12 inches. On roofs having slopes of 3 inches in 12 inches to less than 4 inches in 12 inches, shingles shall be installed with reduced exposures or they shall be installed over an underlayment of not less than one ply of No. 15 felt, applied as required in Section R-802.

Roof valley flashing shall not be less than No. 28 gauge corrosion-resistant sheet metal and shall extend 10 inches from the center line each way for roofs having slopes less than 12 inches in 12 inches and 7 inches from the center line each way for slopes of 12 inches in 12 inches and greater. Sections of flashing shall have an end lap of not less than 4 inches.

Weather exposures shall not exceed those set forth in Table No. R-808.2b. Hip and ridge weather exposures shall not exceed those permitted for the field of the roof. Wood shingle hip and ridge units shall conform to CSSB "Grading Rules for Shingle Hip and Ridge based on the Standards of the Cedar Shake and Shingle Bureau" listed in Section S-26.808. Nails used to fasten hip and ridge units shall be longer than those used in the field of the roof in order to penetrate the sheathing 3/4-inch minimum.

Each bundle of shingles shall be identified by a label of an approved grading or inspection bureau or agency.

Table No. R-808.2a
WOOD SHINGLE OR SHAKE APPLICATION

ROOF SLOPE	WOOD SHINGLES Not Permitted below 3:12 See Table No. R-808.2b	WOOD SHAKES Not Permitted below 4:12[1] See Table No. R-808.2b
DECK REQUIREMENT	Shingles and shakes shall be applied to roofs with solid or spaced sheathing. Spaced sheathing for wood roofs shall be spaced not to exceed 6 inches clear nor more than the nominal width of the sheathing board. Sheathing boards shall be not less than 1 inch by 3 inches nominal dimensions. Sheathing shall conform to Sections R-808.1 and R-809.1.	
UNDERLAYMENT Temperature climate	No Requirements	One 18-inch-wide interlayment of Type 30 felt shingled between each course in such a manner that no felt is exposed to the weather below the shake butts.
Severe climate: In areas subject to wind-driven snow or of ice buildup.	Two layers of nonperforated Type 15 felt applied shingle fashion shall be installed and solid cemented together with approved cementing material between the plies extending from the eaves up the roof to a line 36 inches inside the exterior wall line of the building.	Sheathing shall be solid and the shakes shall be applied over a layer of nonperforated Type 15 felt applied shingle fashion. Two layers of nonperforated Type 15 felt applied shingle fashion shall be installed and solid cemented together with approved cementing material between the plies extending from the eave up the roof to a line 36 inches inside the exterior wall line of the building.
ATTACHMENT Type of Fasteners	Corrosion-resistant nails, minimum No. 14 1/2-gauge, 7/32-inch head, or corrosion resistant staples when approved by the building officials.	Corrosion-resistant nails, minimum No. 13-gauge 7/32 inch head, or corrosion-resistant staples, when approved by the building official.
	Fasteners shall be long enough to penetrate into the sheathing 3/4 inch or through the thickness of the sheathing, whichever is less.	
No. of fasteners	2 per shingle	2 per shake
Exposure Field of roof Hips and and ridges	Weather exposures shall not exceed those set forth in Table No. R-808.2b. Hip and ridge weather exposures shall not exceed those permitted for the field of the roof.	

(continued)

Table No. R-808.2a (Continued)

ROOF SLOPE	WOOD SHINGLES Not Permitted below 3:12 See Table No. R-808.2b	WOOD SHAKES Not Permitted below 4:12[1] See Table No. R-808.2b
Method	Shingles shall be laid with a side lap of not less than 1 1/2 inches between joints in adjacent courses, and not in direct alignment in alternate courses. Spacing between shingles shall be approximately 1/4 inch. Each shingle shall be fastened with two nails only, positioned approximately 3/4 inch from each edge and approximately 1 inch above the exposure line. Starter course at the eaves shall be doubled.	Shakes shall be laid with a side lap of not less than 1 1/2 inches between joints in adjacent courses. Spacing between shakes shall not be less than 1/8 inch nor more than 5/8 inch except for preservative-treated wood shakes which shall have a spacing not less than 1/4 inch nor more than 3/8 inch. Shakes shall be fastened to the sheathing with two nails only, positioned approximately 1 inch from each edge and approximately 2 inches above the exposure line. The starter course at the eaves shall be doubled. The bottom or first layer may be either shakes or shingles. 15-inch or 18-inch shakes may be used for the starter course at the eaves and final course at the ridge.
FLASHINGS Valleys Other flashings	Per Sections R-808.2 and R-809.2 Per accepted practice	

[1] When approved by the building official, wood shakes may be installed on a slope of not less than 3 inches in 12 inches when an underlayment of not less than nonperforated Type 15 felt is installed.

Table No. R-808.2b
WOOD SHINGLE AND SHAKE MAXIMUM RECOMMENDED WEATHER EXPOSURES

GRADE	LENGTH	3" TO LESS THAN 4" IN 12" (Inches)	4" IN 12" AND STEEPER (Inches)
WOOD SHINGLES			
No. 1	16 inch	3 3/4	5
No. 2[1]	16 inch	3 1/2	4
No. 3[1]	16 inch	3	3 1/2
No. 1	18 inch	4 1/4	5 1/2
No. 2[1]	18 inch	4	4 1/2
No. 3[1]	18 inch	3 1/2	4
No. 1	24 inch	5 3/4	7 1/2
No. 2[1]	24 inch	5 1/2	6 1/2
No. 3[1]	24 inch	5	5 1/2
WOOD SHAKES[2]			
No. 1	18 Inch	Per R-809.2	7 1/2
No. 2	18 Inch[3]	Per R-809.2	5 1/2
No. 1	24 Inch	Per R-809.2	10
No. 2	24 Inch[3]	Per R-809.2	7 1/2

1 To be used only when specifically permitted by the building official.

2 Exposure of 24-inch by 3/8-inch resawn handsplit shakes shall not exceed 7 1/2 inches regardless of the roof slope.

3 No.2 grade wood shakes pertain to Taper-Sawn shakes only.

SECTION R-809—WOOD SHAKES

R-809.1 Sheathing requirements: Wood shakes and preservatively treated wood shakes shall be applied to roofs with solid or spaced sheathing. Spaced sheathing shall be spaced not to exceed 4 inches clear nor more than the width of the sheathing board. Spaced sheathing shall be not less than 1-inch by 4-inch nominal size for shakes installed at 7 1/2-inch exposures and not less than 1-inch by 6-inch nominal size for shakes installed at 10-inch exposures. In snow areas, sheathing shall be solid and the shakes shall be applied over an underlayment of not less than No. 15 felt, applied as required in Section R-802.

R-809.2 Installation: Wood shakes and preservatively treated wood shakes shall be applied in accordance with CSSB "Cedar Shake and Shingle Bureau Design and Application Manual for New Roof Construction" listed in Section S-26.809. Preservatively treated wood shakes shall conform to CSSB "Wood Shakes (Preservative Treated) based on Grading and Packing Rules for treated Southern Pine Taper-Sawn Shakes of the Cedar Shake and Shingle Bureau" listed in Section S-26.809. Shakes may be laid in straight or staggered courses with a side lap of not less than 1 1/2 inches. Joints in adjacent courses shall be offset a minimum of 1 1/2 inches. Spacing between shakes shall be not less than 3/8 inch and not more than 5/8 inch.

Wood shakes shall be fastened to the sheathing in accordance with Table No. R-808.2a.

The starter course at the eaves shall be doubled and the bottom layer shall be either 15-, 18- or 24-inch wood shakes or wood shingles. Fifteen-inch or 18-inch wood shakes may be used for the final course at the ridge.

Shakes shall be interlaid with 18-inch-wide strips of not less than No. 30 felt shingled between each course in such a manner that no felt is exposed to the weather by positioning the lower edge of each felt strip above the butt end of the shake it covers a distance equal to twice the weather exposure.

Shakes shall not be installed on a roof having a slope less than 4 inches in 12 inches unless they are installed over an underlayment of not less than No. 15 felt, applied as required in Section R-802.

Roof valley flashing shall not be less than No. 28 gauge corrosion-resistant sheet metal and shall extend at least 11 inches from the center line each way. Sections of flashing shall have an end lap of not less than 4 inches.

Weather exposures shall not exceed those set forth in Table No. R-808.2b. Hip and ridge weather exposures shall not exceed those permitted for the field of the roof. Wood shake hip and ridge units shall conform to CSSB "Grading Rules for Shake Hip and Ridge based on the Standards of the Cedar Shake and Shingle Bureau" listed in Section S-26.809. Nails used to fasten hip and ridge units shall be longer than those used in the field of the roof in order to penetrate the sheathing 3/4 inch minimum.

Each bundle of shakes shall be identified by a label of an approved grading or inspection bureau or agency.

Chapter 9
CHIMNEYS AND FIREPLACES

SECTION R-901—MASONRY CHIMNEYS

R-901.1 Support: Masonry chimneys shall be designed, anchored, supported and reinforced as required in this chapter and the applicable provisions of Chapters 2, 3 and 4. In Seismic Zone Nos. 3 and 4, masonry and concrete chimneys shall be reinforced and anchored as detailed in Section R-903 for chimneys serving fireplaces. In Seismic Zone Nos. 0, 1 or 2, reinforcement and seismic anchorage is not required. Chimneys shall be structurally sound, durable, smoke-tight and capable of conveying flue gases to the exterior safely.

Masonry chimneys shall be supported on foundations of solid masonry or concrete at least 12inches thick and at least 6 inches beyond each side of the exterior dimensions of the chimney. Footings shall be founded on natural undisturbed earth below frostline. In areas not subject to freezing, footings shall be located a minimum of 12 inches below finished grade.

R-901.2 Corbeling: Masonry chimneys should not be corbeled more than 6 inches from a wall or foundation, nor should a chimney be corbeled from a wall or foundation which is less than 12 inches in thickness unless it projects equally on each side of the wall, except that on the second story of a two-story dwelling, corbeling of chimneys on the exterior of the enclosing walls may equal the wall thickness. The projection of a single course shall not exceed one-half the unit height or one-third of the unit bed depth, whichever is less.

R-901.3 Changes in dimension: The chimney wall or chimney flue lining shall not change in size or shape within 6 inches above or below where the chimney passes through floor components, ceiling components or roof components.

R-901.4 Additional load: Chimneys shall not support loads other than their own weight unless they are designed and constructed to support the additional load.

R-901.5 Termination: Chimneys shall extend at least 2 feet higher than any portion of the building within 10 feet, but shall not be less than 3 feet above the point where the chimney passes through the roof.

R-901.6 Wall thickness: Masonry chimney walls shall be constructed of solid masonry units with not less than 4 inches nominal thickness.

R-901.7 Flue lining (material): Masonry chimneys shall be lined with fireclay flue liners not less than 5/8 inch in thickness or with other approved liner of material that will resist, without cracking or softening, a temperature of 1,800 degrees F.

Exception: Masonry chimneys may be constructed without flue liners when walls are at least 8 inches in thickness of solid masonry.

R-901.8 Flue lining (installation): Flue liners shall extend from a point not less than 8 inches below the lowest inlet or, in the case of fireplaces, from the top of the smoke chamber, to a point above the enclosing walls. Fireclay flue liners shall be laid with tight mortar joints left smooth on the inside and installed to maintain a 1/2-inch-wide air space separating the flue liners from the interior face of the chimney masonry walls. Flue lining shall be supported on all sides.

R-901.9 Multiple flues: When two or more flues are located in the same chimney, masonry wythes shall be built between adjacent flue linings. The masonry wythes shall be at least 4 inches thick and bonded into the walls of the chimney.

> **Exception:** When venting only one appliance, two flues may adjoin each other in the same chimney with only the flue lining separation between them. The joints of the adjacent flue linings shall be staggered at least 7 inches.

R-901.10 Flue area (appliance): Chimney flues shall not be smaller in area than that of the area of the connector from the appliance. The sizing and installation of a chimney flue to which multiple-appliance venting systems are connected shall be in accordance with Section M-1604.3.2.

R-901.11 Inlet: Inlets to masonry chimneys shall enter from the side. All inlets shall have a thimble of fireclay, rigid refractory material, metal, or other arrangement that will prevent the connector from pulling out of the inlet or from extending beyond the wall of the liner.

R-901.12 Cleanout opening: Cleanout openings, when provided, shall be equipped with ferrous metal doors and frames constructed to remain tightly closed, except when in use.

Cleanouts shall be accessible and so located that ash removal will not create a hazard to combustible materials. Except for chimneys serving fireplaces, cleanouts shall be not less than 2 feet below the lowest flue inlet.

R-901.13 Chimney clearance: Wood beams, joists, headers and studs shall not be placed within 2 inches from the outside face of a masonry chimney built partially or entirely within the dwelling. Masonry chimneys built entirely outside the dwelling may be placed 1 inch minimum from combustible material.

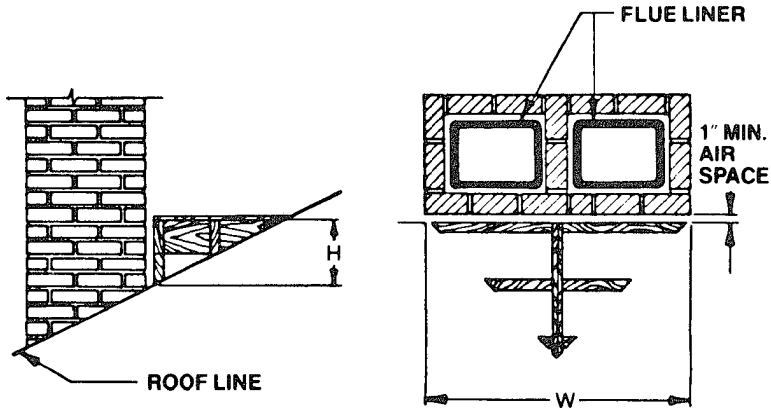
R-901.14 Chimney firestopping: See Section R-402.7.

R-901.15 Chimney crickets: Chimney shall be provided with crickets when the dimension parallel to the ridgeline is greater than 30 inches and does not intersect the ridgeline. The intersection of the cricket and the chimney shall be flashed and counterflashed in the same manner as normal roof-chimney intersections. Crickets shall be constructed in conformity with Figure No. R-901.15 and Table No. R-901.15.

Table No. R-901.15
CRICKET DIMENSIONS

ROOF SLOPE	H
12 - 12	1/2 of W
8 - 12	1/3 of W
6 - 12	1/4 of W
4 - 12	1/6 of W
3 - 12	1/8 of W

Figure No. R-901.15
CHIMNEY CRICKET



SECTION R-902—FACTORY-BUILT CHIMNEYS

Factory-built chimneys shall conform to the conditions of their listing and the manufacturer's instructions.

Factory-built fireplaces shall conform to Section R-904.1.

SECTION R-903—MASONRY FIREPLACES

R-903.1 Fireplace support: Fireplace foundations and supporting walls shall be designed, anchored, supported and reinforced as required in this chapter and the applicable provisions of Chapters 2 and 3. When a design is not provided, foundations for masonry fireplaces and their chimneys shall be constructed of concrete or solid masonry at least 12 inches thick and extend at least 6 inches beyond the fireplace supporting wall on all sides.

Footings shall be founded on natural undisturbed earth below frost depth. In areas not subjected to freezing, footings shall be at least 12 inches below finished grade. Masonry fireplaces and chimneys constructed in conformity with Figure No. R-903.1 and Table No. R-903.1 shall be deemed to meet the requirements of this section. In Seismic Zone Nos. 3 and 4, seismic anchorage and reinforcement of masonry chimneys and fireplaces shall conform to the minimum details shown in Figure No. R-903.1 and Table No. R-903.1. In Seismic Zone Nos. 0, 1 or 2, reinforcement of fireplaces and their chimneys may be omitted.

Table No. R-903.1
REQUIREMENTS FOR MASONRY FIREPLACES AND CHIMNEYS

ITEM	LETTER[1]	REQUIREMENTS
Hearth slab thickness	A	4"
Hearth extension (each side of opening)	B	8" fireplace opening < 6 sq. ft 12" fireplace opening ≥ 6 sq. ft.
Hearth extension (front of opening)	C	16" fireplace opening < 6 sq. ft 20" fireplace opening ≥ 6 sq. ft.
Hearth slab reinforcing	D	Reinforced to carry its own weight and all imposed loads.
Thickness of wall of firebox	E	10" common brick or 8" where a firebrick lining is used. Joints in firebrick 1/4" max.
Distance from top of opening to throat	F	8"
Smoke chamber edge of shelf Rear wall—thickness Front and sidewall—thickness	G	 6" 8"
Chimney Vertical Reinforcing	H	Four No. 4 full-length bars for chimney up to 40" wide. Add two No. 4 bars for each additional 40" or fraction of width or each additional flue.
Horizontal reinforcing	J	1/4" ties at 18" and two ties at each bend in vertical steel.
Bond beams	K	No specified requirements
Fireplace lintel	L	Noncombustible material.
Walls with flue lining	M	Brick with grout around lining 4" min. from flue lining to outside face of chimney.
Walls with unlined flue	N	8" solid masonry
Distances between adjacent flues	——	See Section R-901.9
Effective flue area (based on area of fireplace opening)	P	Round lining—1/12 or 50 sq. in. min. Rectangular lining—1/10 or 64 sq. in. min. Unlined or lined with firebrick—1/8 or 100 sq. in. min.
Clearances Wood frame Combustible material Above roof	R	 See Sections R-901.13 and R-903.7 See Section R-903.9 2' at 10'
Anchorage Strap Number Embedment into chimney Fasten to Bolts	S	 3/16" × 1" 2 12" hooked around outer bar w/6" ext. 4 joists Two 1/2" diameter.
Footing Thickness Width	T	 12" min. 6" each side of fireplace wall.

[1]The letters refer to Figure No. R-903.1.

Figure No. R-903.1
FIREPLACE AND CHIMNEY DETAILS

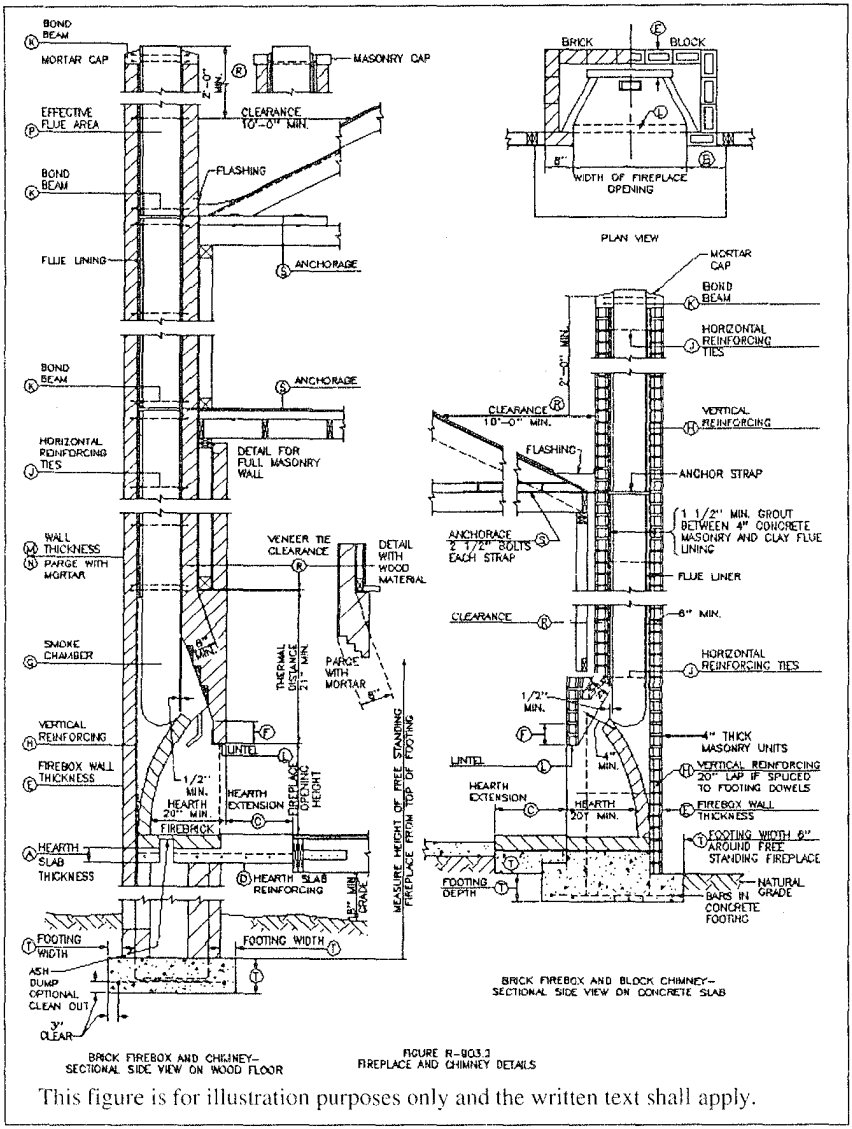


FIGURE R-903.1
FIREPLACE AND CHIMNEY DETAILS

This figure is for illustration purposes only and the written text shall apply.

R-903.2 Fireplace walls: Masonry fireplaces shall be constructed of solid masonry units, stone, or reinforced concrete in accordance with Figure No. R-903.1. Where a lining of firebrick at least 2 inches in thickness or other approved lining is provided, the total thickness of back and sides, including the lining, shall be not less than 8 inches. Where no lining is provided, the thickness of back and sides shall be not less than 10 inches.

R-906.4 Inlet: The exterior air inlet can be located in the sides of the firebox chamber, or within 24 inches of the firebox opening on or near the floor. The inlet shall be closeable and designed to prevent burning material from dropping into concealed combustible spaces.

Part IV—Mechanical

Chapter 10
GENERAL MECHANICAL REQUIREMENTS AND DEFINITIONS

SECTION M-1001—GENERAL

M-1001.1 Application: The provisions of this part shall establish the general scope of the mechanical system and equipment requirements of this code and the definitions of terms related thereto. The use of materials or methods accomplishing the purposes intended by this code and approved by the building official in accordance with Section R-108 shall be accepted as complying with this code.

M-1001.2 Approval: Heating and cooling appliances shall bear the label of an approved agency or shall be approved by the building officials for safe use.

M-1001.3 Conformity: Conformity with the applicable provisions and standards specified in each section of Part IV shall indicate that the equipment is safe for installation under this code. Where differences occur between the provisions of this code and referenced standards, the provisions of this code shall apply.

M-1001.4 Authority to disconnect: The building official shall have the authority to order disconnected any fuel supply or appliance that does not conform to this code. A notice shall be attached to the piping or appliances stating the reasons for disconnection. Such notice shall not be removed nor shall the system or appliance be reconnected until authorized by the building official.

SECTION M-1002—APPLIANCE LABELING

M-1002.1 General: All appliances shall bear a permanent and legible factory-applied label which shall include the following information:

1. Name or trademark of the manufacturer.
2. The model and serial number.
3. Identity of the agency certifying compliance of equipment with recognized standards.
4. Clearances from combustible construction for heat producing appliances.

M-1002.2 Fuel-burning appliances: The label for fuel burning appliances, except wood stoves and fireplaces, shall also indicate:

1. The type of fuel approved for use with the appliance.
2. The input or output ratings.

M-1002.3 Other than fuel-burning appliances: The label for other than fuel-burning appliances shall also indicate, where applicable:

1. The output or capacity rating.
2. The electrical rating in volts, amperes (or Watts) and phase.
3. Type of refrigerant and test pressures for heat pumps and refrigeration cooling equipment.

SECTION M-1003—TYPE OF FUEL

Each appliance shall be designed for use with the type of fuel to which it is connected. Appliances converted from the fuel specified on the rating plate for use with a different fuel shall be reapproved by the building official. Gas conversion burners shall conform to ANSI Z21.17 and shall be installed in accordance with ANSI Z21.8.

SECTION M-1004—APPLIANCE ACCESS

Appliances shall be accessible for inspection, service, repair and replacement without removing permanent construction. Unless otherwise specified, at least 30 inches of working space and platform shall be provided in front of the control side to service an appliance. Room heaters shall be installed with at least an 18-inch working space. A platform shall not be required for room heaters.

SECTION M-1005—APPLIANCE CLEARANCES

Appliances shall have clearances from combustible materials in accordance with Figure No. M-1005 and Table No. M-1005a, unless otherwise provided in the manufacturer's installation instructions and approved by the building official. Reduced clearances are allowed where protection is provided in accordance with Table No. M-1005b, or labeled systems in accordance with the manufacturer's installation instructions. Forms of protection with ventilated air space shall conform to the following requirements:

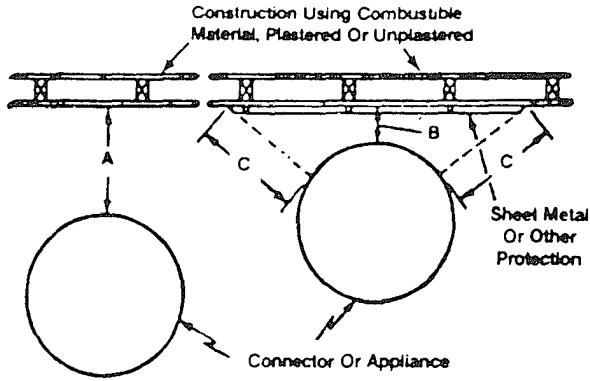
1. Not less than 1-inch air space shall be provided between the protector and combustible wall surface.

2. Adequate air circulation shall be provided by having edges of the wall protector open at least 1-inch.

3. If the wall protector is mounted on a single flat wall away from corners, adequate air circulation shall be provided by having the bottom and top edges, or the side and top edges open at least 1 inch.

4. Wall protectors covering two walls in a corner shall be open at the bottom and top edges at least 1 inch.

Figure No. M-1005
REDUCED CLEARANCE DIAGRAM



Notes:
"A" equals the required clearance with no protection, specified in Table No. M-1005a. "B" equals the reduced clearance permitted in accordance with Table No. M-1005b. The protection applied to the construction using combustible material shall extend far enough in each direction to make "C" equal to "A".

Table No. M-1005a
STANDARD INSTALLATION CLEARANCES FOR HEATING APPLIANCES[1]

RESIDENTIAL-TYPE APPLIANCES	CLEARANCE (inches)			
	Above Top[2]	From Front	From Back	From Sides
Boilers and Water Heaters:				
Automatic oil or combination gas and oil-	6	24	6	6
Automatic gas-	6	18	6	6
Solid-	6	48	6	6
Electric-	6	18	6	6
Central Furnaces:				
Automatic oil or combination gas and oil-	6	24	6	6
Automatic gas-	6	18	6	6
Solid-	18	48	18	18
Electric-	6	18	6	6
Floor Furnaces:				
Automatic oil or combination gas and oil-	36	12	12	12
Automatic gas-	36	12	12	12
Room Heaters:[3]				
Circulating type: Oil or solid fuel-	36	24	12	12
Gas-	36	24	12	12
Radiant or other type: Oil or solid fuel-	36	36	36	36
Gas-	36	36	18	18
Gas with double metal or ceramic back-	36	36	12	18
Fireplace stove: Solid fuel-	48	54	48	48

[1]Reductions in the required clearance shall be permitted in accordance with Table No. M-1005b.
[2]Same clearances required from top and sides of warm air bonnet or plenum of central furnaces.
[3]Room heaters shall be installed on noncombustible floors.

Table No. M-1005b
REDUCED CLEARANCES WITH SPECIFIED FORMS OF PROTECTION
(INCHES)

TYPE OF PROTECTION	WHERE REQUIRED CLEARANCE WITH NO PROTECTION IS							
	36		18		12		6	
	CLEARANCE MAY BE REDUCED TO							
	Wall	Ceiling	Wall	Ceiling	Wall	Ceiling	Wall	Ceiling
1/2-inch noncombustible insulation board over 1-inch glass fiber or mineral wool batts with no air space	18	24	9	12	6	8	3	4
1/2-inch thick noncombustible insulation board with ventilated air space	12	18	6	9	4	6	2	3
24-gauge sheet metal with ventilated air space	12	18	6	9	4	6	2	3
3 1/2-inch thick masonry wall with air space	12	—	6	—	4	—	2	—

NOTES:
1 Required clearances shall be measured as shown in Figure No. M-1005.
2 The clearance between the appliance and the face of the protection shall not be reduced below that shown in the table. Required clearances between those shown in the table may be interpolated.
3 With all clearance reduction systems using ventilated air space, adequate air circulation shall be provided as described in Section M-1005.
4 Spacers and ties shall be noncombustible, and shall not be used directly behind an appliance or a connector.
5 Mineral wool batts shall have a minimum density of 8 lb per cubic foot and a minimum melting point of 1500°F.
6 Insulation material shall have a thermal conductivity of 1.0 (Btu-in)/(sq ft-hr F) or less.
7 A single wall connector passing through the masonry wall shall have at least 1/2-inch of open ventilated air space between the connector and the masonry.

SECTION M-1006—APPLIANCE INSTALLATION

M-1006.1 General: Except as otherwise provided in this code, the installation of appliances shall conform to the conditions of their label and the manufacturer's installation instructions. The manufacturer's operating instructions shall remain attached to the appliance.

M-1006.2 Anchorage of appliances: Appliances designed to be fixed in position shall be securely fastened in place. In Seismic Zones Nos. 3 and 4 (see Seismic Risk Map in Appendix A) water heaters having nonrigid water connections and over 4-feet in height from the base to the top of the tank case shall be anchored or strapped to the building to resist horizontal displacement due to earthquake motion.

M-1006.3 Appliances located in garage: Heating and cooling appliances located in a garage shall be protected from impact by

automobiles. Appliances that generate a glow, spark, or flame capable of igniting flammable vapors and located in a garage shall be installed with the burners, burner ignition devices or heating elements and switches at least 18-inches above the floor level. Appliances enclosed in a separate compartment having access only from outside of the garage, and installed at floor level, shall have combustion air taken from and the products of combustion discharged to, the exterior of the garage.

M-1006.4 Electrical appliances: Electrical appliances shall be installed in accordance with Chapter 12 and Part VI of this code.

SECTION M-1007—CONTROL DEVICES

M-1007.1 Gas Appliances: Automatic gas-burning appliances shall be equipped with a labeled device or devices that will shut off the fuel supply to the main burner or burners in the event of pilot or ignition failure. In addition, liquefied petroleum gas heating appliances shall be equipped with a labeled automatic device or devices that will shut off the flow of gas to the pilot in the event of ignition failure. The labeled shutoff devices shall not be required on range or cooking tops, log lighters, lights or other open-burner manually operated appliances, or labeled appliances not requiring such devices as approved by the building official.

M-1007.2 Oil-burning appliances: Oil burning appliances shall be provided with automatic limit devices to sense and control overheating, and primary safety controls that will shut off flow of fuel to the burners in the event of ignition failure or failure of the main burner flame. Oil-fired water boilers shall be provided with labeled relief valves and temperature-limiting devices whose combined Btu/h rating shall be equal to or greater than the boiler rating.

M-1007.3 Forced-air furnaces: Forced-air furnaces shall be equipped with a labeled limit control that will prevent outlet air temperature from exceeding 250°F. Such controls shall be located in the bonnet or plenum, or in accordance with the terms of the label.

M-1007.4 Electric duct heaters: Electric duct heaters shall be equipped with an approved automatic reset air outlet temperature-limit control that will limit the outlet air temperature to not more than 200°F. The electric elements of the heater shall be equipped with fusible links or a manual reset temperature-limit control that will prevent air temperature in the immediate vicinity of the heating elements from exceeding 250°F.

SECTION M-1008—EXISTING MECHANICAL SYSTEMS

Any addition, alteration, repair or replacement made to an existing mechanical system shall be made in conformity with applicable regulations of this code. Where additions or alterations subject parts of existing systems to loads exceeding those permitted herein, such parts shall be made to comply with this code.

SECTION M-1009—INSPECTIONS

All fuel supply piping and equipment installations shall be subject to rough and final inspections. Portions of fuel supply piping or equipment intended to be concealed shall be inspected before concealment. When installation of equipment is complete, a final inspection shall be made. Equipment regulated by this code shall comply with all applicable requirements of this code and shall be approved by final inspection before being placed in service.

M-1009.1 Rough inspection: Gas piping, from the point of delivery to points of use or connection to equipment, shall be inspected before it is covered or concealed. Equipment venting that will be concealed shall also be a part of this inspection. Critical inspection factors for fuel supply piping shall include but are not limited to: trenching, sizing, materials and supports. Critical inspection factors for equipment venting shall include sizing, materials, supports, and clearances.

M-1009.2 Final inspection: This inspection shall focus primarily on final connections to the fuel supply and venting system, and installation and operation of equipment. Critical inspection factors shall include but are not limited to: a gas pressure test, equipment accessibility and clearances, combustion air, availability of manufacturer's specifications on the job, and performance of a complete operational firing sequence.

SECTION M-1010—DEFINITIONS

Unless otherwise expressly stated, the following terms shall, for the purpose of this code, have the meanings indicated in this section. Words used in the present tense include the future; the singular number includes the plural and the plural the singular. Where terms are not defined in this section and are defined in Section R-118 or Section P-2016 of this code, they shall have the meanings ascribed to them as those sections. Where terms are not defined in these sections, they shall have their ordinarily accepted meanings or such as the context implies.

Accessible: Signifies access that requires the removal of an access panel or similar removable obstruction.

Accessible, readily: Signifies access without the necessity of removing any panel or similar obstruction.

Air circulation, forced: A means of providing space conditioning utilizing movement of air through ducts or plenums by mechanical means.

Air-conditioning system: An air-conditioning system consists of heat exchangers, blowers, filters, supply exhaust and return-air systems and shall include any apparatus installed in connection therewith.

Alteration: A change in an air-conditioning, heating, ventilating or refrigeration system that involves an extension, addition or change to the arrangement, type or purpose of the original installation.

Appliance: A device which utilizes fuel or other forms of energy to produce light, heat, power, refrigeration or air-conditioning. This definition shall also include a vented decorative appliance.

Boiler, hot water heating: A self-contained appliance from which hot water is circulated for heating purposes and then returned to the boiler, and which operates at water pressures not exceeding 160-psig and at water temperatures not exceeding 250°F at or near the boiler outlet.

Brazed joints: A joint obtained by the joining of metal parts with metals or alloys that melt at a temperature above 1000°F but lower than the melting temperature of the parts to be joined.

Chimney: (See also "Vent" and "Venting System") One or more passageways, vertical or nearly so, for conveying flue or vent gases to the outside atmosphere.

Factory-built chimney: A chimney composed of labeled factory-built components assembled in accordance with the label to form the completed chimney.

Masonry chimney: A field-constructed chimney of masonry units, bricks, stones, labeled masonry chimney units, or reinforced portland cement concrete, lined with suitable chimney flue liners.

H.T. chimney: A high temperature chimney complying with the requirements of Section 21 in UL 103, as listed in Section S-26.1010. A Type H.T. chimney is identifiable by markings stating "Type H.T." on each chimney pipe section.

Chimney connector: A pipe that connects a fuel appliance to a chimney.

Closet: A small room or chamber used for storage.

Combustible material: Any material not defined as noncombustible.

Combustion air: The air that must be provided to fuel-burning equipment including air for fuel combustion, draft hood dilution, and ventilation of the equipment enclosure.

Concealed gas piping: Piping that is enclosed in the building construction with no means of access.

Condensate: The liquid which separates from a gas due to a reduction in temperature, e.g. water that condenses from flue gases and water that condenses from air circulating through the cooling in air conditioning equipment.

Condensing appliance: An appliance that condenses water generated by the burning of fuels.

Conditioned air: Air treated to control its temperature, relative humidity or quality.

Conditioned space: The space contained within an insulated building enclosure which is conditioned directly or indirectly by heating or cooling systems.

Control, limit: An automatic control responsive to changes in liquid flow or level, pressure, or temperature for limiting the operation of an appliance.

Control, primary safety: A safety control responsive directly to flame properties that senses the presence or absence of flame and, in event of

ignition failure or unintentional flame extinguishment, automatically causes safety shutdown of mechanical equipment.

Convector: A system incorporating heating element in an enclosure in which air enters an opening below the heating element, is heated, and leaves the enclosure through an opening located above the heating element.

Convenience outlet, gas: A permanently mounted hand operated device for connecting and disconnecting an appliance to the gas supply piping conforming to AGA Requirement 7-90, as listed in Sections S-26.1010. The device includes an integral, manually operated gas valve so that the appliances can be disconnected only when the valve is in the closed position.

Damper, volume: Any device that will restrict, retard or direct the flow of air in any duct, or the products of combustion in any heat-producing equipment, vent connector, vent or chimney.

Decorative appliance: An appliance whose function lies primarily in the aesthetic effect rather than heating.

Dilution air: Air that enters a draft hood or draft regulator and mixes with flue gases.

Direct-vent appliance: A fuel-burning appliance with a sealed combustion system that draws all air for combustion from the outside atmosphere and discharges all flue gases to the outside atmosphere.

Draft: The flow of gases or air through chimney, flue or equipment caused by pressure differences.

Mechanical or induced: The draft developed by fan or air or steam jet or other mechanical means.

Natural: The draft developed by the difference in temperature of hot gases and outside atmosphere.

Draft hood: A device built into an appliance, or a part of the vent connector from an appliance, which is designed to (1) provide for the ready escape of the flue gases from the appliance in the event of no draft, backdraft, or stoppage beyond the draft hood, (2) prevent a back draft from entering the appliance, and (3) neutralize the effect of stack action of the chimney or gas vent upon the operation of the appliance.

Draft regulator: A device which functions to maintain a desired draft in the appliance by automatically reducing the draft to the desired value.

Duct system: A duct system is a continuous passageway for the transmission of air which, in addition to ducts, may include duct fittings, dampers, plenums, fans and accessory air-handling equipment.

Equipment: A general term including materials, fittings, devices, appliances and apparatus used as part of or in connection with installations regulated by this code.

Evaporative cooler: A device used for reducing air temperature by the process of evaporating water into an airstream.

Excess air: Air which passes through the combustion chamber and the appliance flue in excess of that which is theoretically required for complete combustion.

Exhaust hood, full opening: An exhaust hood with an opening at least equal to the diameter of the connecting vent.

Fireplace stove: A freestanding, chimney-connected solid-fuel-burning heater with or without doors connected to the chimney.

Flame-spread rating: A numerical index indicating the relative surface burning behavior of a material tested in accordance with ASTM E84 listed in Section S-26.1010.

Floor furnace: A self-contained furnace suspended from the floor of the space being heated, taking air for combustion from outside such space, and with means for lighting the appliance from such space.

Flue: See "Vent."

Flue collar: The portion of a fuel-burning appliance designed for the attachment of a draft hood, vent connector, or venting system.

Flue gases: Products of combustion plus excess air in appliance flues or heat exchangers.

Fuel piping system: All piping, tubing, valves, and fittings used to connect fuel utilization equipment to the point of fuel delivery.

Furnace, warm-air: A vented comfort-heating appliance designed or arranged to discharge heated air into a conditioned space.

Gas: Fuel gas, such as natural gas, manufactured gas, undiluted liquefied petroleum gas (vapor phase only), liquefied petroleum gas-air mixture, or mixtures of these gases.

Hybrid pressure gas supply systems: Gas supply systems that convey medium pressure gas (0.5 to 5.0 psig) from the meter to a pounds-to-inches regulator, and low pressure gas (less than 14-inches water column [0.5-psig]) from the regulator to the outlets or appliances.

Labeled: Devices, equipment or materials to which have been affixed a label, seal, symbol or other identifying mark of an approved testing laboratory, inspection agency or other organization concerned with product evaluation that maintains periodic inspection of the production of the above labeled items and by whose label the manufacturer attests to compliance with applicable standards.

Listed: Equipment or materials included in a list published by an approved testing laboratory, inspection agency or other organization concerned with product evaluation that maintains periodic inspection of production of listed equipment or materials, and whose listing states either that the equipment or material meets applicable standards or has been tested and found suitable for use in a specified manner. The means for identifying listed equipment may vary for each testing laboratory, inspection agency, or other organization concerned with product evaluation, some of which do not recognize equipment as listed unless it is also labeled.

LP-gas: Liquefied petroleum gas composed predominately of propane, propylene, butanes or butylenes, or mixtures thereof which are gaseous under normal atmospheric conditions, but can be liquefied under moderate pressure at normal temperatures.

Manufacturer's installation instructions: Printed instructions included with equipment as part of the conditions of listing or labeling.

Mechanical exhaust system: Equipment installed in a venting system to provide an induced draft.

Noncombustible material: Materials that pass the test procedure for defining noncombustibility of elementary materials set forth in ASTM E136 listed in Section S-26.1010.

Nonconditioned space: A space that is isolated from any conditioned space by insulated walls, floors or ceilings.

Plenum: A chamber which forms part of an air-circulation system other than the occupied space being conditioned

Purge: To clear of air, gas, or other foreign substances.

Quick disconnect device: A hand-operated device that provides a means for connecting and disconnecting an appliance to a gas supply and that is equipped with an automatic means to shut off the gas supply when the device is disconnected.

Refrigerant: A substance used to produce refrigeration by its expansion or evaporation.

Refrigerating System: A combination of interconnected refrigerant-containing parts constituting one closed refrigerant circuit in which a refrigerant is circulated for the purpose of extracting heat. In a direct cooling system, the refrigeration is circulated through a heat exchanger located in the circulating air passage. In an indirect cooling system, a secondary working fluid is cooled by the refrigerating system and circulated through a heat exchanger located in the circulating air passage.

Regulator: A device for reducing, controlling, and maintaining the pressure in a portion of a piping system downstream of the device.

Return air: Air removed from a conditioned space through openings, ducts, plenums or concealed spaces to the heat exchanger of a heating, cooling or ventilating system.

Room heater: A freestanding, comfort-heating appliance installed in the space being heated and not connected to ducts.

Smoke-developed rating: A numerical index indicating the relative density of smoke produced by burning assigned to a material tested in accordance with ASTM E84 listed in Section S-26.1010.

Supply air: Air delivered to a conditioned space through ducts or plenums from the heat exchanger of a heating, cooling or ventilating system.

Type B vent: A labeled vent conforming to UL 441, as listed in Section S-26.1010, for venting gas appliances with draft hoods and other gas appliances listed for use with Type B vents.

Type BW vent: A labeled vent conforming to UL 441, as listed in Section-26.1010, for venting gas-fired vented wall furnaces listed for use with Type BW vents.

Type L vent: A labeled vent conforming to UL 641, as listed in Section S-26.1010, for venting oil-burning appliances listed for use with Type L vents or with listed gas appliances.

Vent: A passageway for conveying flue gases from fuel-fired appliances, or their vent connectors, to the outside atmosphere.

Vent collar: See "Flue collar.".

Vent connector: That portion of a venting system which connects the flue collar or draft hood of an appliance to a vent. This term is interchangeable with the term flue connector.

Vent damper device, automatic: A device intended for installation in the venting system, in the outlet of or downstream of the appliance draft hood, of an individual, automatically operated fuel-burning appliance and which is designed to automatically open the venting system when the appliance is in operation and to automatically close off the venting system when the appliance is in a standby or shutdown condition.

Vent gases: Products of combustion from fuel-burning appliances, plus excess air and dilution air, in the venting system above the draft hood or draft regulator.

Vented gas appliance categories: The following categories are used to differentiate gas utilization equipment according to vent pressure and flue gas temperature:

Category I: An appliance that operates with a non-positive vent pressure and with a flue gas temperature at least 140°F above its dewpoint.

Category II: An appliance that operates with a non-positive vent pressure and with a flue gas temperature less than 140°F above its dewpoint.

Category III: An appliance that operates with a positive vent pressure and with a flue gas temperature at least 140°F above its dewpoint.

Category IV: An appliance that operates with a positive vent pressure and with a flue gas temperature less than 140°F degrees above its dewpoint.

Ventilation: The process of supplying or removing conditioned or unconditioned air by natural or mechanical means to or from any space.

Venting: Removal of combustion products to the outdoors.

Chapter 11
CENTRALLY DUCTED HEATING AND COOLING SYSTEMS

SECTION M-1101—HEATING AND COOLING EQUIPMENT

M-1101.1 General: Heating and cooling equipment shall be installed in accordance with the manufacturers installation instructions and the requirements of this code.

M-1101.1.1 Access: Heating and cooling equipment shall be located with respect to building construction and other equipment to permit maintenance, servicing, and replacement. Sufficient clearances shall be maintained to permit cleaning of heating and cooling surfaces, replacement of filters, blowers, motors, controls, vent connections, lubrication of moving parts, and adjustments.

M-1101.1.2 Sizing: Heating and cooling equipment shall be sized according to ACCA Manual J, as listed in Section S-26.1101, or other approved methods.

M-1101.1.3 Furnace room installations: When equipment is located in an equipment room, the room shall have an opening or door that is large enough to permit removal of the largest piece of equipment, but not less than 20-inches wide. An unobstructed working space not less than 30-inches wide and not less than 30 inches high shall be provided along the control side of the equipment when the door of the equipment room is open.

M-1101.1.4 Attic installations: When equipment is located in an attic, a minimum 22-inch wide by 30-inch high passageway shall be provided from the attic opening to the equipment and its controls. The access opening shall be not smaller than 20-inches wide by 30-inches long, and may be located in any room, hall or closet. The opening and passageway shall be large enough to allow replacement of any part. The passageway shall have a minimum 22-inch wide floor. Flooring shall extend a minimum of 30-inches in width along the control side of the equipment with a 30-inch high clear working space on all sides where access is necessary for servicing.

A permanent electric outlet and lighting fixture shall be provided near the equipment which shall be controlled by a switch located at the passageway opening.

M-1101.1.5 Crawl space installations: When equipment is installed in a crawl space, an access opening and passageway of a height and width sufficient to permit replacement of the mechanical equipment, but not less than 20-inches wide by 30-inches, shall be provided to the working space in front of the equipment.

Equipment supported from the ground shall be level and firmly supported on a concrete slab or masonry units extending not less than 3-inches above the adjoining ground. Equipment suspended from the floor shall have a clearance of not less than 6-inches from the ground.

Excavations for equipment installations shall extend to a depth of 6-inches below the equipment and 12-inches on all sides, except that the control side shall have a clearance of 30-inches. When an excavation exceeds 12-inches in depth, the excavation shall have concrete or masonry walls extending to a height 4-inches above the adjoining ground.

A permanent electric outlet and lighting fixture shall be provided near the equipment which shall be controlled by a switch located at the passageway opening.

M-1101.1.6 Exterior installations: Equipment installed outdoors shall be labeled for outdoor installation. Supports and foundations shall be adequate to prevent excessive vibration, settlement, or movement of the equipment. Supports and foundations shall be level and conform to the manufacturer's recommendations.

M-1101.2 Warm Air Furnaces

M-1101.2.1 General: Warm air furnaces shall conform to the applicable ANSI standard Z21.47 or Z21.64, as listed in Section S-26.1101. Fuel-burning warm-air furnaces shall not be installed in a storage closet or under a stairway. Furnaces located in a bedroom or bathroom shall be installed in a sealed enclosure such that combustion air will not be taken from the living space. Direct vent furnaces are not required to be installed within an enclosure.

M-1101.2.2 Clearance: Clearances shall be provided for warm-air furnaces in accordance with Table No. M-1005a or in accordance with the manufacturer's installation instructions, as approved.

M-1101.2.3 Combustion air: Fuel-burning warm-air furnaces shall be supplied with adequate combustion air in accordance with Chapter 15 of this code. Combustion air openings shall have clearance not less than 6-inches in front of the openings.

M-1101.2.4 Electric furnaces: Electric furnaces shall be installed in accordance with Part VI of this code.

M-1101.3 Heat Pump Equipment

M-1101.3.1 Heating elements: Heat pump equipment utilizing supplement electric heating elements shall have such elements installed in accordance with Part VI of this code.

M-1101.3.2 Foundations and supports: Supports and foundations for the outdoor unit of heat pumps shall be raised at least 3-inches above the ground to permit free drainage of defrost water, and shall conform to the manufacturer's recommendations.

M-1101.4 Refrigeration Cooling Equipment

M-1101.4.1 Approved refrigerants: Only Group I refrigerants, as specified in ANSI/ASHRAE 15, as listed in Section S-26.1101, shall be used in direct refrigeration equipment.

M-1101.4.2 Refrigeration coils in warm air furnaces: Where a cooling coil is located in the supply plenum of a warm air furnace, the furnace blower shall be rated at not less than 0.5-inch water column static pressure

unless the furnace is labeled for use with a cooling coil. Cooling coils shall not be located upstream from heat exchangers unless labeled for such use. Conversion of existing furnaces for use with cooling coils shall be permitted provided the furnace will operate within the temperature rise specified for the furnace.

M-1101.4.3 Condensate disposal: A condensate drain shall be provided to dispose of condensate from the cooling coil. Condensate drains shall terminate to daylight outside of the building, or to a floor drain, plumbing fixture, sump, or other approved location.

Where the cooling coil or air conditioning unit is located indoors above a living space, a water-tight pan of corrosion-resistant metal shall be installed beneath the unit to catch overflow condensate due to a clogged condensate drain. The pan shall be provided with a drain pipe of minimum 3/4-inch nominal pipe size which discharges at a conspicuous location to indicate that the regular drain is clogged.

M-1101.4.4 Insulation of refrigerant piping: Refrigerant piping and fittings within a building that return refrigerant to the outdoor unit shall be insulated to prevent condensation from forming on the piping.

M-1101.5 Absorption Cooling Equipment

M-1101.5.1 Approval of equipment: Absorption systems shall be labeled and installed in accordance with the manufacturer's installation instructions.

M-1101.5.2 Condensate disposal: Condensate from the cooling coil shall be disposed of as provided in Section M-1101.4.3.

M-1101.5.3 Insulation of piping: Refrigerant piping, brine piping, and fittings within a building shall be insulated to prevent condensation from forming on piping.

M-1101.5.4 Pressure-relief protection: Absorption systems shall be protected by a pressure-relief device. Discharge from the pressure relief device shall be located so as not to create a hazard to persons or property.

M-1101.6 Evaporative Cooling Equipment: Cooling equipment that utilizes evaporation of water for cooling shall be installed in accordance with manufacturer's recommendations. Evaporative coolers shall be installed on a level platform or base not less than 3-inches above the adjoining ground and secured to prevent displacement. Openings in exterior walls shall be flashed in an approved manner in accordance with the building requirements of this code.

SECTION M-1102—DUCT SYSTEMS

M-1102.1 Materials: Ducts and duct materials used for a duct serving heating and cooling equipment shall be fabricated in accordance with the following requirements:

1. Above ground duct systems shall conform to the following:
   a. Equipments connected to duct systems shall have a 250°F temperature limit control.

b. Supply ducts shall be constructed of Class O, Class 1 or Class 2 materials as designated in Table No. M-1102.1a. Class 2 materials shall not be used for ducts located within the first 3-feet of the bonnet, plenum or casing of the heating unit.

c. Minimum thicknesses of metal duct material shall be listed in Table No. M-1102.1b. Galvanized steel shall conform to ASTM A525, as listed in Section S-26.1102.

d. Gypsum products may be used as ducts or plenums, provided that the air temperature does not exceed 125°F and exposed surfaces are not subject to condensation.

e. Return ducts, except those portions directly above the heating surface or closer than 2-feet to the heating unit casing, shall be constructed of materials having a flame spread rating not greater than 200.

f. Structural areas between studs or partitions to be used as return ducts shall be isolated from unused spaces with tight-fitting stops of sheet metal, or with wood not less than 2-inch nominal thickness.

2. Underground duct systems shall be constructed of approved concrete, clay, metal, plastic or other approved materials. The maximum duct temperatures for plastic ducts shall be not greater than 150°F. Plastic pipe and fittings shall conform to cell classification 12454-B of ASTM D1784, as listed in Section S-26.1102, and external loading properties of ASTM D2412, as listed in Section S-26.1102.

M-1102.1.1 Factory-made ducts: Factory made air ducts or duct material shall be approved for the use intended, and shall be installed in accordance with the manufacturer's installation instructions. Each portion of a factory-made air duct system shall bear a label or mark indicating compliance with UL 181, as listed in Section S-26.1102.

M-1102.1.2 Duct insulation materials: Duct insulation materials shall conform to the following requirements:

1. Duct coverings and linings shall have a flame-spread rating not greater than 25, and a smoke-developed rating not greater than 50.
2. Duct coverings and duct linings shall withstand a test temperature of 250°F minimum in accordance with the Test for Hot-Surface Performance of High-Temperature Thermal Insulation, ASTM C411, as listed in Section S-26.1102.
3. Fiberglass or mineral wool insulation shall be a minimum 2-inch thick, 3/4-pound density wrap or 1-inch thick, 1 1/2-pound liner.
4. When nonmetallic ducts or other approved insulating or lining materials are used, the minimum thermal resistance value of the material shall be R-4.2.
5. Blanket insulation and factory-insulated flexible duct shall be labeled with the R-value, flame-spread rating,and smoke-developed rating.

Table No. M-1102.1a
CLASSIFICATION OF DUCTS

Duct Class	Maximum Flame Spread Rating
0	0
1	25
2	50

Table No. M-1102.1b
GAGES OF METAL DUCTS AND PLENUMS USED FOR COMFORT HEATING OR COOLING

TYPE OF DUCT	SIZE (INCHES)	NOMINAL THICKNESS (INCHES)	EQUIVALENT GALVANIZED SHEET GAGE	APPROXIMATE ALUMINUM B.&S. GAGE
Round ducts and enclosed rectangular ducts	14 or less	0.016	30	26
	Over 14	0.019	28	24
Exposed rectangular ducts	14 or less	0.019	28	24
	Over 14	0.022	26	22

M-1102.1.3 Vibration isolators: Vibration isolators installed between mechanical equipment and metal ducts shall be fabricated from approved materials and shall not exceed 10 inches in length.

M-1102.2 Installation

M-1102.2.1 Duct sizing: Supply and return ducts shall be sized according to ACCA Manual D or SMACNA Installation Standards for Residential Heating and Air Conditioning Systems, as listed in Section S-26.1102, or other approved methods.

M-1102.2.2 Joints and seams: Joints of duct systems shall be made substantially air-tight by means of tapes, mastics, gasketing, or other means. Crimp joints for round ducts shall have a contact lap of at least 1 1/2 inches and shall be mechanically fastened by means of at least three sheet metal screws equally spaced around the joint, or an equivalent fastening method.

M-1102.2.3 Support: Metal ducts shall be securely supported, hung, or suspended by 1-inch x 18-gage metal straps, 12-gage galvanized wire or other approved means at intervals not exceeding 10 feet. Nonmetallic ducts shall be supported in accordance with the manufacturer's installation instructions.

M-1102.2.4 Firestopping: Duct installations shall be firestopped in accordance with Section R-402.7.

M-1102.2.5 Duct insulation: Duct insulation shall be installed in accordance with the following requirements:

1. All ductwork installed in nonconditioned areas shall be insulated.
2. Vapor retarders with a maximum permeance of 0.05 perm, or aluminum foil with a minimum thickness of 2 mils, shall be installed on cooling supply ducts that pass through nonconditioned spaces conducive to condensation.
3. Exterior ducts shall be protected with an approved weatherproofing covering.
4. Duct coverings shall not penetrate a firestopped wall or floor.

M-1102.2.6 Ducts in slabs: Ducts shall be labeled for underground installation. Metallic ducts not having an approved protective coating shall be completely encased in a minimum of 2 inches of concrete. Metallic ducts having an approved protective coating and nonmetallic ducts shall be installed in accordance with the manufacturer's installation instructions.

M-1102.2.7 Factory-made air ducts: Factory-made air ducts, unless labeled for such use, shall not be installed in or on the ground, in tile or metal pipe, or within masonry or concrete.

M-1102.3 Under-floor plenums: An under-floor space used as a supply plenum shall conform to the requirements of this section.

M-1102.3.1 General: The space shall be cleaned of all loose combustible materials and scrap, and shall be tightly enclosed. The ground surface of the space shall be covered with a moisture barrier having a permeability not greater than 1 perm.

M-1102.3.2 Materials: The under-floor space, including the sidewall insulation, shall be formed by materials having flame spread ratings not greater than 200.

M-1102.3.3 Furnace connections: A duct shall extend from the furnace supply outlet to not less than 6 inches below the combustible framing. This duct shall comply with the provisions of Section M-1102.1. A noncombustible receptacle shall be installed below the floor opening into the plenum in accordance with the following requirements:

1. The receptacle shall be securely suspended from the floor members and shall be not more than 18 inches below the floor opening.
2. The area of the receptacle shall extend 3 inches beyond the opening on all sides.
3. The perimeter of the receptacle shall have a vertical lip at least 1-inch high at the open sides.

M-1102.3.4 Access: Access to an under-floor plenum shall be provided through an opening in the floor with minimum dimensions of 18 inches by 24 inches.

M-1102.3.5 Furnace controls: The furnace shall be equipped with an automatic control that will start the air-circulating fan when the air in the furnace bonnet reaches a temperature not greater than 150°F The furnace shall additionally be equipped with an approved automatic control that limits the outlet air temperature to 200°F.

SECTION M-1103—CIRCULATING AIR

M-1103.1 Return air

M-1103.1.1 Required area: The total unobstructed area of return ducts or openings to a warm air furnace shall be inaccordance with the manufacturer's recommendations, but not less than 2-square inches for each 1,000 Btu/h rating of the furnace. The minimum unobstructed total area of the return air ducts or openings to a heat pump shall be in accordance with the manufacturer's recommendations, but shall be not less than 6-square inches for each 1,000 Btu/h nominal output rating.

M-1103.1.2 Prohibited sources: Return air for a warm-air furnace shall not be taken from bathrooms, kitchens, garages, or other dwelling units. Outdoor air shall not be taken from within 10-feet of an appliance or plumbing vent outlet that is located less than 3-feet above the air inlet.

M-1103.1.3 Inlet opening protection: Outdoor air inlets shall be covered with screen or equivalent protection having no less than 1/4-inch openings and no greater than 1/2-inch openings.

M-1103.2 Supply air: The minimum unobstructed total area of supply ducts from a warm-air furnace shall be in accordance with the manufacturer's recommendations, but shall be not less than 2-square inches for each 1,000 Btu/h rating of the furnace. The minimum unobstructed total area of the supply air ducts from a heat pump shall be in accordance with the manufacturer's recommendations, but shall be not less than 6-square inches per 1,000 Btu/h nominal output rating. Dampers, grilles, or registers installed for the purpose of controlling the supply airflow shall not be considered as obstructions.

Chapter 12
ELECTRIC RESISTANCE HEATERS

SECTION M-1201—BASEBOARD CONVECTORS

Electric baseboard convectors shall be labeled and shall be installed in accordance with the manufacturer's installation instructions and Part VI of this code.

SECTION M-1202—RADIANT HEATING SYSTEMS

M-1202.1 General: Radiant heating systems shall be labeled and shall be installed in accordance with the manufacturer's installation instructions and Part VI of this code.

M-1202.2 Clearances: Clearances for radiant heating panels or elements to any wiring, outlet boxes, and junction boxes used for installing electrical devices or mounting lighting fixtures shall comply with Part VI of this code.

M-1202.3 Installation of radiant panels: Radiant panels installed to wood framing shall conform to the following requirements:

1. Heating panels shall be installed parallel to framing members, and secured to the surface of framing members or mounted between framing members.
2. Panels shall be nailed or stapled only though the unheated portions provided for this purpose and shall not be fastened at any point closer than 1/4-inch from an element.
3. Unless labeled for field cutting, heating panels shall be installed as complete units.

M-1202.4 Installation in concrete or masonry: Radiant heating systems installed in concrete or masonry shall conform to the following requirements:

1. Radiant heating systems shall be identified as being suitable for the installation and shall be secured in place as specified in the manufacturer's installation instructions.
2. Radiant heating panels or radiant heating panel sets shall not be installed where they bridge expansion joints unless protected from expansion and contraction.

M-1202.5 Gypsum panels: Where radiant heating systems are used in gypsum assemblies, operating temperatures shall not exceed 125°F.

M-1202.6 Finish Surfaces: Finish materials installed over radiant heating panels or systems shall be installed in accordance with the manufacturer's installation instructions. Surfaces shall be secured such that nails or other fastenings do not pierce the radiant heating elements.

SECTION M-1203—DUCT HEATERS

M-1203.1 General: Electric duct heaters shall be labeled and shall be installed in accordance with the manufacturer's installation instructions and Part VI of this code.

M-1203.2 Installation: Electric duct heaters shall be installed such that they will not create a fire hazard. Class 1 ducts, duct coverings and linings shall be interrupted at each heater to provide the clearances specified in the manufacturer's installation instructions. Such interruptions are not required for duct heaters labeled for zero clearance from combustible materials. Insulation installed in the immediate area of each heater shall be classified for the maximum temperature produced on the duct surface.

M-1203.3 Installation with heat pumps and air conditioners: Duct heaters located within 4-feet of a heat pump or air conditioner shall be labeled for such installations. The heat pump or air conditioner shall additionally be labeled for such duct heater installations.

M-1203.4 Access: Duct heaters shall be accessible for servicing, and sufficient clearances shall be maintained to permit adjustment, servicing, and replacement of controls and heating elements.

Chapter 13
HYDRONIC HEATING SYSTEMS

SECTION M-1301—BOILERS

M-1301.1 Installation: The installation of boilers shall conform to the manufacturer's installation instructions and the requirements of this code. Operating instructions shall be attached to the boiler. Boilers shall have all controls set, adjusted, and tested by the installer. Fuel-burning boilers shall be provided with combustion air as required by Chapter 15.

M-1301.2 Clearance: Boiler clearances shall be in accordance with their label or Section M-1005.

SECTION M-1302— OPERATING AND SAFETY CONTROLS

M-1302.1 Safety controls: Electrical and mechanical operating and safety controls for boilers shall be labeled.

M-1302.2 Boiler gauges: Boilers shall be equipped with pressure and temperature gauges that indicate pressure and temperature within the normal range of operation.

M-1302.3 Pressure relief valve: Boilers shall be equipped with pressure-relief valves with minimum rated capacities for the equipment served. Pressure-relief valves shall be set at the maximum rating of the boiler. Discharge shall be piped to drain by gravity to within 18-inches of the floor or to an open receptor.

SECTION M-1303—EXPANSION TANKS

M-1303.1 General: Boilers shall be provided with expansion tanks. Nonpressurized expansion tanks shall be securely fastened to the structure or boiler and supported adequately to carry twice the weight of the tank filled with water without placing any strain on connecting piping. Provisions shall be made for draining nonpressurized tanks without emptying the system.

Pressurized expansion tanks shall be consistent with the volume and capacity of the system. Tanks shall be capable of withstanding a hydrostatic test pressure of two and one half times the allowable working pressure of the system.

M-1303.2 Minimum capacity: The minimum capacity of expansion tanks shall be determined from Table No. M-1303.2.

Table No. M-1303.2
EXPANSION TANK MINIMUM CAPACITY[1] FOR FORCED HOT-WATER SYSTEMS (GALLONS)

SYSTEM VOLUME[2] (GALLONS)	PRESSURIZED DIAPHRAGM TYPE	NONPRESSURIZED TYPE
10	1.0	1.5
20	1.5	3.0
30	2.5	4.5
40	3.0	6.0
50	4.0	7.5
60	5.0	9.0
70	6.0	10.5
80	6.5	12.0
90	7.5	13.5
100	8.0	15.0

[1]Based on average water temperature of 195°F, fill pressure of 12-psig, and a maximum operating pressure of 30-psig.

[2]System volume includes volume of water in boiler, convectors, and piping, not including the expansion tank.

SECTION M-1304—HYDRONIC PIPING SYSTEMS INSTALLATION

M-1304.1 General: Hydronic piping shall conform to Table No. M-1304.1 or other approved materials. Approved piping, valves, fittings, and connections shall be installed in accordance with the installation instructions of the manufacturers of system equipment and components. Pipe and fittings shall be rated for use at the operating temperature and pressure of the hydronic system. Used pipe, fittings, valves, or other materials shall be free of foreign materials and adequate for the service intended.

M-1304.2 Prohibited tees: Circulating hot water in a system shall not enter a tee fitting through the side opening.

M-1304.3 System drain down: Hydronic piping systems shall be designed and installed to permit the system to be drained. When the system drains to the plumbing drainage system, the installation shall conform to the requirements of Part V of this code.

M-1304.4 Protection of potable water: The potable water system shall be protected from backflow in accordance with the provisions listed in Section P-2402.

M-1304.5 Pipe penetrations: Openings through concrete or masonry building elements shall be sleeved.

M-1304.6 Contact with building material: A hydronic piping system shall not be in direct contact with any building material which causes the piping material to degrade or corrode.

M-1304.7 Drilling and notching: Wood-framed structural members shall be drilled, notched or altered in accordance with the provisions of Sections R-402.5, R-602.5, R-602.6, R-702.5 and R-702.6.

M-1304.8 Expansion, contraction and settlement: Piping shall be installed so that piping, connections and equipment shall not be subjected to excessive strains or stresses. Provisions shall be made to compensate for expansion, contraction, shrinkage, and structural settlement.

M-1304.9 Piping support: Hangers and supports shall be of material of sufficient strength to support the piping, and shall be fabricated from materials compatible with the piping material. Piping shall be supported at intervals not exceeding the spacing specified in Table No. M-1304.9.

Table No. M-1304.1
HYDRONIC PIPING MATERIALS

MATERIAL	USE CODE[1]	STANDARD[2]	JOINTS	NOTES
Copper Pipe	1	ASTM B42, B302	Brazed, soldered, mechanical fittings, threaded, welded, flanged	
Copper Tubing (Type K, L, or M)	1,2	ASTM B75, B88 B251	Brazed, soldered, flared, mechanical fittings	Joints embedded in concrete
Steel Pipe	1,2	ASTM A53, A106	Brazed, welded, threaded, flanged, mechanical fittings	Joints in concrete shall be welded. Galvanized shall not be welded or brazed.
Steel Tubing	1	ASTM A254	Mechanical fittings, welded	
Brass Pipe	1	ASTM B43	Brazed, welded, threaded, mechanical flanged fittings	
Brass Tubing	1	ASTM B135	Brazed, soldered, mechanical fittings	
Polybutylene (PB) pipe and tubing	1,2,3	ASTM D3309	Heat-fusion, crimp/insert, compression	Joints in concrete shall be heat-fused.
Crosslinked Polyethylene (PEX) tubing	2,3	ASTM F876, F877	Mechanical compression	Install in accordance with manufacturer's instructions.

[1]Use Code:
1. Above ground.
2. Embedded in radiant system.
3. Temperatures below 180°F only.

[2]Standards as listed in Section S-26.1304.

Table No. M-1304.9
HANGER SPACING INTERVALS

PIPING MATERIAL	MAXIMUM HORIZONTAL SPACING (FEET)	MAXIMUM VERTICAL SPACING (FEET)
Copper or copper alloy pipe	12	10
Copper or copper alloy tubing	6	10
PB pipe or tubing	3	4
Steel pipe	12	15
Steel tubing	8	10

SECTION M-1305—BASEBOARD CONVECTORS

Baseboard convectors shall be installed in accordance with the manufacturer's installation instructions. Convectors shall be supported independent of hydronic piping.

SECTION M-1306—FLOOR HEATING SYSTEMS

M-1306.1 Piping materials: Piping for embedment in concrete or gypsum materials shall be standard-weight steel pipe, copper tubing, polybutylene, other approved plastic pipe or tubing with a minimum rating of 100-psi at 180°F, or other approved materials.

M-1306.2 Piping joints: Piping joints that are embedded shall be installed in accordance with the following requirements:

1. Steel pipe joints shall be welded.
2. Copper tubing shall be joined with brazing material having a melting point exceeding 1000°F.
3. Polybutylene pipe and tubing joints shall be installed with socket type heat fused polybutylene fittings.

M-1306.3 Testing: Piping or tubing to be embedded shall be tested by applying a hydrostatic pressure of not less than 100-psi. The pressure shall be maintained for 30 minutes, during which all joints shall be visually inspected for leaks.

SECTION M-1307—WATER HEATERS USED FOR SPACE HEATING

M-1307.1 Piping: Piping and components connected to a water heater for space heating application shall be suitable for use with potable water. Water heaters that will be used to supply potable water shall not be connected to a heating system or components previously used with a non-potable water heating appliances.

M-1307.2 Labeling: Water heaters shall bear the label or marking of an approved labeling agency.

M-1307.3 Installation: Where a combination water heating-space heating system requires water for space heating at temperatures higher than 140°F, a means such as a mixing valve shall be installed to temper the water for domestic uses.

M-1307.4 Protection of potable water: Toxic chemicals used for boiler treatment shall not be introduced into a water heater for potable water heating.

Chapter 14
VENTED FLOOR, WALL AND ROOM HEATERS

SECTION M-1401—VENTED FLOOR FURNACES

M-1401.1 General: Vented floor furnaces shall conform to ANSI Z21.48, as listed in Section S-26.1401, and shall be installed in accordance with the manufacturer's installation instructions and the requirements of the code.

M-1401.2 Clearances: Vented floor furnaces shall be installed in accordance with Table No. M-1005a unless otherwise approved.

M-1401.3 Location: Unless otherwise approved, location of floor furnaces shall conform to the following requirements:

1. Floor registers of floor furnaces shall be installed not less than 6 inches from a wall.
2. Wall registers of floor furnaces shall be installed not less than 6minches from the adjoining wall at inside corners.
3. The furnace register shall be located not less than 12 inches from doors, draperies, or similar combustible objects.
4. The furnace register shall be located at least 5 feet below any projecting combustible materials.
5. The floor furnace burner assembly shall not project into an occupied under-floor area.

M-1401.4 Access: An opening in the foundation not less than 18 inches by 24 inches, or a trap door not less than 20 inches by 30 inches shall be provided for access to a floor furnace. The opening and passageway shall be large enough to allow replacement of any part of the equipment.

M-1401.5 Installation: Unless otherwise approved, floor furnace installations shall conform to the following requirements:

1. Thermostats controlling floor furnaces shall not be located in a room that can be separated from the room in which the register of the floor furnace is located.
2. Floor furnaces shall be supported independently of the furnace floor register.
3. Floor furnaces shall be installed not closer than 6 inches to the ground. Clearance may be reduced to 2 inches, provided that the lower 6-inches of the furnace is sealed to prevent water entry.
4. When excavation is required for a floor furnace installation, the excavation shall extend 18 inches beyond the control side of the floor furnace and 12 inches beyond the remaining sides. Excavations shall slope outward from the perimeter of the base of the excavation to the surrounding grade at an angle not exceeding 45 degrees from horizontal.
5. Floor furnaces shall not be supported from the ground.

SECTION M-1402—VENTED WALL FURNACES

M-1402.1 General: Vented wall furnaces shall conform to ANSI Z21.44 or Z21.49, as listed in Section S-26.1402 and shall be installed in accordance with the manufacturer's installation instructions and the requirements of this code.

M-1402.2 Location: Unless otherwise approved, the location of vented wall furnaces shall conform to the following requirements:

1. Vented wall furnaces shall be located not less than 6-inches from adjoining walls at inside corners.
2. Vented wall furnaces shall not be located where a door can swing within 12-inches of the furnace air inlet or outlet, and shall not be installed less than 18-inches below overhead projections.

M-1402.3 Installation: Unless otherwise approved, vented wall furnace installations shall conform to the following requirements:

1. Required wall thicknesses shall be in accordance with the furnace manufacturer's installation instructions.
2. Ducts shall not be attached to a wall furnace. Casing extensions or boots shall only be installed when approved as part of the labeled appliance.

SECTION M-1403—VENTED ROOM HEATERS

M-1403.1 General: Vented room heaters shall conform to ANSI Z21.11.1 as listed in Section S-26.1403, and shall be installed in accordance with the manufacturer's installation instructions and the requirements of this code.

M-1403.2 Clearances: Vented room heaters shall be installed with clearances in accordance with Table No. M-1005a or in accordance with the manufacturer's installation instructions, as approved.

M-1403.3 Location: A room heater shall be placed so as not to cause a hazard to walls, floors, curtains and drapes, or to the free movement of persons. Heaters designed and marked "For use in noncombustible fireplace only," shall be installed as labeled.

M-1403.4 Installation: Unless otherwise approved, room heaters shall be installed on noncombustible floors or approved assemblies constructed of noncombustible materials that extend at least 18-inches beyond the appliance on all sides.

M-1403.5 Prohibited locations: Solid fuel burning heaters shall not be installed in garages.

Chapter 15
COMBUSTION AIR

SECTION M-1501—GENERAL

M-1501.1 Air supply: Fuel-burning equipment shall have provision for a sufficient supply of air for fuel combustion, draft hood dilution and ventilation of the space in which the equipment is installed. The methods of providing combustion air in this chapter do not apply to direct vent appliances.

M-1501.2 Exhaust and ventilation system: Air requirements for the operation of exhaust fans, kitchen ventilation systems, clothes dryers and fireplaces shall be considered in determining the adequacy of a space to provide combustion air.

M-1501.3 Volume dampers prohibited: Volume dampers shall not be installed in combustion air openings.

M-1501.4 Prohibited sources: Combustion air ducts and openings shall not connect appliance enclosures with space in which the operation of a fan may adversely affect the flow of combustion air. Combustion air shall not be obtained from an area in which flammable vapors present a hazard.

M-1501.5 Opening area: The free area of each opening shall be used for determining combustion air. Unless otherwise specified by the manufacturer or determined by actual measurement, the free area shall be considered 75 percent of the gross area for metal louvers and 25 percent of the gross area for wood louvers.

SECTION M-1502—INDOOR AIR

M-1502.1 Required volume: If the volume of the space in which fuel-burning appliances are installed is greater than 50-cubic feet per 1,000 Btu/h of aggregate input rating of appliances, normal infiltration shall be regarded as adequate to provide combustion air. Rooms communicating directly with the space in which the appliances are installed through openings not furnished with doors shall be considered part of the required volume.

M-1502.2 Confined space: Where the space in which the appliance is located does not meet the criterion specified in Section M-1502.1, two permanent openings to adjacent spaces shall be provided so that the combined volume of all spaces meets the criterion. One opening shall be within 12-inches of the top and one within 12-inches of the bottom of the space, as illustrated in Figure No. M-1502.2. Each opening shall have free area equal to a minimum of 1-square inch per 1,000 Btu/h input rating of all appliances installed within the space, but not less than 100-square inches.

M-1502.3 Tight construction: If the space is of adequate volume in accordance with Section M-1502.1 or M-1502.2, but is within a building

sealed so tightly that infiltration air is not adequate for combustion, combustion air shall be obtained from outdoors or from spaces freely communicating with the outdoors in accordance with Section M-1503 or M-1504.

SECTION M-1503—OUTDOOR AIR

M-1503.1 Connections to outdoors: When the space in which fuel-burning appliances are located does not meet the criterion for indoor air specified in Section M-1502, outside combustion air shall be supplied through openings or ducts extending from the appliance room to the outdoors. One opening shall be within 12 inches of the top, and one within 12 inches of the bottom of the space, as illustrated in Figure No. M-1503.1. Openings are permitted to connect to spaces directly communicating with the outdoors, such as ventilated crawl spaces or ventilated attic spaces. The same duct shall not serve both combustion air openings. The duct serving the upper air opening shall be level or extend upward from the appliance space.

M-1503.2 Size of opening: When communicating with the outdoors by means of vertical ducts, each opening shall have free area of at least 1 square inch per 4,000 Btu/h of total input rating of all appliances in the space. If horizontal ducts are used, each opening shall have a free area of at least 1 square inch per 2,000 Btu/h of total input of all appliances in the space. Ducts shall be of the same minimum cross-sectional area as the required free area of the openings to which they connect. The minimum cross-sectional dimension of rectangular air ducts shall be 3 inches.

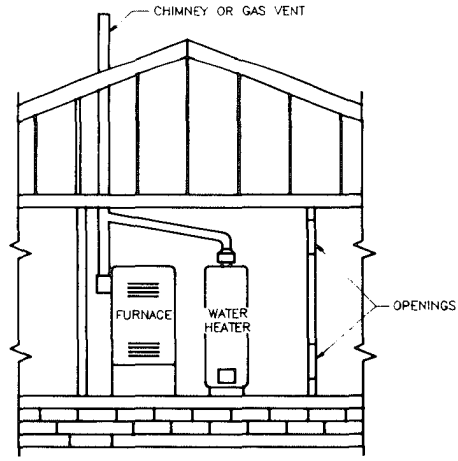
M-1503.3 Attic combustion air: Combustion air obtained from an attic area, as illustrated in Figure No. M-1503.3, shall be in accordance with the following:

1. The attic ventilation shall be sufficient to provide the required volume of combustion air.
2. The combustion air opening shall be provided with a metal sleeve or other approved material extending from the appliance enclosure to at least 6 inches above the top of the ceiling joists and ceiling insulation.
3. The end of ducts that terminate in an attic shall not be screened unless required by the building official.

M-1503.4 Under-floor combustion air: Combustion air obtained from under-floor areas, as illustrated in Figure No. M-1503.4, shall have a free opening area to the outside equivalent to not less than twice the required combustion air opening.

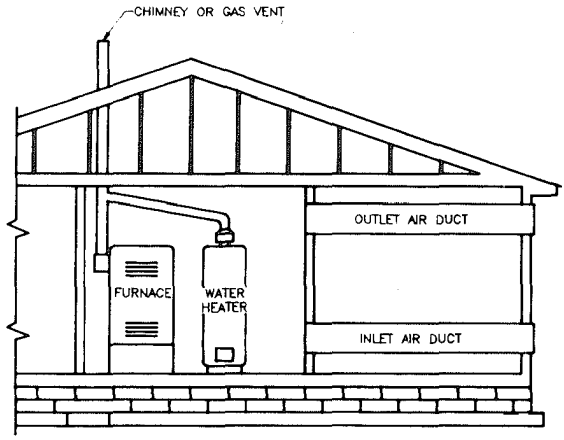
M-1503.5 Opening requirements: Outside combustion air openings shall be covered with corrosion-resistant screen or equivalent protection having no less than 1/4-inch openings, and not greater than 1/2-inch openings.

Figure No. M-1502.2
EQUIPMENT LOCATED IN CONFINED SPACES
ALL AIR FROM ADJACENT SPACES
WITHIN THE BUILDING



NOTE: Each opening shall have a free area of not less than one square inch per 1,000 Btu/h of the total input rating of all equipment in the enclosure, but not less than 100 square inches.

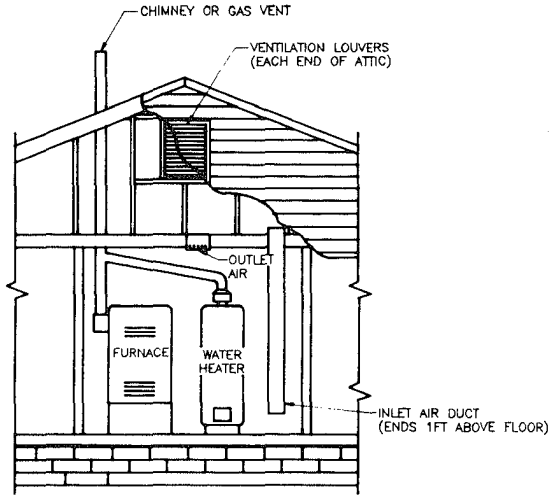
Figure No. M-1503.1
EQUIPMENT LOCATED IN CONFINED SPACES
ALL AIR TAKEN FROM OUTDOORS



NOTE: Each air duct opening shall have a free area of not less than one square inch per 2,000 Btu/h of the total input rating of all equipment in the enclosure.

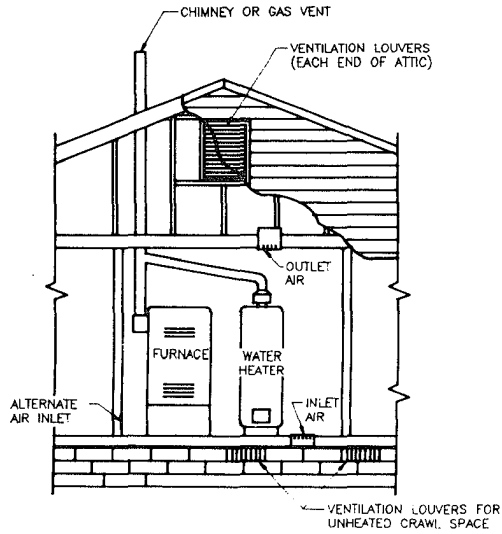
If the equipment room is located against an outside wall and the air openings communicate directly with the outdoors, each opening shall have a free area of not less than one square inch per 4,000 Btu/h of the total input rating of all equipment in the enclosure.

Figure No. M-1503.3
EQUIPMENT LOCATED IN CONFINED SPACES
ALL AIR FROM OUTDOORS THROUGH VENTILATED ATTIC



NOTE: The inlet and outlet air openings shall each have a free area of not less than one square inch per 4,000 Btu/h of the total input rating of all equipment in the enclosure.

Figure No. M-1503.4
EQUIPMENT LOCATED IN CONFINED SPACES
INLET AIR FROM VENTILATED
CRAWL SPACE AND OUTLET AIR TO VENTILATED ATTIC



NOTE: The inlet and outlet air openings shall each have a free area of not less than one square inch per 4,000 Btu/h of the total input rating of all equipment in the enclosure.

SECTION M-1504—COMBINED USE OF INDOOR AND OUTDOOR AIR

M-1504.1 General: When the space in which fuel-burning appliances are located does not meet the criterion for indoor air specified in Section M-1502, combustion air supplied by a combined use of indoor and outdoor air shall be supplied through openings and ducts extending to the appliance room or to the vicinity of the appliance.

M-1504.2 Openings and supply ducts: Two openings for ventilation shall be located and sized in accordance with Section M-1502.2. In addition, there shall be one opening directly communicating with the outdoors or to such spaces (crawlspace or attic) that freely communicate with the outdoors. This opening shall have free area of at least 1-square inch per 5,000 Btu/h of total input of all appliances in the space. Ducts shall be of the same minimum cross-sectional area as the required free area of the opening. Ducts admitting outdoor air shall be connected to the return air side of the heating system.

CHAPTER 16
EQUIPMENT VENTING

SECTION M-1601 – GENERAL

Fuel-burning appliances shall be vented to the outside in accordance with their label and manufacturer's installation instructions unless labeled for unvented use. Venting systems shall consist of approved chimneys or vents, or venting assemblies which are integral parts of labeled appliances.

M-1601.1 Draft requirements: A venting system shall satisfy the draft requirement of the equipment in accordance with the manufacturer"s installation instructions and shall be designed and constructed to develop a positive air flow adequate to convey all combustion products to the outside atmosphere.

M-1601.2 Inspection of chimneys: Before connecting a vent connector to a chimney, the chimney passageway shall be examined to ascertain that it is free of obstructions. When inspection reveals that an existing chimney is not safe for the intended application, it shall be rebuilt to conform to Sections R-901 and R-902, lined or relined with a suitable liner, or replaced with a vent or chimney suitable for the equipment to be attached.

M-1601.3 Mechanical draft systems: A mechanical draft system shall be used only with equipment labeled for such use. Provision shall be made to prevent the flow of fuel to the equipment when the draft system is not operating. Forced draft systems and all portions of induced draft systems under positive pressure during operation shall be designed and installed so as to prevent leakage of flue gases into a building.

M-1601.4 Direct vent appliances: Direct vent appliances shall be labeled and shall be installed in accordance with the manufacturer's installation instructions.

M-1601.5 Support: Venting systems shall be adequately supported for the weight of the material used.

M-1601.6 Duct penetrations: Vents or vent connectors shall not extend into or through supply and return air ducts or plenums.

M-1601.7 Firestopping: Vent and chimney installations shall be fire-stopped in accordance with Section R-402.7.

M-1601.8 Unused openings: Unused openings in any venting system shall be closed or capped.

SECTION M-1602—VENT COMPONENTS

M-1602.1 Draft hoods: Draft hoods shall be located in the same room or space as the combustion air openings for the appliances.

M-1602.2 Vent dampers

M-1602.2.1 Manually operated: Manually operated dampers shall not be installed except in connectors or chimneys of solid fuel-burning appliances.

M-1602.2.2 Automatically operated: Automatically operated dampers shall be installed in accordance with the terms of their label, and shall be installed to prevent firing of the burner unless the damper is opened to a safe position. Automatic dampers shall conform to the applicable ANSI standard Z21.66, Z21.67 or Z21.68, as listed in Section S-26.1602.

M-1602.3 Draft regulators: Draft regulators shall be provided for oil fired appliances required to be connected to a chimney unless the appliance is labeled for use without a draft regulator.

Draft regulators provided for solid fuel burning appliances to reduce draft intensity shall be installed and set in accordance with the manufacturer's installation instructions.

Where required, draft regulators shall be installed in the same room or enclosure as the appliance such that no difference in pressure between the air at the regulator and the combustion air supply will exist.

SECTION M-1603—CHIMNEY AND VENT CONNECTORS

M-1603.1 General: Connectors shall be used to connect fuel-burning appliances to a vertical chimney or vent unless the chimney or vent is attached directly to the appliance.

M-1603.2 Connectors for gas appliances: Connectors for labeled gas appliances and appliances equipped with a labeled gas burner and draft hood shall be of Type B or Type L vent material, or single-wall metal pipe not thinner than 28 gage galvanized steel. Connectors for Category II, III, and IV equipment shall be as specified by the equipment manufacturer.

M-1603.3 Connectors for oil and solid fuel appliances: Connectors for oil and solid fuel burning appliances shall be fabricated from factory-built chimney material, Type L vent material, or single-wall metal pipe having resistance to corrosion and heat, and thickness not less than that of galvanized pipe as specified in Table No. M-1603.3.

Table No. M-1603.3
THICKNESS FOR SINGLE-WALL METAL PIPE CONNECTORS

DIAMETER OF CONNECTOR (INCHES)	SHEET METAL GAGE NUMBER
LESS THAN 6	26
6 TO 10	24

M-1603.4 Installation: Vent and chimney connectors shall be installed in accordance with the manufacturer's installation instructions and within the space that the appliance is located. Appliances shall be located as close as practical to the vent or chimney. Connectors shall be as short and straight as possible and constructed with a rise of not less than 1/4-inch to the foot run. Connectors shall be securely supported and joints shall be fastened with sheet metal screws, rivets, or by other approved means.

Devices that obstruct the flow of flue gases shall not be installed in a connector unless labeled or approved for such installations.

M-1603.4.1 Location: When the connector serving a gas appliance with a draft hood is located in nonconditioned space, that portion of the connector shall be labeled Type B or Type L vent material, or be provided with equivalent insulation.

M-1603.4.2 Floor, ceiling and wall penetrations: A chimney connector or vent connector shall not pass through any floor, ceiling, wall, or partition unless the connector is labeled for wall pass-through, or is routed through a device labeled for wall pass-through and is installed in accordance with the conditions of its label. Connectors for labeled gas appliances with draft hoods, and oil appliances labeled for Type L vents, passing through walls or partitions shall be in accordance with the following:

1. Type B or Type L vent material for gas appliances, Type L vent material for oil appliances, shall be installed with not less than labeled clearances to combustible material.
2. Single-wall metal pipe shall be guarded by a ventilated metal thimble not less than 4 inches larger in diameter than the vent connector.

M-1603.4.3 Length: The horizontal run of an uninsulated connector to a natural draft chimney shall not exceed 75 percent of the height of the vertical portion of the chimney above the connector. The horizontal run of an insulated connector to a natural draft chimney shall not exceed 100 percent of the height of the vertical portion of the chimney above the connector. The horizontal length, design and construction of combined connector, or connector to a manifold joining two or more appliances to a chimney, shall be determined in accordance with approved engineering methods.

M-1603.4.4 Size: A connector shall be not smaller than the flue collar of the appliance unless otherwise approved according to the manufacturer's installation instructions.

M-1603.4.5 Clearance: Connectors shall be installed with clearance to combustibles as set forth in Table No. M-1603.4.5. Reduced clearances to combustible material shall be in accordance with Table No. M-1005b and Figure No. M-1005.

M-1603.4.6 Access: The entire length of a connector shall be accessible for inspection, cleaning and replacement unless labeled materials are used and concealment is approved by the building official.

M-1603.4.7 Fireplace connection: An appliance shall not be connected to a chimney flue serving a fireplace unless the fireplace opening is sealed or the chimney flue which vents the fireplace is permanently sealed below the connection.

TABLE NO. M-1603.4.5
CHIMNEY AND VENT CONNECTOR
CLEARANCES FROM COMBUSTIBLE MATERIALS[1]

Type of Connector	Minimum Clearance (inches)
Single-Wall Metal Pipe Connectors	
Gas Appliances without Draft Hoods	18
Oil and Solid-Fuel Appliances	18
Unlabeled Gas Appliances with Draft Hoods	9
Oil Appliances Labeled for Use with Type L Vents	9
Labeled Gas Appliances with Draft Hoods[3]	6
Type L Vent Piping Connectors	
Gas Appliances without Draft Hoods	9
Oil and Solid-Fuel Appliances	9
Unlabeled Gas Appliances with Draft Hoods	6
Oil Appliances Labeled for Use with Type L Vents	—[2]
Labeled Gas Appliances with Draft Hoods	—[3]
Type B Gas Vent Piping Connectors	
Labeled Gas Appliances with Draft Hoods	—[3]

[1]These clearances apply unless the label of an appliance specifies a different clearance. Reduction in clearance shall be provided as in Table No. M-1005b.
[2]If labeled Type L vent piping is used, the clearance shall be in accordance with the vent label.
[3]If labeled Type B or Type L vent piping is used, the clearance shall be in accordance with the vent label.

SECTION M-1604 – VENTS

M-1604.1 Type of Vent Required: Appliances shall be provided with a labeled venting system as set forth in Table No. M-1604.1.

M-1604.2 Termination

M-1604.2.1 Through the roof: Vents passing through a roof shall extend through flashing and terminate in accordance with the manufacturer's recommendations.

M-1604.2.2 Natural draft appliances: Unless otherwise approved according to the manufacturer's installation instructions, vents for natural draft appliances shall terminate at an elevation at least 5-feet above the highest connected appliance outlet, and natural draft gas vents serving wall furnaces shall terminate at an elevation at least 12-feet above the bottom of the furnace.

M-1604.2.3 Type B or BW vent: Type B or BW gas vents shall conform to UL 441, as listed in Section S-26.1604. Such vents shall terminate not less than 1-foot above the roof, and not less than 4-feet from any portion of the building that extends at an angle of more then 45 degrees upward from the horizontal.

M-1604.2.4 Type L vent: Type L venting systems shall conform to UL 641 as listed in Section S-26-1604. Such vents shall terminate not less than 2-feet above the roof, and not less than 4-feet from any portion of the building that extends at an angle of more than 45 degrees upward from the horizontal.

Table No. M-1604.1
VENT SELECTION CHART

Type B Gas	Type BW Gas	Special Gas Vent Systems	Type L Oil, etc.
All labeled gas appliances with draft hoods, and other Category I gas appliance vents labeled for use with Type B gas vents	Vented wall furnaces labeled for use with Type BW vents	Category II, III, and IV gas appliances, according to manufacturer's recommendations and as labeled	Oil burning appliances labeled for use with Type L vents; gas appliances labeled for use with Type B vents.

M-1604.2.5 Direct vent appliances: The vent terminal of a direct vent appliance with an input of 50,000 Btu/h or less shall be located not less than 9-inches from any opening through which vent gases could enter a building. The vent terminal of a direct vent appliance having an input over 50,000 Btu/h shall be located not less than 12-inches from any such opening. The bottom of a vent terminal and an air intake shall be located at least 12-inches above grade.

M-1604.2.6 Mechanical draft systems: Mechanical draft systems other than direct vent systems shall be installed in accordance with the manufacturer's installation instructions or the following requirements:

1. The vent terminal shall be located not less than 3-feet above any forced air inlet located within 10-feet.
2. The vent terminal shall be located not less than 4-feet below, 4-feet horizontally from, or 1-foot above any door, window, or gravity air inlet into a dwelling.
3. The vent terminal shall be located not less than 2-feet from an adjacent building.
4. The bottom of the vent terminal shall be located at least 12-inches above finished ground level.

M-1604.3 Installation: Type B, Type BW, Type L vents shall be installed in accordance with the terms of their label and manufacturer's installation instructions. Venting systems for labeled Category II, III, and IV gas appliances shall be installed in accordance with the appliance manufacturer's installation instructions.

M-1604.3.1 Size of single appliance venting systems: An individual vent for a single appliance shall have a cross-sectional area equal to or greater than the area of the connector to the appliance, but not less than 7-square inches except where the vent is an integral part of a labeled appliance. Vents shall be sized according to Table No. M-1604.3.1 for a single Category I gas appliance or according to NFiPA 54/ANSI Z223.1, as listed in Section S-26.1604, or by other approved methods.

M-1604.3.2 Size of multiple appliance venting systems: Two or more labeled appliances connected to a common natural draft venting system

shall comply with the following requirements:

1. Vents and vent connectors shall be sized according to Table Nos. M-1604.3.2a and M-1604.3.2b for two or more Category I gas appliances, or according to NFiPA 54/ANSI Z223.1, as listed in Section S-26.1604, or by other approved methods.
2. Appliances which are connected to common venting systems shall be located on the same floor of the dwelling except engineered systems as provided in Section M-1601.
3. Inlets to common venting systems shall be offset such that no portion of an inlet is opposite another inlet.
4. Connectors serving appliances operating under natural draft shall not be connected into any portion of a mechanical draft system operating under positive pressure.
5. Unless labeled for such connection, solid fuel-burning appliances shall not be connected to a vent serving another appliance burning other fuels.
6. When two or more vent connectors enter a common gas vent, the smaller connector shall enter at the highest level consistent with the available headroom and clearance to combustible material.

M-1604.3.3 Size of solid fuel vents: Unless otherwise approved according to the manufacturer's installation instructions, the cross-sectional areas of a flue connected to a solid fuel burning appliance shall be not less than the area of the flue collar or connector but not larger than three times the area of the flue collar.

TABLE NO. M-1604.3.1
CAPACITY OF TYPE B VENTS
SERVING A SINGLE CATEGORY I GAS APPLIANCE
(Appliance Input Rating In 1,000 Btu/h)

HEIGHT (ft)	Lateral (ft)	VENT AND CONNECTOR DIAMETER - (INCHES)														
		3			4			5			6			7		
		FAN		NAT	FAN		NAT	FAN		NAT	FAN		NAT	FAN		NAT
		Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max
6	0	38	77	45	59	151	85	85	249	140	126	373	204	165	522	284
	2	39	51	36	60	96	66	85	156	104	123	231	156	159	320	213
	4	NR	NR	33	74	92	63	102	152	102	146	225	152	187	313	208
	6	NR	NR	31	83	89	60	114	147	99	163	220	148	207	307	203
8	0	37	83	50	58	164	93	83	273	154	123	412	234	161	580	319
	2	39	56	39	59	108	75	83	176	119	121	261	179	155	363	246
	5	NR	NR	37	77	102	69	107	168	114	151	252	171	193	352	235
	8	NR	NR	33	90	95	64	122	161	107	175	243	163	223	342	225
10	0	37	87	53	57	174	99	82	293	165	120	444	254	158	628	344
	2	39	61	41	59	117	80	82	193	128	119	287	194	153	400	272
	5	52	56	39	76	111	76	105	185	122	148	277	186	190	388	261
	10	NR	NR	34	97	100	68	132	171	112	188	261	171	237	369	241
15	0	36	93	57	56	190	111	80	325	186	116	499	283	153	713	388
	2	38	69	47	57	136	93	80	225	149	115	337	224	148	473	314
	5	51	63	44	75	128	86	102	216	140	144	326	217	182	459	298
	10	NR	NR	39	95	116	79	128	201	131	182	308	203	228	438	284
20	0	35	96	60	54	200	118	78	346	201	114	537	306	149	772	428
	2	37	74	50	56	148	99	78	248	165	113	375	248	144	528	344
	5	50	68	47	73	140	94	100	239	158	141	363	239	178	514	334
	10	NR	NR	41	93	129	86	125	223	146	177	344	224	222	491	316
30	0	34	99	63	53	211	127	76	372	219	110	584	334	144	849	472
	2	37	80	56	55	164	111	76	281	183	109	429	279	139	610	392
	5	49	74	52	72	157	106	98	271	173	136	417	271	171	595	382
	10	NR	NR	NR	91	144	98	122	255	168	171	397	257	213	570	267
50	0	33	99	66	51	213	133	73	394	230	105	629	361	138	928	515
	2	36	84	61	53	181	121	73	318	205	104	495	312	133	712	443
	5	48	80	NR	70	174	117	94	308	198	131	482	305	164	696	435
	10	NR	NR	NR	89	160	NR	118	292	186	162	461	292	203	671	420

Notes:

1 *Height* is total height of vent from the connector point of entry to the termination outdoors.

2 *Lateral* is the developed horizontal length of the connector from the appliance outlet to the vent connection.

3 *Fan* refers to appliances having fan-assisted or mechanical draft systems.

4 *Nat* refers to appliances having a draft hood.

5 The connector shall be single wall metal, Type L or Type B material.

6 Vent configurations with lateral lengths are assumed to have a maximum of two 90° elbows.

7 This table is only applicable to vents enclosed in a chase.

8 NR indicates not recommended.

Table No. M-1604.3.2a
CAPACITY OF TYPE B VENT
SERVING TWO OR MORE CATEGORY I GAS APPLIANCES
(Appliance Input Rating In 1,000 Btu/h)

HEIGHT (feet)	COMMON VENT DIAMETER (INCHES)														
	4			5			6			7			8		
	FAN + FAN	FAN + NAT	NAT + NAT	FAN + FAN	FAN + NAT	NAT + NAT	FAN + FAN	FAN + NAT	NAT + NAT	FAN + FAN	FAN +- NAT	NAT +- NAT	FAN +- FAN	FAN +- NAT	NAT + NAT
6	89	78	64	136	113	100	200	158	144	304	244	196	398	310	257
8	98	87	71	151	126	112	218	173	159	331	269	218	436	342	285
10	106	94	76	163	137	120	237	189	174	357	292	236	467	369	309
15	121	108	88	189	159	140	275	221	200	416	343	274	544	434	357
20	131	118	98	208	177	155	305	247	223	463	383	302	606	487	395
30	145	132	113	236	202	179	350	237	257	533	446	349	703	570	459
50	159	145	138	268	233	204	406	337	296	622	529	410	833	686	535

Notes:

[1] Fan + Fan refers to combination of two fan-assisted appliances.

[2] Fan + Nat refers to combination of a fan-assisted and a draft hood-equipped appliance.

[3] Nat + Nat refers to combination of two draft hood-equipped appliances.

[4] When more than two appliances are connected to a common vent, and at least one of the common vented appliances is a fan-assisted type, the common vent must have a maximum capacity lower than that of the smallest fan-assisted appliance.

[5] If the common vent has an offset, the maximum capacity shall be reduced by 20 percent.

[6] This table is only applicable to vents enclosed in a chase.

[7] NR indicates not recommended.

Table No. M-1604.3.2b
CAPACITY OF TYPE B CONNECTORS
SERVING TWO OR MORE CATEGORY I GAS APPLIANCES
(Appliance Input Rating In 1,000 Btu/h)

		COMMON VENT DIAMETER (INCHES)													
		3			4			5			6			7	
HEIGHT	RISE	FAN		NAT	FAN		NAT	FAN		NAT	FAN		NAT	FAN	NAT
6	1	NR	NR	26	NR	NR	46	NR	NR	71	NR	NR	102	207	223	140
	2	NR	NR	31	NR	NR	55	NR	NR	85	168	182	123	215	251	167
15	1	NR	NR	29	79	87	52	116	138	81	177	214	116	238	291	158
	2	NR	NR	34	83	94	62	121	150	97	185	230	138	246	314	189
30	1	47	60	31	77	110	57	113	175	89	169	278	129	226	380	175
	2	50	62	37	81	115	67	117	185	106	177	290	152	236	397	208
50	1	46	69	33	75	128	60	109	207	96	162	336	137	217	460	188
	2	49	71	40	79	132	72	114	215	113	170	345	164	226	473	223

Notes:

[1] Rise is the vertical rise of the connector between the appliance outlet and vent connection.

[2] Maximum vent connector length shall be 1-1/2 feet (18 inches) for each inch of connector diameter.

[3] Other notes from Table M-1605.4.1 apply.

[4] NR indicates not recommended.

SECTION M-1605—MASONRY AND FACTORY-BUILT CHIMNEYS

M-1605.1 General: Masonry and factory-built chimneys shall be built and installed in accordance with Sections R-901 and R-902, respectively.

M-1605.2 Installation of factory-built chimneys: Factory-built chimneys and chimney units shall be installed in accordance with the manufacturer's installation instructions such that flue gas temperatures in the chimney shall not exceed the limits specified in their label. Factory-built chimneys for use with wood-burning appliances shall be Type HT or labeled for 2100°F flue gases.

M-1605.3 Masonry chimney connection: A chimney connector shall enter a masonry chimney not less than 6-inches from the bottom of the chimney, except that if 6-inches are not available, a cleanout shall be provided by installing a capped tee in the connector next to the chimney. A connector entering a masonry chimney shall extend through, but not beyond the wall and shall be flush with the inner face of the liner. Connectors, or thimbles, when used, shall be firmly cemented into the masonry.

M-1605.4 Size of masonry chimneys: The effective area of a natural draft chimney flue for one appliance shall be not less than the area of the connector to the appliance. Chimneys connected to more than one appliance shall be not less than the area of the largest connector plus 50 percent of the areas of additional vent connectors.

M-1605.4.1 Size of chimney for single gas appliance: Masonry chimneys serving a single Category I gas appliance shall be sized in accordance with Table No. M-1605.4.1 or NFiPA 54/ANSI Z223.1, as listed in Section S-26.1605, or by other approved methods.

M-1605.4.2 Size of chimney for multiple gas appliance: Venting of multiple gas appliances through masonry chimneys shall conform to Section M-1604.3.2, except that masonry chimneys serving multiple Category I gas appliances shall be sized in accordance with Table Nos. M-1605.4.2a and M-1605.4.2b or NFiPA 54/ANSI Z223.1, as listed in Section S-26.1605, or by other approved methods.

TABLE NO. M-1605.4.1
CAPACITY OF MASONRY CHIMNEY SERVING A SINGLE CATEGORY I APPLIANCE
(Appliance Input Rating In 1,000 Btu/h)

		CHIMNEY AND CONNECTOR DIAMETER (INCHES)														
		3			4			5			6			7		
Height	Lateral	FAN		NAT	FAN		NAT	FAN		NAT	FAN		NAT	FAN		NAT
(ft)	(ft)	Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max
6	2	NR	NR	28	NR	NR	52	NR	NR	86	NR	NR	130	NR	NR	180
	5	NR	NR	25	NR	NR	48	NR	NR	31	NR	NR	116	NR	NR	164
10	2	NR	NR	31	NR	NR	61	NR	NR	102	NR	NR	161	171	403	220
	5	NR	NR	28	NR	NR	56	NR	NR	95	NR	NR	147	212	387	203
	10	NR	NR	24	NR	NR	49	NR	NR	86	NR	NR	137	NR	NR	189
15	2	NR	NR	35	NR	NR	67	NR	NR	113	NR	NR	178	166	473	249
	5	NR	NR	32	NR	NR	61	NR	NR	106	NR	NR	163	206	454	230
	10	NR	NR	27	NR	NR	54	NR	NR	96	NR	NR	151	NR	NR	214
	15	NR	NR	NR	NR	NR	46	NR	NR	87	NR	NR	138	NR	NR	198
20	2	NR	NR	38	NR	NR	73	NR	NR	123	NR	NR	200	163	520	273
	5	NR	NR	35	NR	NR	67	NR	NR	115	NR	NR	183	201	500	252
	10	NR	NR	NR	NR	NR	59	NR	NR	105	NR	NR	170	NR	NR	235
	15	NR	NR	NR	NR	NR	NR	NR	NR	95	NR	NR	156	NR	NR	217
	20	NR	NR	NR	NR	NR	NR	NR	NR	80	NR	NR	144	NR	NR	202
30	2	NR	NR	41	NR	NR	81	NR	NR	136	NR	NR	215	158	578	302
	5	NR	NR	NR	NR	NR	75	NR	NR	127	NR	NR	196	194	550	279
	10	NR	NR	NR	NR	NR	66	NR	NR	113	NR	NR	182	NR	NR	260
	15	NR	NR	NR	NR	NR	NR	NR	NR	105	NR	NR	168	NR	NR	240
	20	NR	NR	NR	NR	NR	NR	NR	NR	83	NR	NR	155	NR	NR	223
	30	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	182
50	2	NR	NR	NR	NR	NR	91	NR	NR	160	NR	NR	250	NR	NR	350
	5	NR	NR	NR	NR	NR	NR	NR	NR	149	NR	NR	228	NR	NR	321
	10	NR	NR	NR	NR	NR	NR	NR	NR	136	NR	NR	212	NR	NR	301
	15	NR	NR	NR	NR	NR	NR	NR	NR	124	NR	NR	195	NR	NR	278
	20	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	180	NR	NR	258
	30	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Minimum Internal Area of Chimney, (Square Inches)		12			19			28			38			50		
Maximum Internal Area of Chimney, (Square Inches)		49			88			137			198			269		

Notes:

1. *Height* is total height of vent from the connector point of entry to the termination outdoors.
2. *Lateral* is the developed horizontal length of the connector from the appliance outlet to the vent connection.
3. *Fan* refers to appliances having fan-assisted or mechanical draft systems.
4. *Nat* refers to appliances having a draft hood.
5. The connector shall be single wall metal, Type L or Type B material.
6. Vent configurations with lateral lengths are assumed to have a maximum of two 90° elbows.
7. NR indicates not recommended.

Table No. M- 1605.4.2a
CAPACITY OF MASONRY CHIMNEY
SERVING TWO OR MORE CATEGORY I APPLIANCES
(Appliance Input Rating In 1,000 Btu/h)

		VENT CONNECTOR DIAMETER (INCHES)																	
		3"			4"			5"			6"			7"			8"		
Height	Rise	FAN		NAT	FAN		NAT	FAN		NAT	FAN		NAT	FAN		NAT	FAN		NAT
(ft)	(ft)	Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max
6	1	NR	NR	21	NR	NR	39	NR	NR	66	179	191	100	231	271	140	292	366	200
	2	NR	NR	28	NR	NR	52	NR	NR	84	186	227	123	239	321	172	301	432	231
	3	NR	NR	34	NR	NR	61	134	153	97	193	258	142	247	365	202	309	491	269
15	1	NR	NR	23	NR	NR	43	129	151	73	199	271	112	268	376	171	349	502	225
	2	NR	NR	30	92	103	54	135	170	88	207	295	132	277	411	189	359	548	256
	3	NR	NR	34	96	112	63	141	185	101	215	315	151	286	439	213	368	586	289
30	1	NR	NR	24	86	108	47	126	187	80	193	347	124	259	492	183	338	665	250
	2	NR	NR	31	91	119	57	132	203	93	201	366	142	269	518	205	348	699	282
	3	NR	NR	35	95	127	65	138	216	105	209	381	160	277	540	229	358	729	312
50	1	NR	NR	25	85	113	48	124	204	80	188	392	130	252	567	194	328	778	265
	2	NR	NR	31	89	123	57	130	218	94	196	408	149	262	588	218	339	806	298
	3	NR	NR	35	94	131	65	136	231	106	205	422	167	271	607	243	349	831	328

Notes:

1. *Rise* is the vertical rise of the connector between the appliance outlet and vent connection.
2. Maximum vent connector length shall be 1-1/2 feet (18 inches) for each inch of connector diameter.
3. Other notes from Table No. M-1604.3.1 apply.
4. NR indicates not recommended.

Table No. M-1605.4.2b
CAPACITY OF MASONRY CHIMNEY
SERVING TWO OR MORE CATEGORY I APPLIANCES
(Appliance Input Rating In 1,000 Btu/h)

Hgt ft	MINIMUM INTERNAL AREA OF CHIMNEY, (SQUARE INCHES)																							
	12			19			28			38			50			63			78			113		
	FAN + FAN	FAN + NAT	NAT + NAT	FAN + FAN	FAN + NAT	NAT + NAT	FAN + FAN	FAN + NAT	NAT + NAT	FAN + FAN	FAN + NAT	NAT + NAT	FAN + FAN	FAN + NAT	NAT + NAT	FAN + FAN	FAN + NAT	NAT + NAT	FAN + FAN	FAN + NAT	NAT + NAT	FAN + FAN	FAN + NAT	NAT + NAT
6	NR	73	25	NR	118	45	NR	176	71	NR	255	102	NR	348	142	NR	455	187	NR	579	245	NR	846	NR
8	NR	79	28	NR	128	52	NR	190	81	NR	276	118	NR	380	162	NR	497	217	NR	633	277	NR	928	405
10	NR	83	31	NR	136	56	NR	205	89	NR	295	129	NR	405	175	NR	532	234	NR	680	300	NR	1000	450
15	NR	88	36	NR	149	66	NR	230	105	NR	335	150	NR	460	210	NR	602	280	NR	772	360	NR	1139	540
20	NR	90	40	NR	157	74	NR	247	120	NR	362	170	NR	503	240	NR	661	321	NR	849	415	NR	1264	640
30	NR	90	NR	NR	162	NR	NR	266	135	NR	398	195	NR	558	275	NR	739	377	NR	957	490	NR	1447	740
50	NR	83	NR	NR	160	NR	NR	280	NR	NR	429	NR	NR	612	325	NR	821	456	NR	1076	600	NR	1672	910

Notes:

[1] Fan + Fan refers to combination of two fan-assisted appliances.

[2] Fan + Nat refers to combination of a fan-assisted and a draft hood-equipped appliance.

[3] Nat + Nat refers to combination of two draft hood-equipped appliances.

[4] When more than two appliances are connected to a common vent, and at least one of the common vented appliances is a fan-assisted type, the common vent must have a maximum capacity to accommodate all the common vented appliances, and have a minimum capacity lower than that of the smallest fan-assisted appliance.

[5] If the common vent has an offset, the maximum capacity shall be reduced by 20 percent.

[6] NR indicates not recommended.

Chapter 17
FUEL-GAS SUPPLY SYSTEMS

SECTION M -1701—GENERAL

Fuel-gas supply systems extending from the point of delivery to the connection with each gas utilization appliance shall conform to the requirements of this chapter. For private individual LPG systems, the point of delivery is the outlet of the first stage pressure regulator. For all other fuel gas supply systems, the point of delivery is the outlet of the gas service meter.

SECTION M-1702—AUTHORITY TO RENDER GAS SERVICE

Gas service shall not be rendered until approved by final inspection in compliance with Section M-1009.2.

SECTION M-1703—GAS METERS

M-1703.1 Location: Gas meters shall be readily accessible for inspection, reading, and replacement, and shall be located at least 3-feet from sources of ignition when installed indoors.

M-1703.2 Support: Gas meters shall be securely supported or connected to rigid piping.

SECTION M-1704—GAS PIPING MATERIALS

M-1704.1 Approved types: Pipe and tubing materials shall conform to Table No. M-1704.1, or other approved materials.

M-1704.2 Prohibited piping materials: Pipe, tubing, or fittings constructed of the following materials shall be prohibited unless part of a labeled equipment assembly:

1. Ductile or cast iron pipe and fitting.
2. Plastic pipe and fittings shall not be used within or beneath a building.
3. Copper and brass pipe and tubing, with the exception of tin lined copper tubing, shall not be used if the gas contains an average of 0.3 grains of hydrogen sulfide per 100 standard cubic feet of gas.

M-1704.3 Used materials: Before reusing pipe, tubing, fittings, valves, etc., removed from an existing fuel-gas installation shall be thoroughly cleaned, inspected and ascertained to be equivalent to new material.

Table No. M-1704.1
GAS SUPPLY PIPING MATERIALS

MATERIAL	STANDARD	APPROVED JOINTS	NOTES
Black Steel	ASTM A53, A106	Welded, Threaded, Flanged	Schedule 40 pipe, malleable black or galvanized fittings only. Paint with one coat oil based paint if outside above grade. Protect in accordance with Section M-1707.1.2 if outside below grade.
Galvanized Steel Pipe	ASTM A53	Thread or Flanged	Schedule 40 pipe, malleable black or galvanized fittings only. Protect in accordance with Section M-1707.1.2 if outside below grade.
Corrugated Stainless Steel Tubing	ANSI/AGA LC 1	Proprietary Mechanical Fittings	Labeled system. Install per manufacturer's installation instructions. Above grade use only.
Soft Copper, Type K or L Tubing	ASTM B75, B88, B280, B68	Flared or Brazed	Mark as per Section M-1707.8 when used above grade.
Copper or Brass Pipe	ASTM B42, B43, B302	Threaded or Flared	None
Plastic Pipe	ASTM D2513	Solvent Cement, Adhesive, Heat Fusion, Compression Couplings, Flanged	Use only underground, outside of building.

SECTION M-1705—GAS VALVES

M-1705.1 Approved type: Gas valves shall be labeled for fuel gas service and compatible with the gas piping served. Manually operated gas valves shall conform to ANSI Z21.15, as listed in Section S-26.1705, or as approved.

M-1705.2 Size: Gas valves shall be equivalent in nominal size to the piping served.

M-1705.3 Shutoff valve: Accessible shutoff valves shall be installed within 6 feet of an appliance, within the same room and upstream from the union connection. When an appliance connector is used, the valve shall be installed upstream of the connector. Shutoff valves located adjacent to, inside or under an appliance shall be accessible and allow the appliance to be removed without removal of the valve.

M-1705.4 Fireplace outlets: Gas outlets located in fireplaces shall be controlled by labeled valves located in the same room outside the hearth and not more than 4 feet from the outlets. Where gas piping on the discharge side of the valve penetrated the masonry hearth or walls, it shall be encased in a metal sleeve. The space between the gas pipe and the sleeve shall be sealed with a high-temperature compound to prevent hot embers from endangering adjacent combustible surfaces.

M-1705.5 Quick-disconnect devices: Gas utilization equipment may be connected to the building piping by means of a labeled quick-disconnect device. When installed indoors, a manual shutoff valve shall be installed upstream of the quick-disconnect device. Gas convenience outlets conforming to AGA Requirement 7-90, as listed in Section S-26.1705, shall not require a manual valve upstream of the device.

SECTION M-1706—PIPING JOINTS AND CONNECTIONS

M-1706.1 General: The type of piping joint used shall be suitable for the pressure-temperature conditions and compatible with the piping material.

M-1706.2 Pipe joints: Pipe joint compound or tape shall be used on male threads only.

M-1706.3 Tubing joints: Tubing joints shall be made with approved or labeled gas tubing fittings, or be brazed with a material having a melting point in excess of 1000°F. Brazing alloys shall not contain phosphorus. Flared joints shall be made with the proper flaring tool that will produce a flare compatible with the approved fittings. Other approved joints shall be installed in accordance with the manufacturers recommendations.

M-1706.4 Metallic fittings: Fittings used with steel pipe shall be steel, brass, or bronze. Fittings used with copper or brass pipe shall be copper, brass, or bronze. Brass or bronze fittings, if exposed to soil, shall have a minimum 80 percent copper content. Fittings such as couplings, propriety type joints, saddle tees, gland-type compression fittings, and flared, flareless, or compression type tubing fittings shall be:

1. Used within the service conditions anticipated with respect to vibration, fatigue, and thermal expansion or contraction.
2. Installed and supported to prevent separation of the joint by gas pressure or external force.

M-1706.5 Plastic joints and fittings: Plastic pipe, tubing and fittings shall be joined by solvent-cement, adhesive or heat-fusion methods, or by means of compression couplings or flanges in accordance with the manufacturer's recommendations. The following shall apply to joints in plastic pipe and tubing:

1. Plastic pipe or tubing shall not be threaded.
2. The joint shall be designed and installed so that the longitudinal pull-out resistance of the joint will be at least equal to the tensile strength of the plastic piping material.
3. Solvent-cement joints, adhesive joints, and heat-fusion joints shall be made in accordance with procedures specified by the manufacturer.
4. Solvent-cement or heat-fusion joints shall not be made between different types of plastics.
5. Heat-fusion or mechanical joints shall be used when joining polyethylene pipe, tubing, or fittings.
6. Flanges or special joints shall be used in accordance with the manufacturer's instructions.

7. When compression type mechanical joints are used, the gasket material in the fitting shall be compatible with the plastic piping, and a one-piece internal rigid tubular stiffener shall be used with the fitting.

M-1706.6 Appliance connection: Gas appliances and equipment shall be connected to the building piping by rigid metallic pipes, semi-rigid metallic tubing, or a labeled gas appliance connector, having a diameter not less than the nominal inlet connection to the appliance in accordance with their label. Appliance connectors shall be not more than 6-feet in length, and shall not be concealed within or run through walls, floors or partitions.

SECTION M-1707—GAS PIPING INSTALLATION

M-1707.1 Underground piping: Underground gas piping shall be installed to protect it from settlement, shifting, contact or damage resulting from proximity to structures.

M-1707.1.1 Minimum depth: Underground metallic piping systems shall be installed at a minimum of 12-inches below grade. Plastic piping systems shall be installed at a minimum of 18-inches below grade. If minimum depths cannot be maintained, the piping system shall be installed in conduit or shielded in an approved manner.

M-1707.1.2 Protection against corrosion: Gas piping in contact with material which will corrode the piping shall be protected by approved corrosion control practices. Field wrapping shall be limited to short sections and fittings that must be stripped for threading or welding. Galvanizing shall not be deemed equivalent protection. When dissimilar metals are joined underground, dielectric fittings or couplings shall be used.

M-1707.1.3 Connection of plastic and metallic piping: Connections between metallic and plastic piping shall be made only underground, outside of the building, and with approved transition fittings.

M-1707.1.4 Piping through foundation wall: Penetrations through foundation or basement walls of a dwelling shall be encased in a sleeve. The annular space between the gas piping and the sleeve shall be sealed at the foundation or basement wall to prevent entry of gas or water.

M-1707.1.5 Piping beneath buildings: Fuel gas piping located beneath buildings shall be encased in conduit which is capable of withstanding superimposed loads. The terminal point where the conduit enters the building shall be sealed to prevent the possible entrance of any gas leakage. The conduit shall extend at least 4-inches outside the building and be vented above grade to the outside. This section shall not apply to piping in ventilated crawl spaces.

M-1707.1.6 Tracer for nonmetallic buried piping: A No 18 copper tracer wire or other approved conductor shall be installed adjacent to underground nonmetallic gas piping and shall be accessible or terminate above grade at each end.

M-1707.2 Piping in buildings

M-1707.2.1 Drilling and notching: Where necessary, wood-framed structural members shall be drilled or notched as provided in Sections R-402.5, R-402.5.1, R-602.5, R-602.6, R-702.5 and R-702.6.

M-1707.2.2 Sediment trap: If a sediment trap is not incorporated as a part of the gas utilization equipment, a sediment trap shall be installed as close to the inlet of the equipment as practical. The sediment trap shall be either a tee fitting with a capped nipple in the bottom outlet or other device recognized as an effective sediment trap. Ranges, clothes dryers, and outdoor grills need not be so equipped.

M-1707.2.3 Prohibited locations: Gas piping shall not be run in or through supply and return air ducts, plenums, clothes, chutes, chimneys, vents, dumbwaiters, or elevator shafts. This provision shall not apply to ducts used to provide combustion air in accordance with Chapter 15.

M-1707.2.4 Piping in concealed locations: Portions of gas piping systems installed in concealed locations shall not have unions or running threads. Concealed tubing joints shall be brazed in accordance with Section M-1706.3.

M-1707.2.5 Piping in concrete slabs: Gas piping embedded in concrete slabs shall be surrounded with a minimum of 1 1/2 inches of concrete and shall not be in physical contact with reinforcing or other metallic components. Piping shall not be embedded in concrete slabs containing quickset additives or cinder aggregate. All piping, fittings, and risers shall be protected against corrosion in accordance with Section M-1707.1.2.

M-1707.2.6 Hangers and supports: Hangers and supports shall be of sufficient strength to support the piping, and shall be fabricated of materials compatible with the piping material. Piping shall be supported at intervals not exceeding the spacings specified in Table No. M-1707.2.6.

Table No. M-1707.2.6
GAS PIPING SUPPORTS

MATERIAL	MAXIMUM SPACING (FEET)
Rigid pipe, 3/4-inch diameter and under	10
Rigid pipe, 1-inch diameter and over	12
Tubing, 1-1/2-inch diameter and under	6

M-1707.3 Aboveground outside piping: Piping installed aboveground outside of the building shall be securely supported and protected from physical damage. Piping which penetrates outside walls shall be protected against corrosion. Piping which penetrated masonry or concrete walls or chemically treated lumber shall be sleeved with the annular space between the pipe and sleeve sealed.

M-1707.4 Gas pipe turn

M-1707.4.1 Metallic tubing bends: Metallic tubing shall conform with the following:

1. Bends shall be made only with bending equipment and procedures intended for that purpose.

2. All bends shall be smooth and free from buckling, cracks, or other mechanical damage.
3. The inside radius of a bend shall be not less than 6 times the outside diameter of the tubing.
4. Corrugated stainless steel tubing bends shall be in compliance with the manufacturer's installation instructions.

M-1707.4.2 Plastic pipe bends:

1. Plastic pipe shall not be damaged and the internal diameter of the pipe shall not be effectively reduced.

2. The inside radius of a bend shall be not less than 25 times the inside diameter of the pipe.

3. When the piping manufacturer specifies the use of special bending equipment or procedures, such equipment or procedures shall be used.

M-1707.5 Shielding concealed tubing: Concealed tubing that penetrates a stud, joist or framing member shall be protected from puncture by shielding the area of penetration and within 5-inches of each side (if appropriate) of the penetration, as appropriate. Concealed tubing at support points and points of penetration 2 to 3-inches from any edge of a stud, joist or framing member shall be shielded throughout the area of support. Shielding devices shall be constructed from 16 gage steel plate. Unsupported sections within a wall or ceiling cavity need not be shielded.

M-1707.6 Purging: The fuel-gas piping system shall be purged prior to placing in service. Piping shall not be purged into the combustion chamber of an appliance.

M-1707.7 Cap all outlets: Each outlet, including those with a valve or cock outlet, shall be closed gas-tight with a threaded plug or cap immediately after installation and shall be left closed until the gas utilization equipment is connected thereto. Outlets shall be closed gas-tight when equipment is disconnected. This requirement shall not apply to labeled quick-disconnect devices or gas convenience outlets as provided in Section M-1705.5.

M-1707.8 Marking and labeling: Where other than black steel pipe is used, gas piping shall be identified by yellow labels marked "GAS" in black letters placed at 5-foot intervals where exposed. This marking shall not be required on pipe in the same room as the equipment. All tubing carrying medium pressure gas shall be marked with a label at the beginning and end of each tubing section.

M-1707.9 Electrical bonding and grounding: Each above ground portion of a metallic gas piping system upstream from the appliance shutoff valve shall be electrically continuous and bonded to a grounding electrode in accordance with Part VI of this code. Gas piping shall not be used as a grounding electrode.

Fuel-gas piping or components shall not be used as electrical circuits except that low-voltage (50 volts or less) control circuits, ignition circuits, and electronic flame detection device circuits may make use of piping or components for a part of an electrical circuit.

SECTION M-1708—GAS PIPE SIZING

M-1708.1 Required gas supply: All fuel-gas pipe shall be sized to supply the required demand of the attached appliances. The cubic feet per hour of gas required shall be obtained by dividing the specified Btu/h input of an appliance by the average Btu heating value per cubic foot of gas being supplied. Where the rating of the gas appliance to be installed has not been specified, Table No. M-1708.1 or other approved sources shall be used to estimate the requirement in Btu/h.

M-1708.2 Required size: Fuel-gas pipe operating under low pressure (0.5 psig or less) shall be sized using the following procedure, or according to Appendix C of NFiPA 54/ANSI X223.1, as listed in Section S-26.1708 or by other approved methods:

1. Measure the length of pipe from the point of delivery to the most remote outlet or appliance connection.
2. From Table No. M-1708.2, select the column showing that distance or the next longer distance.
3. Determine gas demand for the most remote section of piping and locate in this column. If the exact figure is not shown, choose the next larger figure. The required pipe or tubing size for that section is shown in the left hand column.
4. Repeat Step 3 above for each section of piping, working back toward the point of delivery.

Table No. M-1708.1
APPROXIMATE DEMAND OF TYPICAL RESIDENTIAL GAS APPLIANCES

APPLIANCE	DEMAND (Btu/h)
Range with Oven	65,000
Built-in Top Burner Section	40,000
Built-in Oven Section	25,000
Storage Water Heater-up to 30 gallon	30,000
Storage Water Heater-40 to 50 gallon	50,000
Clothes Dryer	35,000
Fireplace Log Lighter	25,000
Barbecue	50,000

Table No. M-1708.2
MAXIMUM CAPACITY OF PIPE AND TUBING
IN CUBIC FEET OF GAS PER HOUR
FOR A GAS PRESSURE OF 6 INCH WATER COLUMN
AND A PRESSURE DROP OF 1 INCH WATER COLUMN
(Based on 0.60 Specific Gravity Gas)

NOMINAL TUBING SIZE (INCHES)	NOMINAL PIPE SIZE (INCHES)	LENGTH OF PIPE OR TUBING (FEET)									
		10	20	30	40	50	60	70	80	90	100
3/8	1/4	44	29	23	20	17	16	15	13	12	11
1/2	3/8	100	69	54	46	41	36	33	31	29	27
5/8	1/2	195	131	104	87	77	70	63	59	55	52
3/4	5/8	333	224	177	151	134	120	109	101	95	89
7/8	3/4	521	350	276	234	208	187	172	159	148	139
1-1/8	1	792	542	458	396	359	328	302	281	265	250
1-3/8	1-1/4	1,615	1,156	937	828	729	667	625	583	542	521

SECTION M-1709—HYBRID PRESSURE PIPING SYSTEMS

M-1709.1 Hybrid system piping size: Hybrid pressure gas systems consist of two parts: First, medium pressure (0.5 to 5.0 psig) piping from the meter to the pounds-to-inches regulator to the appliance connection. The low pressure part shall be sized in accordance with Section M-1708.2. Two psig medium pressure systems shall be sized according to Table No. M-1709.1, or in accordance with NFiPA 54/ANSI Z223.1, as listed in Section S-26.1709, or by other approved methods. Systems designed for medium pressures other than 2 psig shall be sized in accordance with NFiPA/ANSI Z223.1.

Table No. M-1709.1
MAXIMUM CAPACITY OF PIPE AND TUBING
IN CUBIC FEET OF GAS PER HOUR
FOR A GAS PRESSURE OF 2 PSIG
AND A PRESSURE DROP OF 1 1/2 PSIG
(Based on 0.60 Specific Gravity Gas)

NOMINAL TUBING SIZE (INCHES)	NOMINAL PIPE SIZE (INCHES)	LENGTH OF PIPE OR TUBING (FEET)									
		10	20	30	40	50	60	70	80	90	100
3/8	1/4	375	250	200	170	149	135	123	115	106	100
1/2	3/8	885	594	464	396	349	312	286	265	250	234
5/8	1/2	1,698	1,125	896	760	672	604	552	510	479	448
3/4	5/8	2,896	1,937	1,542	1,302	1,146	1,042	948	885	823	771
7/8	3/4	4,530	3,070	2,395	2,080	1,820	1,625	1,490	1,385	1,280	1,208
1 1/8	1	7,915	5,625	4,580	3,955	3,485	3,175	2,915	2,760	2,600	2,445

M-1709.2 Gas pressure regulators: Pounds-to-inches regulators installed between the medium pressure and low pressure sections of hybrid pressure gas piping systems shall have full lock-up capability to maintain reduced pressure under static load conditions with no gas flowing and shall be rated for the pressure of the system. Regulators shall be accessible for inspection and maintenance.

M-1709.3 Regulator vent: Pounds to inches regulators installed indoors shall be equipped with a separate vent to the outside or a vent limiting devices shall be mounted horizontally with the limiting device facing upwards. Regulator vents to the outside shall be at least the same size as the vent connection to the regulator, and the vent terminal shall be turned down to prevent the entrance of water.

M-1709.4 Shutoff valve: An approved gas valve shall be installed immediately upstream from each pounds-to-inches regulator.

M-1709.5 Test plugs and sediment trap: A tee fitting with a plug in one opening shall be installed between the pounds-to-inches regulator and the upstream gas valve to permit monitoring of the inlet supply pressure to the regulator and to provide a sediment trap. A second tee fitting shall be installed at least 10 pipe diameters downstream of the regulator to monitor the outlet pressure of the regulator.

SECTION M-1710—LIQUEFIED PETROLEUM GAS SYSTEMS

M-1710.1 Pressure regulating valves: Pressure regulating valves for LPG systems shall be labeled in accordance with UL 144, as listed in Section S-26.1710.

M-1710.2 Location of containers: Above ground LPG tanks shall be located in accordance with Table No. M-1710.2.

M-1710.3 Multi-container installations: Multi-container installations comprised of individual containers having a water capacity of less than 125 gallons each shall comply with Table No. M-1710.2 by applying the capacity per container rather than aggregate capacity when such aggregate is 500 gallons or less.

M-1710.4 Underground containers: Underground containers shall be approved for underground placement. No part of an underground container shall be less than 10-feet from basements, structures which extend below ground level, or adjoining property lines.

Table No. M-1710.2
LPG TANK LOCATIONS

Container Type	Size (Water capacity in gallons)	Minimum Horizontal Distance From:			
		Tank To Buildings, Structures or Property Lines (feet)	Pressure Relief Device To Building Openings (feet)	Pressure Relief Device To Sources of Ignition or Vents (feet)	Fill Connection and Gage Vent To Sources of Ignition or Vents (feet)
DOT Exchanged	Less than 125	None	3	5	—
DOT Site Filled	Less than 125	None	3	5	10
ASME	Less than 125	None	5	5	10
ASME	125 to 500	10	—	—	10

SECTION 1711—TESTING

M-1711.1 General: All fuel-gas piping shall be subject to rough and final inspections per Section M-1009.

M-1711.2 Test medium: Piping systems operating at pressures of 0.5-psig or less shall use air, nitrogen, carbon dioxide or fuel-gas as the test medium. Piping systems operating at pressures greater than 0.5-psig shall use air, nitrogen, or carbon dioxide as the test medium. Oxygen shall never be used.

M-1711.3 Test preparation: When the piping system is connected to equipment or components designed for operating pressures less than the test pressure, such equipment or components shall be isolated from the piping system by bypassing or disconnecting them and capping the outlets.

M-1711.4 Test pressure: The test pressure to be used shall be not less than 1-1/2 times the proposed maximum working pressure, but not less than 3-psig, and shall be applied for a duration of not less than 10 minutes without showing any drop in pressure.

M-1711.5 Hybrid piping systems: Hybrid piping systems shall be tested by one of two methods:

1. A two-part pressure test in which:
   a. The first part is performed on the higher pressure section, between the meter connection and the pounds-to-inches regulator.
   b. The second part is performed on the lower pressure section, between the pounds-to-inches regulator and the gas appliance outlet.
2. A one-part test in which the higher and lower pressure sections are joined with tubing or pipe in place of the pounds-to-inches regulator, and tested together at 1-1/2 times the maximum working pressure of the higher pressure section.

M-1711.6 Detection of leaks and defects: Any loss of test pressure as indicated by pressure gauges shall be deemed to indicate the presence of a leak. The leak shall be located by means of an approved combustible gas detector, soap and water, or an equivalent nonflammable solution. Matches, candles, open flames, or other methods which could provide a source of ignition shall not be used. Where potentially corrosive leak test solutions, including soap and water are used, the piping shall be rinsed with water after testing. Vent limiting devices shall not be tested with a liquid test solution, which could contaminate the internal mechanism or plug the breathing hole. When leaks or other defects are located, the affected portion of the piping system shall be repaired or replaced, and the piping system shall be retested.

Chapter 18
FUEL OIL SUPPLY SYSTEMS

SECTION M-1801 – OIL TANKS

M-1801.1 Materials: Fuel oil supply tanks shall be fabricated from steel or other approved materials.

M-1801.2 Aboveground tanks: The maximum amount of fuel oil stored above ground or inside of a building shall be 660 gallons. The supply tank shall be securely supported on rigid noncombustible supports to prevent settling or shifting.

M-1801.2.1 Tanks within buildings: Supply tanks for use inside of buildings shall be of such size and shape to permit installation and removal from dwellings as whole units. Supply tanks larger than 10 gallons shall be placed not less than 5-feet to an adjoining property line. Such tanks shall be suitably protected from the weather and from physical damage.

M-1801.2.2 Outside aboveground tanks: Tanks installed outside above ground shall be a minimum of 5-feet to an ajoining property line. Such tanks shall be suitably protected from the weather and from physical damage.

M-1801.3 Underground tanks: Excavations for underground tanks shall not undermine the foundations of existing structures. The clearance from any part of the tank to the nearest wall of any basement, pit, or property line shall be not less than 1-foot. Tanks shall be set on and surrounded with noncorrosive inert materials such as clean earth, sand, or gravel well tamped in place. Tanks shall be covered with not less than 1-foot of earth. Corrosion protection shall be provided in accordance with Section M-1803.7.

M-1801.4 Multiple tanks: Cross connection of two supply tanks shall be permitted in accordance with section M-1803.6.

M-1801.5 Oil gauges: Inside tanks shall be provided with a device to indicate when the oil in the tank has reached a predetermined safe level. Glass gauges or any gauge or any gauge subject to breakage that could result in the escape of oil from the tank shall not be used.

SECTION M-1802—OIL PIPING, FITTING AND CONNECTIONS

M-1802.1 Materials: Piping shall consist of steel pipe, copper tubing, steel tubing conforming to ASTM A539, as listed in Section S-26.1802, or other approved materials. Aluminum tubing shall not be used between the fuel-oil tank and the burner units.

M-1802.2 Joints and fittings: Piping shall be connected with standard fittings compatible with the piping material. Cast iron fittings shall not be used for oil piping. Unions requiring gaskets or packings, right or left couplings, and sweat fittings employing solder having a melting point less

than 1000°F shall not be used for oil piping. Threaded joints and connections shall be made tight with suitable lubricant or pipe thread compound.

M-1802.3 Flexible connectors: Flexible metal hose used where rigid connections are impractical or to reduce the effect of jarring and vibration, shall be labeled and shall be installed in compliance with its label and the manufacturer's installation instructions. Connectors made from combustible materials shall not be used inside of buildings or above ground outside of buildings.

SECTION M-1803—INSTALLATION

M-1803.1 General: Piping shall be installed in a manner to avoid placing stresses on the piping, and to accommodate expansion and contraction of the piping system.

M-1803.2 Supply piping: Supply piping used in the installation of oil burners and appliances shall be not smaller than 3/8-inch pipe or 3/8-inch OD tubing. Copper tubing and fittings shall be minimum Type L.

M-1803.3 Fill piping: Fill piping shall terminate outside of dwellings at a point at least 2-feet from any dwelling opening at the same or lower level. Fill openings shall be equipped with a tight metal cover designed to discourage tampering.

M-1803.4 Vent piping: Vent piping shall be of adequate size to avoid pressure build-up in the tank during filling, but shall be no smaller than 1-1/4-inch pipe. Vent piping shall be laid to drain towards the tank without sags or traps in which liquid can collect. Vent pipes shall not be cross connected with fill pipes, lines from burners, or overflow lines from auxiliary tanks. The lower end of a vent pipe shall enter the tank through the top and shall extend into the tank not more than 1-inch.

M-1803.5 Vent termination: Vent piping shall terminate outside of buildings at a point not less than 2-feet, measured vertically or horizontally, from any building opening. Outer ends of vent piping shall terminate in a weather-proof cap or fitting having an unobstructed area at least equal to the cross-sectional area of the vent pipe, and shall be located sufficiently above the ground to avoid being obstructed with snow and ice.

M-1803.6 Cross connection of tanks: Cross connection of two supply tanks, not exceeding 660 gallons aggregate capacity, with gravity flow from one tank to another, shall be acceptable providing that the two tanks are on the same horizontal plane.

M-1803.7 Corrosion Protection: Underground tanks and buried piping shall be protected by corrosion resistant coatings, special alloys, fiber glass reinforced plastic, or other approved systems.

SECTION M-1804—OIL PUMPS AND VALVES

M-1804.1 Pumps: Oil pumps that are not part of a labeled burner shall be positive displacement types that automatically shut off the oil supply when stopped. Automatic pumps shall be labeled and shall be installed in compliance with their label.

M-1804.2 Shutoff valves: A readily accessible manual shutoff valve shall be installed between the oil supply tank and the burner. When the shutoff valve is installed in the discharge line of an oil pump, a pressure-relief valve shall be incorporated to bypass or return surplus oil.

M-1804.3 Maximum pressure: Pressure at the oil supply inlet to an appliance shall be not greater than 3-psi unless the appliance is approved for a higher inlet pressure.

M-1804.4 Relief valves: Fuel-oil lines incorporating heaters shall be provided with relief valves that will discharge to a return line when excess pressure exists.

Chapter 19
MISCELLANEOUS APPLIANCES

SECTION M-1901 – RANGES AND OVENS

M-1901.1 Clearances: Freestanding or built in ranges have a vertical clearance above the cooking top of not less than 30-inches to unprotected combustible material. When the underside of such combustible material is protected with noncombustible material, the distance shall not be less than 24-inches.

M-1901.2 Gas ranges and ovens: Gas ranges and ovens shall be labeled and shall conform to ANSI Z21.1, as listed in Section S-26.1901.

M-1901.3 Built-in units: Built-in household cooking appliances shall be labeled and shall be installed in accordance with the manufacturer's installation instructions. The installation shall not interfere with combustion air or accessibility for operation and servicing.

M-1901.4 Range hood: Range hoods shall be vented to the outdoors by a single-wall pipe constructed of galvanized steel, stainless steel, copper or other material approved by the building official for the use intended. Vents serving range hoods shall not terminate in an attic or crawl space or any area inside the building. Labeled unvented range hoods shall be installed in accordance with the terms of their label.

SECTION M-1902 – OPEN-TOP GAS BROILER UNITS

M-1902.1 General: Open-top gas broiler units shall be labeled and shall be installed in accordance with the manufacturer's installation instructions. Open-top gas broiler units shall conform to ANSI Z21.1, as listed in Section S-26.1902.

M-1902.2 Overhead ventilating hoods: Domestic open-top broiler units shall be provided with a metal ventilating hood, not less than 28 gage, with a clearance of not less than 1/4-inch between the hood and the underside of combustible material or cabinets. A clearance of at least 24-inches shall be maintained between the cooking surface and the combustible material or cabinet. The hood shall be at least as wide as the broiler unit and shall extend over the entire unit. Broiler units incorporating an integral exhaust system, and labeled for use without a ventilating hood, need not be provided with a ventilating hood.

SECTION M-1903 – OUTDOOR GAS COOKING APPLIANCES

Outdoor gas cooking appliances shall be labeled and shall be installed in accordance with the manufacturer's installation instructions. Outdoor gas cooking appliances shall conform to ANSI Z21.54 and Z21.58, as listed in Section S-26.1903.

SECTION M-1904 – CLOTHES DRYERS

M-1904.1 General: Gas clothes dryers shall be labeled and shall be installed in accordance with the manufacturer's installation instructions. Gas clothes dryers shall conform to ANSI Z21.5.1, as listed in Section S-26.1904.

M-1904.2 Closet installation: Gas clothes dryers installed in closets shall be labeled for such installations and no other fuel-burning appliance shall be installed in the same closet.

M-1904.3 Clothes dryer exhaust: Dryer vent systems shall be independent of all other systems and shall convey the products of combustion and moisture to the outdoors. Vents shall not be connected with sheet-metal screws or other fastening means which extend into the vent. Exhaust vents shall be equipped with a back-draft damper. All concealed vents shall be constructed of minimum 0.016-inch thick rigid metal ducts with joints running in the direction of air flow.

M-1904.3.1 Exhaust vent size: The minimum diameter of the exhaust vent shall be as recommended by the manufacturer or in accordance with Section M-1904.3.2, but shall not be less than the diameter of the appliance outlet.

M-1904.3.2 Length limitation: The maximum length of a 4-inch diameter exhaust vent shall not exceed 25-feet from the dryer location to wall or roof termination, and shall terminate with a full opening exhaust hood. A reduction in maximum length of 2.5-feet for each 45-degree bend and 5-feet for each 90-degree bend shall apply. For installations where this length limitation is exceeded, the maximum vent diameter shall be 5-inches.

SECTION M-1905 – WATER HEATERS

Water heaters shall be labeled and shall be installed in accordance with the manufacturer's installation instructions and Section P-2408 of this code.

SECTION M-1906 – VENTED DECORATIVE APPLIANCES

M-1906.1 General: Vented decorative appliances shall comply with other requirements of this code applying to gas heating equipment and heating appliances. Vented decorative appliances shall conform to ANSI Z21.50, as listed in Section S-26.1906.

M-1906.2 Installation: Vented decorative appliances shall be labeled and shall be installed in accordance with the manufacturer's installation instructions.

M-1906.3 Gas logs: Labeled gas logs shall be installed in solid-fuel burning fireplaces in accordance with the provisions of this section. Gas logs equipped with a pilot shall have a labeled safety shutoff valve.

M-1906.4 Combustion and circulating air: Combustion and circulating air shall be provided in accordance with Chapter 15.

SECTION M-1907 – GAS LIGHTS

M-1907.1 Clearances: Enclosed gas lights shall be labeled and shall be installed in accordance with the manufacturer's installation instructions.

M-1907.2 Mounting on buildings: Gas lights designed for wall or ceiling mounting shall be securely attached to substantial structures in such a manner that they are not dependent on the gas piping for support.

M-1907.3 Mounting on posts: Gas lights designed for post mounting shall be securely and rigidly attached to a post. Posts shall be rigidly mounted. The strength and rigidity of posts greater than 3-feet in height shall be at least equivalent to that of a 2-1/2-inch diameter post constructed of 14 gage steel, or 1-inch Schedule 40 steel pipe. Posts 3-feet or less in height shall not be smaller than a 3/4-inch Schedule 40 steel pipe. Drain openings shall be provided near the base of posts when there is a possibility of water collecting inside them.

M-1907.4 Gas appliance pressure regulator: When a gas appliance pressure regulator is not supplied with a gas light, a pressure regulator shall be installed in the service line of the line to the gas light. For multiple installations, one regulator used to serve several gas lights shall be of adequate capacity.

SECTION M-1908 – POOL HEATERS

M-1908.1 Location: Pool heaters shall be located or protected to guard against accidental contact of hot surfaces by persons.

M-1908.2 Clearances: In no case shall the clearances be such as to interfere with combustion air, draft hood or flue terminal relief, or accessibility for servicing.

M-1908.3 Temperature and pressure limiting devices: Pool heaters shall have relief valves, controls or devices to limit excessive temperature and pressure.

M-1908.4 Bypass valves: If an integral bypass system is not provided as a part of the pool heater, a bypass line and valve shall be installed between the inlet and outlet piping for use in adjusting the flow of water through the heater.

M-1908.5 Venting: Pool heaters shall be installed with the venting means supplied by the manufacturer and in accordance with the manufacturer's installation instructions. Pool heaters for indoor installations shall be vented in accordance with Chapter 16 of this code.

SECTION M-1909 – SAUNA HEATERS

M-1909.1 Locations and protection: Sauna heaters shall be protected from accidental contact by persons with a guard or barrier of material having a low thermal conductivity, such as wood. The guard shall have no substantial effect on the transfer of heat from the heater to the room.

M-1909.2 Installation: Sauna heaters shall be labeled and shall be installed in accordance with the manufacturer's installation instructions.

M-1909.3 Connection of gas-fired heaters: The provisions of Chapter 17 shall apply to gas connections. When access to controls is form an adjacent room, connections shall be made in that location.

M-1909.4 Combustion air: Combustion air for gas fired sauna heaters shall not be taken form inside the sauna room. Adequate combustion air and venting for a non-direct vent type heater shall be provided in accordance with Chapters 15 and 16, respectively.

M-1909.5 Controls: Sauna heaters shall be equipped with a thermostat that will limit room temperature to no greater than 194F. If the thermostat is not an integral part of the heater, the heat sensing element shall be located within 6-inches of the ceiling.

SECTION M-1910 – SOLAR ENERGY SYSTEMS

M-1910.1 General: This section provides for construction, installation, alteration, and repair of equipment and systems utilizing solar energy to provide space heating or cooling, hot water heating, and swimming pool heating.

M-1910.2 Installation

M-1910.2.1 Access: Solar energy collectors, controls, dampers, fans, blowers, and pumps shall be accessible for inspection, maintenance, repair, and replacement.

M-1910.2.2 Roof mounted collectors: The roof shall be constructed to support the loads imposed by roof mounted solar collectors. Roof mounted solar collectors that serve as a roof covering shall conform to the requirements for roof coverings in Chapter 8 of this code. When mounted on or above the roof coverings, the collectors and supportive structure shall be constructed of noncombustible materials or fire-retardant treated wood equivalent to that required for the roof construction.

M-1910.2.3 Pressure and temperature relief: System components containing fluids shall be protected against pressures and temperatures exceeding design limits with pressure and temperature relief valves. Relief devices shall be installed in sections of the system in which excessive temperatures or pressures may develop such that a section cannot be valved off or isolated form a relief device.

M-1910.2.4 Vacuum relief: System components that may be subjected to pressure drops below atmospheric pressure during operation or shutdown shall be designed to withstand the pressures, or shall be protected by a vacuum relief valve.

M-1910.2.5 Protection from freezing: System components shall be protected from damage by freezing of heat transfer liquids at the lowest ambient temperatures during operation.

M-1910.2.6 Expansion tanks: Expansion tanks in solar energy systems shall be installed in accordance with Section M-1303.

M-1910.2.7 Roof penetrations: All roof penetrations shall be adequately flashed and waterproofed in accordance with Chapter 8 of this code.

M-1910.3 Labeling

M-1910.3.1 Collectors: Collectors shall be labeled to show the manufacturer's name, model, serial number, collector weight, maximum allowable temperatures and pressures, and the type of heat transfer fluids allowed.

M-1910.3.2 Thermal storage units: Pressurized thermal storage units shall be labeled to show the manufacturer's name, model, serial number, maximum and minimum allowable operating temperatures and pressures, and the type of heat transfer fluids allowed.

M-1910.4 Prohibited heat transfer fluids: Flammable gases and liquids shall not be used as heat transfer fluids.

SECTION M-1911 – CNG RESIDENTIAL FUELING FACILITIES

Residential fueling facilities for compressed natural gas vehicular fuel systems shall be installed in accordance with NFiPA 52, as listed in Section S-26.1911.

Part V – Plumbing

Chapter 20
GENERAL PLUMBING REQUIREMENTS AND DEFINITIONS

SECTION P-2001 – GENERAL

P-2001.1 Application: The provisions of this part shall establish the general scope of the plumbing system and equipment requirements of this code and the definitions of terms related thereto. The use of materials or methods of construction not specified in this chapter accomplishing the purposes intended by this code and approved by the building official in accordance with Section R-108 shall be accepted as complying with this code. Plumbing materials and systems shall conform to the provisions of this chapter, Chapters 21 through 25 and the standards specified in Table No. P-2001.1, as applicable.

Table No. P-2001.1
PLUMBING STANDARDS
(As listed in Section S-26.2001)

ANSI A112.1.2	ASME/ANSI A112.19.8M
ANSI B16.12	ASME/ANSI A112.21.1M
ANSI B16.22	ASME/ANSI B16.3
ANSI B16.26	ASME/ANSI B16.4
ANSI Z21.10.1	ASME/ANSI B16.15
ANSI Z21.10.3	ASME/ANSI B16.29
ANSI Z21.12	ASSE/ANSI 1001
ANSI Z21.13	ASSE/ANSI 1002
ANSI Z21.22	ASSE/ANSI 1003
ANSI Z21.24	ASSE/ANSI 1006
ANSI Z21.41	ASSE/ANSI 1007
ANSI Z21.45	ASSE/ANSI 1008
ANSI Z124.1	ASSE/ANSI 1010
ANSI Z124.2	ASSE/ANSI 1011
ANSI Z124.3	ASSE/ANSI 1014
ANSI Z124.4	ASSE/ANSI 1016
ANSI Z124.6	ASSE/ANSI 1019
ANSI/NSF 14	ASSE/ANSI 1023
ASME A112.18.1M	ASSE/ANSI 1025
ASME B16.18	ASSE/ANSI 1037
ASME B16.23	ASTM A53
ASME/ANSI A112.19.1M	ASTM A74
ASME/ANSI A112.19.2M	ASTM A126
ASME/ANSI A112.19.3M	ASTM A197
ASME/ANSI A112.19.4M	ASTM A377
ASME/ANSI A112.19.5	ASTM A525
ASME/ANSI A112.19.6	ASTM B32
ASME/ANSI A112.19.7M	

(Continued)

Table No. P-2001.1 *(Continued)*
PLUMBING STANDARDS
(As listed in Section S-26.2001)

ASTM B43	ASTM D2672
ASTM B75	ASTM D2737
ASTM B88	ASTM D2751
ASTM B135	ASTM D2846
ASTM B152	ASTM D2949
ASTM B306	ASTM D3000
ASTM B447	ASTM D3034
ASTM C14	ASTM D3212
ASTM C425	ASTM D3122
ASTM C564	ASTM D3261
ASTM C700	ASTM D3309
ASTM D1527	ASTM F402
ASTM D1785	ASTM F409
ASTM D1861	ASTM F438
ASTM D2104	ASTM F439
ASTM D2235	ASTM F441
ASTM D2239	ASTM F442
ASTM D2241	ASTM F493
ASTM D2282	ASTM F628
ASTM D2321	ASTM F656
ASTM D2447	ASTM F845
ASTM D2466	ASTM F891
ASTM D2467	CISPI HS 74
ASTM D2468	CISPI HSN
ASTM D2564	CISPI 301
ASTM D2609	CSA B602M
ASTM D2661	FS QQ-L-201f-2
ASTM D2662	UL 174
ASTM D2665	UL441
ASTM D2666	UL 726
	UL 732

P-2001.2 Connection: Plumbing fixtures, drains and appliances used to receive or discharge liquid wastes or sewage shall be connected to the drainage system of the building or premises in accordance with the requirements of this code.

P-2001.3 Existing systems: Where existing plumbing installations are to be altered or repaired, necessary deviations may be permitted, provided such deviations conform to the intent of the code and are first approved by the building official.

SECTION P-2002—INDIVIDUAL WATER SUPPLY AND SEWAGE DISPOSAL

The water-distribution and drainage system of any building or premises where plumbing fixtures are installed shall be connected to a public water-supply or sewer system, respectively, if available. Where

either a public water-supply or sewer system, or both, are not available, or connection thereto is not feasible, an individual water-supply or individual (private) sewage-disposal system, or both, shall be provided.

SECTION P-2003 – STRUCTURAL AND PIPING PROTECTION

P-2003.1 General: In the process of installing or repairing any part of a plumbing and drainage installation, the finished floors, walls, ceilings, tile work or any other part of the building or premises which must be changed or replaced shall be left in a safe structural condition in accordance with the requirements of the building portion of this code.

P-2003.2 Drilling and notching: Wood-framed structural members shall not be drilled, notched or altered in any manner except as provided in Sections R-402.5, R-402.5.1, R-602.5, R-602.6, R-702.5 and R-702.6.

P-2003.3 Breakage and corrosion: Pipes passing under or through walls shall be protected from breakage. Pipes passing through or under cinder or concrete or other corrosive material shall be protected against external corrosion by protective coating, wrapping or other means which prevent such corrosion.

P-2003.4 Sleeves: Annular spaces between sleeves and pipes shall be filled or tightly caulked as approved by the administrative authority.

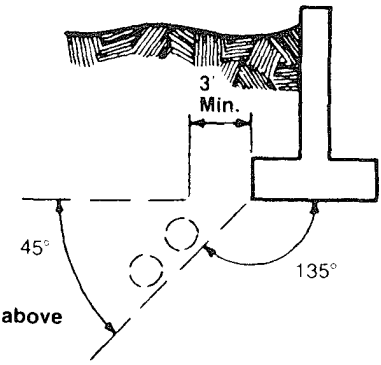
Annular spaces between sleeves and pipes in fire-rated assemblies shall be filled or tightly caulked in accordance with the building portion of this code.

P-2003.5 Pipes through footings or foundation walls: A soil or waste pipe, or building drain passing under a footing or through a foundation wall shall be provided with a relieving arch; or there shall be built into the masonry wall an iron pipe sleeve two pipe sizes greater than the pipe passing through as may be approved by the administrative authority.

P-2003.6 Freezing: Water, soil or waste pipe shall not be installed or permitted outside of a building or in an exterior wall unless adequate provision is made to protect such pipe from freezing where necessary.

P-2003.7 Depth: Piping installed deeper than and parallel to footings or bearing walls shall be 45 degrees therefrom (see Figure No. P-2003.7) except as may be approved by the administrative authority.

Figure No. P-2003.7
PIPE LOCATION WITH RESPECT TO FOOTINGS



P-2003.8 Waterproofing of openings: Joints at the roof, around vent pipes, shall be made water-tight by the use of lead, copper, galvanized iron or other approved flashings or flashing material or approved elastomeric material. Exterior wall openings shall be made water-tight.

SECTION P-2004 – EXCAVATIONS

Excavations required for the installation of a building drainage system shall be open trench work and shall be kept open until the piping has been inspected, tested and approved.

SECTION P-2005 – SUPPORT

Support for piping shall be provided in accordance with the following:

1. Piping shall be supported so as to ensure alignment and prevent sagging.
2. Piping in the ground shall be laid on a firm bed for its entire length, except where support is otherwise provided.
3. Hangers and anchors shall be of sufficient strength to maintain their proportional share of the weight of pipe and contents.
4. Piping shall be supported at distances not to exceed those indicated in Table No. P-2005.

Table No. P-2005
PIPING SUPPORT

PIPE MATERIAL	MAXIMUM HORIZONTAL SPACING	MAXIMUM VERTICAL SPACING
Cast-iron soil pipe	5′ except may be 10′ where 10′ lengths of pipe are installed.	Base and each story height but not to exceed 15′0″
Threaded-steel pipe	¾″ diameter and under—10′0″ 1″ diameter and over—12′0″	15′0″
Copper tube and copper pipe	1¼″ diameter and under—6′0″ 1½″ diameter and over—10′0″	Each story height but not to exceed 10′0″
Lead pipe	Continuous support	4′0″
Plastic pipe (DWV)	4′0″	Each story height and piping shall have a midstory guide.
Plastic pipe and tube, hot- and cold-water, rigid	3′0″	Each story height and piping shall have a midstory guide.
Plastic pipe and tube, hot- and cold-water, flexible	32″	Each story height and piping shall have a midstory guide.

SECTION P-2006 – JOINTS AND CONNECTIONS

Pipe-joint compound used on threads shall be insoluble materials compatible with the type of service.

SECTION P-2007 – MORTAR

Rigid mortar or similar joints shall not be used with concrete or clay building sewers.

SECTION P-2008 – SLIP JOINTS

In drainage piping, slip joints may be used on both sides of the trap and in the trap seal. Slip joints in water piping may be used on the exposed fixture supply only. All slip joints shall be accessible.

SECTION P-2009 – GROUND, FLARED, FERRULE

Brass or copper ground joint, flared or ferrule-type connections which allow adjustment of tubing, but provide a rigid joint when made up, shall not be considered as slip joints.

SECTION P-2010 – UNIONS

Approved unions may be used in drainage work when accessibly located in the trap seal or between a fixture and its trap, in the vent system, except underground or in wet vents, and at any point in the water-supply system.

SECTION P-2011 – FLANGED CONNECTIONS

Fixture connections between drainage pipes, water closets and similar fixtures shall be made by means of approved flanges. The connection shall be bolted with an approved gasket, washer or setting compound between the fixtures and the flange. The floor flange shall be set on the finish floor and fastened to an approved firm base.

Bends or stubs shall be cut off so as to present a smooth surface level with the top of the flange. The flange shall be inspected before the fixture is set.

SECTION P-2012 – WATERPROOFING OF OPENINGS

Roof and exterior wall penetrations shall be made water-tight. Counterflashing shall not restrict the required internal cross-sectional area of any vent.

SECTION P-2013 – WORKMANSHIP

Valves, pipes and fittings shall be installed in correct relationship to the direction of the flow.

Burred ends shall be reamed to the full bore of the pipe.

SECTION P-2014 – INSPECTION AND TESTS

P-2014.1 Inspection required: New plumbing work and parts of existing systems affected by new work or alterations shall be inspected by the administrative authority to ensure compliance with the requirements of this code.

P-2014.2 Concealment: A plumbing or drainage system, or part thereof, shall not be covered, concealed or put into use until it has been tested, inspected and approved by the administrative authority.

P-2014.3 Responsibility of permittee: Test equipment, materials and labor shall be furnished by the permittee.

SECTION P-2015 – BUILDING SEWERS

Building sewers shall be tested by plugging the ends and filling the sewer with water from the lowest to the highest point thereof, or by such other test as may be accepted by the administrative authority. The building sewer shall be water-tight.

SECTION P-2016 – DEFINITIONS

For the purpose of the plumbing requirements, the following terms shall be defined as follows and as set forth in Section R-115:

Accessible and readily accessible: "Accessible" means having access thereto but which first may require opening an access panel, door or similar obstruction. "Readily accessible" means direct access without the use of tools for removing or moving any such obstruction.

Administrative authority: The individual official, board, department or agency established and authorized by a state, county, city or other political subdivision created by law to administer and enforce the provisions of this code as adopted or amended.

Air admittance valve: A one-way valve designed to allow air into the plumbing drainage system when a negative pressure develops in the piping. This device shall close by gravity and seal the terminal under conditions of positive internal pressure.

Air break, drainage system: An arrangement in which a discharge pipe from a fixture, appliance or device drains indirectly into a receptor below the flood-level rim of the receptor.

Air gap, drainage system: The unobstructed vertical distance through free atmosphere between the outlet of a waste pipe and the flood-level rim of the fixture or receptor into which it is discharging.

Air gap, water-distribution system: The unobstructed vertical distance through free atmosphere between the lowest opening from a water supply discharge to the flood-level rim of a plumbing fixture.

Anchors: See "Supports."

Antisiphon: A term applied to valves or mechanical devices that eliminate siphonage.

Approved: "Approved" refers to approval by the building official as the result of investigation and tests conducted by him or her or by reason of accepted principles or tests by nationally recognized organizations.

Backflow, drainage: A reversal of flow in the drainage system.

Backflow preventer: A device or means to prevent backflow.

Backflow preventer, reduced-pressure-zone type: A backflow-prevention device consisting of two independently acting check valves, internally force loaded to a normally closed position and separated by an intermediate chamber (or zone) in which there is an automatic relief means of venting to atmosphere internally loaded to a normally open position between two tightly closing shutoff valves and with means for testing for tightness of the checks and opening of relief means.

Backflow, water distribution: The flow of water or other liquids into the potable water-supply piping from any sources other than its intended source. Back-siphonage is one type of backflow.

Back-siphonage: The flowing back of used or contaminated water from piping into a potable water-supply pipe due to a negative pressure in such pipe.

Backwater valve: A device installed in a drain or pipe to prevent backflow of sewage.

Ball cock: A valve that is used inside a gravity-type water closet flush tank to control the supply of water into the tank. It may also be called a flush-tank fill valve or water control.

Bend: A drainage fitting, designed to provide a change in direction of a drain pipe of less than the angle specified by the amount necessary to establish the desired slope of the line (see "Elbow" and "Sweep").

Branch: Any part of the piping system other than a riser, main or stack.

Branch, fixture: See "Fixture branch, drainage."

Branch, horizontal: See "Horizontal branch, drainage."

Branch interval: A distance along a soil or waste stack corresponding to a story height, but not less than 8 feet, within which the horizontal branches from one floor or story of a building are connected to the stack.

Branch main: A water-distribution pipe which extends horizontally off a main or riser to convey water to branches or fixture groups.

Branch vent: A vent connecting two or more individual vents with a vent stack or stack vent.

Building drain: The lowest piping that collects the discharge from all other drainage piping inside the house and conveys it to the building sewer, 3-feet outside the building wall.

Building sewer: That part of the drainage system which extends from the end of the building drain and conveys its discharge to a public sewer, private sewer, individual sewage-disposal system, or other point of disposal.

Cleanout: An accessible opening in the drainage system used for the removal of possible obstruction.

Common vent: A single pipe venting two trap arms within the same branch interval, either back-to-back or one above the other.

Continuous waste: A drain from two or more similar adjacent fixtures connected to a single trap.

Cross connection: Any connection between two otherwise separate piping systems whereby there may be a flow from one system to the other.

Dead end: A branch leading from a DWV system terminating at a developed length of 2 feet or more. Dead ends shall be prohibited except as an approved part of a rough-in for future connection.

Developed length: The length of a pipeline measured along the center line of the pipe and fittings.

Diameter: Unless specifically stated, the term "diameter" is the nominal diameter as designated by the approved material standard.

Drain: Any pipe which carries soil and water-borne wastes in a building drainage system.

Drainage fitting: A pipe fitting designed to provide connections in the drainage system which have provisions for establishing the desired slope in the system. These fittings are made from a variety of both metals and plastics. The methods of coupling provide for required slope in the system (see "Durham fitting").

Durham fitting: A special type of drainage fitting for use in the "Durham Systems" installations in which the joints are made with recessed and tapers screw fittings, as opposed to bell and spigot lead/oakum or solvent/cemented or soldered joints. The tapping is at an angle (not 90 degrees) to provide for proper slope in otherwise rigid connections.

Durham system: A term used to describe soil or waste systems where all piping is of threaded pipe, tube or other such rigid construction using recessed drainage fittings to correspond to the types of piping.

DWV: Abbreviated term for drain, waste and vent piping as used in common plumbing practice.

Effective opening: The minimum cross-sectional area at the point of water-supply discharge, measured or expressed in terms of (1) diameter of a circle, (2) if the opening is not circular, the diameter of a circle of equivalent cross-sectional area. (This is applicable to air gap.)

Elbow: A pressure pipe fitting designed to provide an exact change in direction of a pipe run. An elbow provides a sharp turn in the flow path (see "Bend" and "Sweep").

Equivalent length: For determining friction losses in a piping system, the effect of a particular fitting equal to the friction loss through a straight piping length of the same nominal diameter. See Table No. E.1, Appendix E.

Existing work: Existing work is a plumbing system or any part thereof which has been installed prior to the effective date of this code.

Fixture: See "Plumbing fixture."

Fixture branch, drainage: A drain serving one or more fixtures which discharges into another portion of the drainage system.

Fixture branch, water-supply: A water-supply pipe between the fixture supply and a main water-distribution pipe or fixture group main.

Fixture drain: The drain from the trap of a fixture to the junction of that drain with any other drain pipe.

Fixture fitting: Any device to control or guide the flow of water into or convey water from fixtures.

Fixture group main: The main water-distribution pipe (or secondary branch) serving a plumbing fixture grouping such as a bath, kitchen or laundry area to which two or more individual fixture branch pipes are connected.

Fixture supply: The water-supply pipe connecting a fixture or fixture fitting to a fixture branch.

Fixture unit, drainage (d.f.u.): A measure of probable discharge into the drainage system by various types of plumbing fixtures, used to size DWV piping systems. The drainage fixture-unit value for a particular fixture depends on its volume rate of drainage discharge, on the time duration of a single drainage operation, and on the average time between successive operations. See Table No. P-2205.

Fixture unit, water-supply (w.s.f.u.): A measure of the probable hydraulic demand on the water supply by various types of plumbing fixtures, used to size water-piping systems. The water-supply fixture-unit value for a particular fixture depends on its volume rate of supply, on the time duration of a single supply operation, and on the average time between successive operations. See Table No. P-2409.2.

Flood-level rim: The edge of the receptor or fixture from which water overflows.

Floor drain: A plumbing fixture for recess in the floor having a floor-level strainer intended for the purpose of the collection and disposal of waste water used in cleaning the floor and for the collection and disposal of accidental spillage to the floor.

Flow pressure: The static pressure reading in the water-supply pipe near the faucet or water outlet while the faucet or water outlet is open and flowing at capacity.

Flushometer tank: A device integrated within an air accumulator vessel which is designed to discharge a predetermined quantity of water to fixtures for flushing purposes.

Flushometer valve: A flushometer valve is a device which discharges a predetermined quantity of water to fixtures for flushing purposes and is actuated by direct water pressure.

Flush valve: A device located at the bottom of a flush tank that is operated to flush water closets.

Fullway valve: A valve that in the full open position has an opening cross-sectional area equal to a minimum of 85 percent of the cross-sectional area of the connecting pipe.

Grade, piping: See "Slope."

Hangers: See "Supports."

Horizontal branch, drainage: A drain pipe extending laterally from a soil or waste stack or building drain, which receives the discharge from one or more fixture drains.

Horizontal pipe: Any pipe or fitting which makes an angle of less than 45 degrees with the horizontal.

Hot water: Water that is supplied to plumbing fixtures and appliances at a temperature between 120 degrees F. and 140 degrees F.

Indirect waste pipe: A waste pipe which discharges into the drainage system through an air gap into a trap, fixture or receptor.

Individual sewage disposal system: A system for disposal of sewage by means of a septic tank or mechanical treatment, designed for use apart from a public sewer to serve a single establishment or building.

Individual vent: A pipe installed to vent a single-fixture drain that connects with the vent system above or terminates independently outside the building.

Individual water supply: A supply other than an approved public water supply which serves one or more families.

Main: The principal pipe artery to which branches may be connected.

Main sewer: See "Public sewer."

Manifold water distribution systems: A fabricated piping arrangement in which a large supply main is fitted with multiple branches in close proximity in which water is distributed separately to fixtures from each branch.

Offset: A combination of fittings which makes two changes in direction bringing one section of the pipe out of line but into a line parallel with the other section.

Pitch: See "Slope."

Plumbing: For the purpose of this code, plumbing refers to those installations, repairs, maintenance and alterations regulated by this part.

Plumbing appliance: An energized household appliance with plumbing connections, such as a dishwasher, food-waste grinder, clothes washer or water heater.

Plumbing appurtenance: A device or assembly which is an adjunct to the basic plumbing system and demands no additional water supply nor adds any discharge load to the system. It is presumed that it performs some useful function in the operation, maintenance, servicing, economy or safety of the plumbing system. Examples include filters, relief valves and aerators.

Plumbing fixture: A receptor or device which requires both a water-supply connection and a discharge to the drainage system, such as water closets, lavatories, bathtubs and sinks. Plumbing appliances as a special class of fixture are further defined.

Plumbing system: Includes the water supply and distribution pipes, plumbing fixtures, supports and appurtenances; soil, waste and vent pipes; sanitary drains and building sewers to an approved point of disposal.

Potable water: Water that is safe to drink.

Pressure-relief valve: A pressure-actuated valve held closed by a spring or other means and designed to automatically relieve pressure at the pressure at which it is set.

Public sewer: A common sewer directly controlled by public authority.

Public water main: A water-supply pipe for public use controlled by public authority.

Quick-closing valve: A valve or faucet that closes automatically when released manually or controlled by mechanical means for fast-action closing.

Receptor: A fixture or device which receives the discharge from indirect waste pipes.

Relief valve, pressure: A safety device that automatically releases water from a supply system due to an excess build-up of pressure.

Relief valve, vacuum: A device to prevent excessive build-up of vacuum in a pressure vessel.

Riser: A water pipe which extends vertically one full story or more to convey water to branches or to a group of fixtures.

Rough-in: The installation of all parts of the plumbing system which must be completed prior to the installation of fixtures. This includes DWV, water supply and built-in fixture supports.

Sanitary sewer: A sewer which carries sewage and excludes storm, surface and groundwater.

Septic tank: A water-tight receptor which receives the discharge of a building sanitary drainage system and is constructed so as to separate solids from the liquid, digest organic matter through a period of detention, and allow the liquids to discharge into the soil outside of the tank through a system of open joint or perforated piping or a seepage pit.

Sewage: Any liquid waste containing animal matter, vegetable matter or other impurity in suspension or solution.

Sewage pump: A permanently installed mechanical device for removing sewage or liquid waste from a sump.

Shall: The term, when used in the code, is construed as mandatory.

Side vent: A vent connecting to the drain pipe through a fitting at an angle less than 45 degrees to the horizontal.

Slip joint: A mechanical-type joint used primarily on fixture traps. The joint tightness is obtained by compressing a friction-type washer such as

rubber, nylon, neoprene, lead or special packing material against the pipe by the tightening of a (slip) nut.

Slope (also fall, grade, pitch): The fall of a line of pipe in reference to a horizontal plane. In plumbing, it is expressed as the fall in a fraction of an inch per length of pipe.

Soil stack (or pipe): A pipe which conveys sewage containing fecal material.

Stack: Any main vertical DWV line, including offsets, that extends one or more stories as directly as possible to its vent terminal.

Stack vent: The extension of soil or waste stack above the highest horizontal drain connected.

Stack venting: A method of venting a fixture or fixtures through the soil or waste stack without individual fixture vents.

Storm sewer (drain): A pipe used for conveying rainwater, surface water, condensate, cooling water or similar liquid wastes.

Sump: A tank or pit which receives sewage or waste, located below the normal grade of the gravity system and which must be emptied by mechanical means.

Sump pump: A pump installed to empty a sump. The pump is chosen to handle the type material to be pumped — either clear water waste or soil-type sewage. The pump is selected for the specific head and volume of the load and is usually operated by level controllers.

Supports: Devices for supporting, hanging and securing pipes, fixtures and equipment.

Sweep: A drainage fitting designed to provide a change in direction of a drain pipe of less than the angle specified by the amount necessary to establish the desired slope of the line. Sweeps provide a longer turning radius than bends and a less turbulent flow pattern (see "Bend" and "Elbow").

Temperature- and pressure-relief (T and P) valve: A combination relief valve designed to function as both a temperature-relief and pressure-relief valve.

Temperature-relief valve: A temperature-actuated valve designed to automatically discharge at the temperature at which it is set.

Trap: A fitting, either separate or built into a fixture, which provides a liquid seal to prevent the emission of sewer gases without materially affecting the flow of sewage or waste water through it.

Trap arm: That portion of a fixture drain between a trap weir and the vent fitting.

Trap primer: A device or system of piping to maintain a water seal in a trap, typically installed where infrequent use of the trap would result in evaporation of the trap seal, such as floor drains.

Trap seal: The trap seal is the maximum vertical depth of liquid that a trap will retain, measured between the crown weir and the top of the dip of the trap.

Vacuum breakers: A device which prevents back-siphonage of water by admitting atmospheric pressure through ports to the discharge side of the device.

Vent stack: A vertical vent pipe installed to provide circulation of air to and from the drainage system and which extends through one or more stories.

Vent system: Piping installed to equalize pneumatic pressure in a drainage system to prevent trap seal loss or blow-back due to siphonage or back pressure.

Vertical pipe: Any pipe or fitting which makes an angle of 45 degrees or more with the horizontal.

Waste: Liquid-borne waste free of fecal matter.

Waste pipe (or stack): Piping which conveys only liquid sewage not containing fecal material.

Water-distribution system: Piping which conveys water from the service to the plumbing fixtures, appliances, appurtenances, equipment, devices or other systems served, including fittings and control valves.

Water heater: A closed vessel in which water is heated by the combustion of fuels, electricity or any other source and is withdrawn for use external to the vessel at pressures not exceeding 160 psig, including the apparatus by which heat is generated, and all controls and devices necessary to prevent water temperatures from exceeding 210 degrees F. Note that Section P-2403.2 limits the maximum average static pressure of the water distribution system to 80 psig.

Water main: A water-supply pipe for public use.

Water outlet: A valved discharge opening, including a hose bibb, through which water is removed from the potable water system supplying water to a plumbing fixture or plumbing appliance which requires either an air gap or backflow prevention device for protection of the supply system.

Water-service pipe: The outside pipe from the water main or other source of potable water supply to the water-distribution system inside the building, terminating at the service valve.

Water-supply system: The water-service pipe, the water-distributing pipes and the necessary connecting pipes, fittings, control valves and all appurtenances in or adjacent to the building or premises.

Wet vent: A vent which also receives the discharge of wastes from other fixtures.

Chapter 21
PLUMBING MATERIALS

SECTION P-2101 — ABOVE GROUND WATER DISTRIBUTION PIPING

Materials for water-distribution pipes and tubing shall be brass, copper water tube minimum Type M, cast-iron pressure pipe, galvanized steel, chlorinated polyvinyl chloride (CPVC) or polybutylene (PB) plastic pipe or tubing, all to be installed with approved fittings. The minimum pressure rating for plastic pipe or tubing shall be 100 psi at 180 degrees F.

SECTION P-2102 — MATERIALS EVALUATION AND LISTING

All plastic pipes, plastic plumbing pipe components and related plastic materials shall be evaluated and listed as conforming to ANSI/NSF Standard 14, listed in Section S-26.2001, by and approved agency. The approved agent shall maintain periodic evaluations of production of listed products or materials, and their listing shall state that the products or materials meet ANSI/NSF Standard 14.

Chapter 22
PLUMBING, DRAINAGE, WASTE AND VENT SYSTEMS (DWV)

SECTION P-2201 – GENERAL

Plumbing materials shall conform to the requirements of this chapter. The drainage waste and vent (DWV) system shall consist of all piping for conveying wastes from plumbing fixtures, appliances and appurtenances, including fixture traps; above-grade drainage piping; below-grade drains within the building (building drain); below- and above-grade venting systems; and piping to the public sewer or private septic system. No portion of the above-grade DWV system other than vent terminals shall be located outdoors, except in those localities having minimum design temperatures above 32 degrees F. (ASHRAE 97.5 percent column, winter, see Appendix A).

SECTION P-2202 – MATERIALS

P-2202.1 Piping within buildings: Drain, waste and vent (DWV) piping in buildings shall be as shown in Table P-2202.1 or other approved materials having a smooth and uniform bore, except that no galvanized wrought-iron or galvanized steel pipe shall be used underground and shall be kept at least 6 inches above ground. *

P-2202.2 Building sewer: Building sewer piping shall be as shown in Table P-2202.2.

P-2202.3 Fittings: Fittings shall be approved and compatible with the type of piping being used and shall be of a sanitary or DWV design for drainage and wet venting. Waterpipe fittings may be accepted for use in engineer designed systems when the design indicates compliance with Section P-2207.2.1.

Drainage fittings shall have a smooth interior waterway of the same diameter as the piping served. All fittings shall conform to the type of pipe used.

Drainage fittings shall have no ledges, shoulders or reductions which can retard or obstruct drainage flow in the piping. Threaded drainage pipe fittings retard or obstruct drainage flow in the piping. Threaded drainage pipe fittings shall be of the recessed drainage type, black or galvanized.

Drainage fittings shall be designed to maintain 1/4-inch-per-foot grade.

P-2202.4 Other Materials

P-2202.4.1 Sheet lead: Sheet lead for the following uses shall weigh not less than indicated below:

1. Shower pans, 4 psf.
2. Flashing of vent terminals, 3 psf.
3. Prefabricated flashing for vent pipes, 2 1/2 psf.

P-2202.4.2 lead bends and traps: Lead bends and lead traps shall be not less than 1/8-inch wall thickness.

P-2202.4.3 Sheet copper: Sheet copper for the following uses shall weigh not less than indicated below:

1. General use, 12 oz per sq ft.
2. Flashing for vent pipes, 8 oz per sq ft.
3. Flush tank linings, 10 oz per sq ft.

Table No. P-2202.1
DRAIN, WASTE AND VENT PIPING AND FITTING MATERIALS[1]
(As listed in Section S-26.2001)

MATERIAL	STANDARD NO.
Welded and Seamless Steel Pipe (black or galvanized[1])	ASTM A53-88a
Cast Iron Soil Pipe and Fittings (hub and spigot)	ASTM A74-87
Cast Iron Fittings (Threaded)	ASTM A126-84
Malleable Iron Fittings (Threaded)	ASTM A197-87
Seamless Copper Pipe, standard sizes	ASTM B42-89
Seamless Red Brass Pipe, standard sizes	ASTM B43-88
Seamless Copper Tube	ASTM B75-86
Seamless Copper Water Tube Type K, L, and M	ASTM B88-88a
ABS-DWV Pipe and Fittings	ASTM D2661-87a
PVC-DWV Pipe and Fittings	ASTM D2665-89a
ABS Sewer Pipe and Fittings	ASTM D2751-83a
3.25-inch O.D. PVC-DWV Pipe and Fittings	ASTM D2949-89
Thermo-Plastic Accessible and Replaceable Plastic Tube and Fittings	ASTM F409-88
ABS-DWV SCH.40 Pipe with Cellular Core	ASTM F628-88
Co-extruded PVC Plastic Pipe with Cellular Core	ASTM F891-88a
Cast Iron Soil Pipe and Fittings (hub and spigot)	CISPI HS74-86
Cast Iron Soil Pipe and Fittings (hubless)	CISPI 301-85
Cast Copper Alloy Solder-Joint Drainage Fittings	ASME B16.23-84
Copper Drainage Tube (DWV)	ASTM B306-88
Mechanical Couplings for Drain, Waste and Vent Pipe and Sewer Pipe	CSA B602M-90

[1]Section P-2001.1 provides for use of other approved materials in accordance with Section R-108.

Table No. P-2202.2
BUILDING SEWER PIPING[1]
(As listed in Section S-26.2001)

MATERIAL	STANDARD NO.
Cast Iron Pipe and Fittings	ASTM A74-87
Cast Iron Pipe and Fittings	CISPI HS74-86
Cast Iron Soil Pipe and Fittings for Hubless Sanitary System	CISPI 301-85
Seamless Copper Tube	ASTM B75-88
Copper Water Tube	ASTM B88-88a
Concrete Sewer, Storm Drain and Culvert Pipe	ASTM C14-88
Compression Joints for Vitrified Clay Pipe and Fittings	ASTM C425-88
Vitrified Clay Pipe and Fittings	ASTM C700-88
Bituminized Fiber Drain and Sewer Pipe	ASTM D1861-88
Recommended Practice for Underground Installation of Flexible Thermoplastic Sewer Pipe	ASTM D2321-83a
ABS-DWV Pipe and Fittings	ASTM D2661-87a
PVC/DWV Pipe and Fittings	ASTM D2665-89a
ABS Sewer Pipe and Fittings	ASTM D2751-83a
3.25 O.D. PVC/DWV Pipe and Fittings	ASTM D2949-89
Type PSM/PVC Sewer Pipe and Fittings	ASTM D3034-89
Joints for Drain and Sewer Plastic Pipe Using Flexible Elastomeric Seals	ASTM D3212-89
ABS Schedule 40 DWV Pipe with Cellular Cor	ASTM F628-88
Co-extruded PVC Schedule 40, PS 50 or PS 100 Plastic Pipe with Cellular Cor	ASTM F891-88a
Copper Drainage Tube (DWV)	ASTM B306-88
Mechanical Couplings for Drain Waste and Vent Pipe and Sewer Pipe	CSA B602m-90

[1]Section P-2001.1 provides for use of other approved materials in accordance with Section R-108.

SECTION P-2203—JOINTS AND CONNECTIONS

P-2203.1 Tightness: Joints and connections in the DWV system shall be gas-tight and water-tight for the intended use or pressure required by test.

P-2203.2 Prohibited joints: In new construction, no running threads, bands or saddles shall be used in the drainage system. No drainage or vent piping shall be drilled, tapped, burned or welded.

Exception: This requirement may be waived in remodeling where no practical alternative exists.

P-2203.3 Joint requirements, similar piping materials

P-2203.3.1 Cast-iron pipe, caulked joints: Lead-caulked joints for cast-iron hub and spigot soil pipe shall be firmly packed with oakum and filled with molten lead not less than 1 inch deep and shall not extend more than 1/8 inch below the rim of the hub. Lead shall be run in one pouring and shall be caulked tight.

P-2203.3.2 Cast-iron pipe, mechanical joints

P-2203.3.2.1 Hubless pipe: Joints for hubless cast-iron soil pipe shall be made with an approved elastomeric sealing sleeve and stainless steel retaining sleeve.

P-2203.3.2.2 Hub and spigot joints: An approved positive-seal one-piece elastomeric compression-type gasket that is placed in the hub before the spigot is inserted may be used for joining hub and spigot cast-iron soil piping and fittings as an alternate for lead and oakum joints.

P-2203.3.3 Threaded pipe joints: Threaded joints shall conform to American National Taper Pipe Thread. Pipe ends shall be reamed or filed to size and all chips removed.

P-2203.3.4 Soldered joints: Soldered joints in tubing shall be made with fittings approved for DWV piping. Surfaces to be soldered shall be cleaned bright. The joints shall be properly fluxed and made with approved solder.

P-2203.3.5 Clay or cement soil pipe joints: Joints in clay or cement piping shall be made using flexible compression joints, elastomeric rings, preformed bituminous rings, elastomeric couplings, oakum and cement or other approved methods.

P-2203.3.6 Plastic pipe joints: Joints in plastic piping shall be made with approved fittings by solvent cementing, elastomeric gaskets or other approved manufactured system.

P-2203.3.7 Slip joints: Slip joints shall be made using approved gaskets or compression washers. Ground joint connections which allow adjustment of tubing but provide a rigid joint when made up shall not be considered as slip joints. Where a ground joint connection is used and the assembled joint does not permit free movement, the joint need not be accessible.

P-2203.4 Joints between different piping materials

P-2203.4.1 Hub-type cast-iron or vitrified clay to other piping materials: Joints between hub-type drainage piping and other materials, including steel, plastic and copper, may be made with a lead and oakum joint and an approved caulking ferrule of the other material or by a lead and oakum joint directly with the other material omitting the adapter ferrule. Where the outside diameter of the other material matches that of the hub pipe, an elastomeric gasket designed for use with the hub pipe may be used.

P-2203.4.2 Hubless pipe to other hubless piping materials: Joints between hubless drainage piping of any dissimilar materials with similar outside diameters may be made with elastomeric sleeve and stainless steel clamp.

P-2203.4.3 Threaded pipe to cast-iron soil pipe: Joints between threaded pipe and cast-iron soil pipe shall be made with approved adapter fittings.

P-2203.4.4 Threaded pipe to copper or plastic pipe: Joints from threaded pipe to copper or plastic piping shall be as approved by the administrative authority.

P-2203.4.5 Joints between drainage piping and water closets: Joints between drainage piping and water closets or similar fixtures shall be made by means of a closet flange compatible with the drainage system

material, securely fastened to a structurally firm base. The inside diameter of the drainage pipe shall not be used as a socket fitting for a 4 x 3 closet flange. The joint shall be bolted, with an approved gasket or setting compound between the fixture and the closet flange.

P-2203.4.6 Flexible adapter fittings: Where a dry vent size is smaller than the drain to which it connects, the reduction may be accomplished by means of an approved elastomeric flexible adapter fitting.

SECTION P-2204 TRENCHING AND BACKFILLING

P-2204.1 Trenching and bedding: Piping shall be installed in trenches so that it rests on solid and continuous bearing. Where overexcavated, the trench shall be backfilled to the proper grade with compacted earth, sand, fine gravel or similar granular material. Piping may not be supported on rocks or blocks at any point. Rocky or unstable soil shall be overexcavated by two or more pipe diameters and brought to the proper grade with suitable compacted granular material.

P-2204.2 Common trench: See Section P-2403.5.1.

P-2204.3 Backfilling: Care shall be exercised in backfilling trenches to avoid rocks, broken concrete, frozen chunks and other rubble until the pipe is covered by at least 12 inches of tamped earth. Backfill shall be placed evenly on both sides of the pipe and tamped to retain proper alignment. Loose earth shall be carefully placed in the trench in 6-inch layers and tamped in place. On private property, puddling of deep trenches is a satisfactory alternate means of obtaining compaction once the pipe has been properly laid, backfilled and tamped to a point 6 inches above the pipe.

P-2204.4 Protection of footings: Trenching installed parallel to footings shall not extend below the 45-degree bearing plane of the bottom edge of a wall or footing.

SECTION P-2205 – DETERMINING DRAINAGE FIXTURE UNITS

The load on DWV-system piping shall be computed in terms of drainage fixture unit (d.f.u.) values in accordance with Table No. P-2205.

Table No. P-2205
DRAINAGE FIXTURE UNIT (d.f.u.) VALUES FOR VARIOUS PLUMBING FIXTURES

TYPE OF FIXTURE OR GROUP OF FIXTURES	DRAINAGE FIXTURE UNIT VALUE (d.f.u.)[1]
Bar sink	1
Bathtub (with or without shower head and/or whirlpool attachments)	2
Bidet	1
Clothes washer standpipe	2
Dishwasher	2
Floor drain	0[2]
Kitchen sink	2
Lavatory	1
Laundry tub	2
Shower stall	2
Water closet (tank type)	4
Water closet (flushometer tank)	4
Full-bath group with bathtub (with or without shower head and/or whirlpool attachment on the bathtub or shower stall)	6
Half-bath group (water closet plus lavatory)	5
Kitchen group (dishwasher and sink with or without garbage grinder)	3
Laundry group (clothes washer standpipe and laundry tub)	3
Multiple-bath groups[3]:	
1 1/2 baths	7
2 baths	8
2 1/2 baths	9
3 baths	10
3 1/2 baths	11

[1] For a continuous or semicontinuous flow into a drainage system, such as from a pump or similar device, 1.5 fixture units shall be allowed per gpm of flow. For a fixture not listed, use the highest d.f.u. value for a similar listed fixture.

[2] A floor drain itself adds no hydraulic load. However, used as a receptor, the fixture unit value of the fixture discharging into the receptor shall be applicable.

[3] Add 2 d.f.u. for each additional full bath.

SECTION P-2206 – DRAINAGE SYSTEM

P-2206.1 Drainage fittings and connections: Changes in direction in drainage piping shall be made by the appropriate use of sanitary tees, wyes, elbows, or by a combination of these or equivalent approved drainage fittings.

P-2206.1.1 Horizontal to vertical (single connection): Horizontal drainage lines connecting with a vertical stack shall enter through a wye, tee-wye, bend, sweep, sanitary tee or other approved fitting. Short-pattern fittings or a sanitary tapped tee shall be an acceptable connection for branch lines serving one fixture.

P-2206.1.2 Horizontal to vertical (multiple connection): Double fittings such as double sanitary tees and tee-wyes or approved multiple connection fittings and back-to-back fixture arrangements that connect two or more branches at the same level shall be permitted as long as directly opposing connections are the same size and the discharge into directly opposing connections is from similar fixture types or fixture groups.

A kitchen sink and water closet shall not be connected to a stack at the same level directly opposed, nor shall either of these fixtures be installed directly opposed to other types of waste fixtures.

P-2206.1.3 Horizontal to horizontal: Horizontal drainage lines connecting with other horizontal drainage lines shall enter through bends, sweeps, wyes, tee-wyes or equivalent long-pattern or combination fittings.

P-2206.1.4 Vertical to horizontal: Vertical drainage lines connecting with horizontal drainage lines shall enter through bends, sweeps, wyes, tee-wyes or other approved fittings of equivalent sweep.

P-2206.1.5 Heel- or side-inlet 1/4 bends, drainage: Heel-inlet 1/4 bends shall be an acceptable means of connection, except where the 1/4 bends serves a water closet a low-heel inlet shall not be used as a wet- vented connection. Side-inlet 1/4 bends shall be an acceptable means of connection for both drainage, wet-venting and stack-venting arrangements.

P-2206.1.6 Heel- or side-inlet 1/4 bends, venting: A heel-inlet or side-inlet 1/4 bends, or any arrangement of pipe and fittings producing a similar effect, shall be acceptable as a dry vent when the inlet is placed in a vertical position. The inlet may be placed in a horizontal position only where the entire fitting is part of a dry vent arrangement.

P-2206.1.7 Water closet connection between flange and pipe: A 3-inch 1/4 bends or bend shall be acceptable for water closet or similar connections, provided a 4-inch by 3-inch flange is installed to receive the closet fixture horn. Alternately, a 3-inch by 4-inch elbow shall be acceptable with a 4-inch flange.

P-2206.1.8 Dead ends: Dead ends shall be prohibited except where necessary to extend a cleanout or as an approved part of a rough-in of 2 feet or more.

P-2206.2 Drainage pipe cleanouts

P-2206.2.1 Materials: Cleanouts shall conform to standards acceptable to the administrative authority. Plugs shall be brass, approved plastic or equivalent.

P-2206.2.2 Spacing: Cleanouts shall be installed not more than 75 feet apart in horizontal drainage lines of 4-inch nominal diameter or less.

P-2206.2.3 Underground drainage cleanouts: When installed in underground drains, cleanouts shall be extended vertically to or above finished grade either inside or outside the building.

P-2206.2.4 Change of direction: Cleanouts shall be installed at each change of direction of the drainage system greater than 45 degrees, except not more than one cleanout shall be required in each 40 feet of run regardless of change in direction.

P-2206.2.5 Accessibility: Cleanouts shall be accessible. Minimum clearance in front of cleanouts shall be 18 inches on 3-inch and larger pipes, and 12 inches on smaller pipes. Concealed cleanouts shall be provided with access of sufficient size to permit removal of the cleanout plug and rodding of the system. Cleanout plugs shall not be concealed with any permanent finishing material.

P-2206.2.6 Base of stacks: Accessible cleanouts shall be provided near the base of each vertical waste or soil stack. Alternatively, such cleanouts may be installed outside the building within 3 feet of the building wall.

P-2206.2.7 Building drain and building sewer junction: There shall be a cleanout near the junction of the building drain and building sewer. This cleanout may be either inside or outside the building wall, provided it is brought up to finish grade or to the lowest floor level. An accessible interior building drain cleanout, test tee or equivalent within close proximity to the building drain exit point shall fulfill this requirement.

P-2206.2.8 Direction of flow: Cleanouts shall be installed so that the cleanout opens in the direction of the flow of the drainage line.

P-2206.2.9 Cleanout size: Cleanouts shall be of the same nominal size as the pipe up to 4 inches and not less than 4 inches for larger piping.

P-2206.2.10 Cleanout equivalent: A fixture trap or a fixture with integral trap, readily removable without disturbing concealed piping shall be acceptable as a cleanout equivalent.

P-2206.2.11 Connections to cleanouts prohibited: Cleanout openings shall not be used for the installation of new fixtures or floor drains except where approved by the administrative authority and where an acceptable alternate cleanout is provided.

P-2206.3 Horizontal drainage piping slope: Horizontal drainage piping shall be installed in uniform alignment at uniform slopes not less than 1/4 inch per foot for 3-inch diameter and less, and not less than 1/8 inch per foot for diameters of 4 inches or more.

P-2206.4 Drain pipe sizing: Drain pipes shall be sized according to drainage fixture unit (d.f.u.) loads. The following general procedure may be used:

1. Draw an isometric layout or riser diagram denoting fixtures on the layout.
2. Assign d.f.u. values to each fixture group plus individual fixtures using Table No. P-2205.
3. Starting with the top floor or most remote fixtures, work downstream toward the building drain accumulating d.f.u. values for fixture groups plus individual fixtures for each branch. Where multiple bath groups are being added, use the reduced

d.f.u. values in Table No. P-2205, which take into account probability factors of simultaneous use.

4. Size branches and stacks by equating the assigned d.f.u. values to pipe sizes shown in Table No. P-2206.4.1.

5. Determine the pipe diameter and slope of the building drain and building sewer based upon the accumulated d.f.u. values, using Table No. P-2206.4.2.

P-2206.4.1 Fixture branch and stack sizing:

1. Branches and stacks shall be sized according to Table No. P-2206.4.1. Below-grade drain pipes shall not be less than 1 1/2 inches in diameter.

2. Minimum Stack Size. No drain stack shall be smaller than the largest horizontal branch connected, with the following exceptions:

   a. A 4-inch by 3-inch closet bend or flange or a 4-inch closet bend into a 3-inch by 4-inch stack tee shall be acceptable (see Section P-2206.1.7).

   b. A 4-inch horizontal drain to a 3-inch soil stack by means of a 3-inch by 4-inch tee-wye shall be acceptable.

Table No. P-2206.4.1
MAXIMUM FIXTURE UNITS THAT MAY BE CONNECTED TO BRANCHES AND STACKS

NOMINAL PIPE SIZE (Inches)	ANY HORIZONTAL FIXTURE BRANCH	ANY ONE VERTICAL STACK OR DRAIN
1 1/4[1]	—	—
1 1/2[2]	3	4
2[2]	6	10
2 1/2[2]	12	20
3	20[3]	48[4]
4	160	240

[1] 1 1/4-inch pipe size limited to a single-fixture drain or trap arm. See Table No. P-2206.6.7.
[2] No water closets
[3] Maximum three water closets.
[4] Maximum six water closets.

P-2206.4.2 Building drain and sewer size and slope: Pipe sizes shall be determined from Table No. P-2206.4.2 on the basis of drainage load in fixture units (d.f.u.) computed from Table No. P-2205.

Table No. P-2206.4.2
MAXIMUM NUMBER OF FIXTURE UNITS THAT MAY BE CONNECTED TO THE BUILDING DRAIN, BUILDING DRAIN BRANCHES OR THE BUILDING SEWER

DIAMETER OF PIPE (Inches)	SLOPE PER FOOT		
	1/8 Inch	1/4 Inch	1/2 Inch
1 1/2[1,2]	—	—[1]	—[1]
2[2]	—	21	27
2 1/2[2]	—	24	31
3	—	42	50
4	180	216	250

[1] 1 1/2-inch pipe size limited to a building drain branch serving not more than two waste fixtures, or not more than one waste fixture if serving a pumped discharge fixture or garbage grinder discharge.
[2] No water closets

P-2206.4.3 Provision for future fixtures: When a rough-in is provided for the installation of future fixtures, those provided for shall be included when determining the required sizes of drain and vent pipes. Such future installations shall be terminated with accessible plugged fittings.

P-2206.5 Sizing of drain pipe offsets

P-2206.5.1 Vertical offsets: An offset in a vertical drain, with a change of direction of 45 degrees or less from the vertical, shall be sized as a straight vertical drain.

P-2206.5.2 Horizontal offsets above the lowest branch: A stack with an offset of more than 45 degrees from the vertical shall be sized as follows:

1. The portion of the stack above the offset shall be sized as for a regular stack based on the total number of fixture units above the offset.
2. The offset shall be sized as for a building drain, Table No. P-2206.4.2.
3. The portion of the stack below the offset shall be sized as for the offset or based on the total number of fixture units on the entire stack, whichever is larger.

4. Drainage branch connections shall not be made within five pipe diameters above or below the offset unless a relief vent is installed at the offset.

P-2206.5.3 Horizontal offsets below the lowest branch: In soil or waste stacks below the lowest horizontal branch, there shall be no change in diameter required if the offset is made at an angle of not greater than 45 degrees from the vertical. If an offset greater than 45 degrees from the vertical is made, the offset and stack below it shall be sized as a building drain (see Table No. P-2206.4.2).

P-2206.6 Fixture traps

P-2206.6.1 Design of traps: Traps shall be of standard design, shall have smooth uniform internal waterways, shall be self-cleaning and shall have no interior partitions except where integral with the fixture. They shall be of lead, cast iron, cast or drawn brass, approved plastic or other approved materials. Tubular brass traps shall be not less than No. 20 gauge thickness. Solid connections, slip joints or couplings may be used on the trap inlet, trap outlet, or within the trap seal. Slip joints shall be accessible.

P-2206.6.2 Trap seals: Traps shall have a liquid seal of not less than 2 inches and not more than 4 inches, unless otherwise approved. Traps that could lose their seal due to evaporation because of infrequent use, such as floor drains, may be fitted with a trap primer.

P-2206.6.3 Trap setting and protection: Traps shall be set level with respect to their water seals and shall be protected from freezing. Trap seals shall be protected from siphonage, aspiration or back pressure by an approved system of venting (see Section P-2207).

P-2206.6.4 Building traps: Building traps shall not be installed, except in special cases where sewer gases are extremely corrosive or noxious, as directed by the administrative authority.

P-2206.6.5 Prohibited trap designs: The following types of traps are prohibited:

1. Bell traps.
2. Separate fixture traps with interior partitions.
3. "S" traps except as permitted under Section P-2206.7.3.
4. Drum traps.
5. Trap designs with moving parts.

P-2206.6.6 Number of fixtures per trap: Each plumbing fixture shall be separately trapped by a water seal trap placed as close as possible to the fixture outlet, except as otherwise permitted. The vertical distance from the fixture outlet to the trap weir shall not exceed 24 inches. No fixture shall be double trapped. Exceptions to the separate trapping requirements are as follows:

1. Fixtures that have integral traps.
2. One trap may be installed for two or three drains from kitchen sinks, laundry tubs or lavatories adjacent to each other and located in the same room with a continuous waste arrangement. The trap shall be installed at the center fixture when three such fixtures are installed. Common trapped fixture outlets shall not be more than 30 inches apart.
3. No clothes washer or laundry tub shall be discharged to a trap serving a kitchen sink.
4. The connection of a laundry tray waste line may be made into a standpipe for the automatic clothes-washer drain. Standpipes shall not be less than 18 inches nor more than 48 inches as measured from the crown weir. The outlet of the laundry tray shall be a maximum horizontal distance of 30 inches from the standpipe trap.

P-2206.6.7 Size of fixture traps: Fixture trap size (nominal diameter) shall be sufficient to drain the fixture rapidly and in no case less than given in Table No. P-2206.6.7. No trap, including integral traps, shall be larger than the drainage pipe into which it discharges.

Table No. P-2206.6.7
SIZE OF TRAPS AND TRAP ARMS FOR PLUMBING FIXTURES

PLUMBING FIXTURE	TRAP SIZE MINIMUM (Inches)
Bathtub (with or without shower head and/or whirlpool attachments)	1 1/2
Bidet	1 1/4
Clothes washer standpipe	1 1/2
Dishwasher (on separate trap)	1 1/4
Floor drain	2
Kitchen sink (one or two traps, with or without dishwasher and garbage grinder)	1 1/2
Laundry tub (one or more compartments)	1 1/2
Lavatory	1 1/4
Shower	1 1/4
Water closet	*

*Consult fixture standards for trap dimensions of specific bowls.

P-2206.7 Trap arms

P-2206.7.1 Maximum length of trap arm: Each fixture trap shall have a protecting vent so located that the maximum developed length of the trap arm is within the requirements of Table No. P-2206.7.1. Minimum trap arm length shall be two pipe diameters (see Section P-2207.2.5).

Table No. P-2206.7.1
MAXIMUM LENGTH OF TRAP ARM

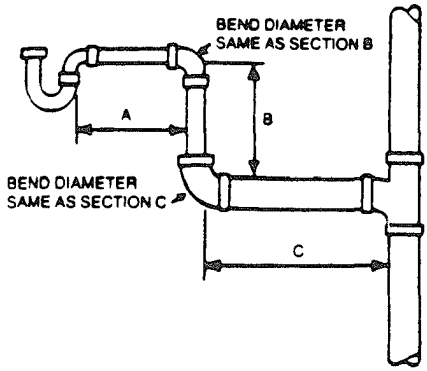
DIAMETER (Inches)	LENGTH (Feet)
1 1/4	5
1 1/2	6
2	8
3	12
4	16

P-2206.7.2 Allowable fall in trap arm: The total fall in trap arm due to pipe slope shall not exceed one pipe diameter, nor shall the vent pipe connection to a fixture drain, except for water closets and similar fixtures, be below the weir of the trap, except as provided in Section P-2206.7.3.

P-2206.7.3 Vertical leg for waste fixture drains: A vertical leg (see Figure No. P-2206.7.3) may be installed in the trap arm of a waste-fixture drain in lieu of the usual trap arm-to-vent connection. Typical installations include island sinks and fixtures not adjacent to a wall. Vertical leg trap arm installations shall meet the following criteria:

1. Minimum trap diameter shall be in accordance with Table No. P-2206.6.7.
2. The diameter of Section A shall be equal to the diameter of the trap.
3. The length of Section A shall be not less than 8 inches and in accordance with Table No. P-2206.7.1.
4. The diameter of Section B shall be one pipe size larger than the diameter of Section A.
5. The length of Section B shall be not more than 36 inches.
6. The diameter of Section C shall be one pipe size larger than the diameter of Section B.
7. There is no restriction on the length of Section C.
8. Bends shall be the diameter of the largest connected section.

Figure No. P-2206.7.3
VERTICAL LEG TRAP ARM SCHEMATIC



*

P-2206.8 Sumps and ejectors

P-2206.8.1 Sewage ejectors or sewage pumps: A sewage ejector or sewage pump receiving discharge of water closets shall have a minimum discharge capacity of 20 gallons per minute. The ejector or pump shall be capable of passing a 1 1/2-inch-diameter solid ball, and the discharge piping of each ejector or pump shall have a backwater valve and be a minimum of 2 inches.

P-2206.8.2 Building drains below sewer (building subdrains): Building drains which cannot be discharged to the sewer by gravity flow shall be discharged into a tightly covered and vented sump from which the contents shall be lifted and discharged into the building gravity drainage system by automatic pumping equipment or by an equally effective method approved by the administrative authority.

The system of drainage piping below the sewer level shall be installed and vented in a manner similar to that of the gravity system. Vents shall be carried separately to the open air, independent of vents serving the gravity drainage system. Only such drains that must be lifted for discharge shall be discharged into sumps. All other drains shall be discharged by gravity.

P-2206.9 Backwater valves: When required, a readily accessible backwater valve shall be installed only in branches of the drainage system subject to backflow of sewage. Drainage piping serving fixtures which have flood level rims located below the elevation of the next upstream manhole cover of the public sewer serving such drainage piping shall be protected from backflow of sewage by installing an approved-type backwater valve. Fixtures above such elevation shall not discharge through the backwater valve.

Backwater valves shall have noncorrosive bearings, seats and self-aligning discs, and shall be so constructed as to ensure a positive mechanical seal. Valve access covers shall be bolted type with gasket unless otherwise approved.

P-2206.10 Existing building sewers and drains: Existing building sewers and drains may be used in connection with new systems when found by examination and/or test to conform to the requirements prescribed by this document.

SECTION P-2207 – VENT SYSTEMS

P-2207.1 General: The protection of trap seals from siphonage, aspiration or back pressure shall be accomplished by venting systems designed and installed so that at no time shall trap seals be subjected to a pneumatic pressure differential of more than 1 inch of water column under design load conditions.

P-2207.1.1 Required drain and vent stack: Buildings shall have at least one soil stack running from the building drain up through the building, with the stack vent terminating outdoors above the topmost branch interval per Section P-2207.5. Additional branches may be served by air admittance valves installed in accordance with Sections P-2207.4 and P-2207.5.6. Valves shall be sized according to Section P-2207.11.

P-2207.1.2 Minimum vent area: The aggregate cross-sectional area of all vents extending to the outside shall be not less than the cross-sectional area of the required building drain. The size of each vent shall be not less than required by Table No. P-2207.7. The vent terminal shall be increased per Section P-2207.6.5 in areas subject to frost closure.

P-2207.1.3 Prohibited use: The plumbing vent system shall not be used for purposes other than the venting of the plumbing system.

P-2207.2 Vent slopes and connections

P-2207.2.1 Vent slope: All vent pipes shall be so sloped and connected as to drain back to the soil or waste pipe by gravity. Slope of vent piping shall be arranged to allow condensation and moisture which may form to flow back to the drain line. Vent piping shall be installed and supported so as to not be "trapped" by water or condensate collecting in the trapped area.

P-2207.2.2 Vent connection to a horizontal drain: Where vent pipes connect to a horizontal soil or waste pipe, the vent shall be taken off so that the invert of the vent pipe is in line with or above the center line of the horizontal soil or waste pipe and downstream of the trap that it serves.

P-2207.2.3 Vent stack connection at base: Vent stacks shall connect full size at their base to the drainage system, below the lowest fixture branch.

P-2207.2.4 Height above flood-level rim: A connection between an individual or branch vent pipe and a vent stack or stack vent shall be made above the flood-level rim of the highest fixture on the same floor level served by the vent.

P-2207.2.5 Crown venting prohibited: No vent shall be installed within two pipe diameters of the trap weir.

P-2207.3 Common vents

P-2207.3.1 Individual vent as common vent: An individual vent installed vertically may be used as a common vent for two fixture traps when both fixture drains connect with the vertical drain or stack at the same level.

P-2207.3.2 Fixtures connected to stack at different levels: A common vent may be used for two waste fixtures connecting at different levels in the stack but within the same branch interval, provided that the portion of the stack that serves as the vertical drain for the upper fixture is one pipe diameter larger than the upper fixture drain, but in no case smaller than the lower fixture drain. The vertical piping between the fixture connections serves as a wet vent for the lower fixture.

P-2207.3.3 Vent headers: Stack vents, vent stacks, individual vents, branch vents and relief vents connected in any combination to a common vent header (larger branch vent) shall be at least 6 inches above the flood-level rim of the highest fixture and terminate in accordance with Section P-2207.5. This header shall be sized in accordance with the requirements of Table No. P-2207.7.

P-2207.4 Mechanical vents: Approved mechanical venting devices shall be permitted for a single fixture or fixture trap where a vertical leg trap arm as described in Section P-2206.7.3 cannot be installed and no other practical alternative exists. The mechanical vent shall be installed a minimum of 6 inches above the flood-level rim of the fixture served and shall be accessible for periodic inspection and/or replacement.

P-2207.5 Air admittance valves: Approved air admittance valves complying with ASSE 1051 as listed in Section S-26.2207 shall be permitted for a single fixture or for multiple fixture traps. The air admittance valve shall be installed to permit free movement of air and not less than 4 inches above the trap arm of the fixture served and shall be accessible for periodic inspection and/or replacement. Valves shall be sized per Section P-2207.12.

P-2207.6 Vent terminals

P-2207.6.1 Location of vent terminal: No vent terminal shall be located beneath any door, window or other opening nor shall any such vent terminal be within 5 feet horizontally of such an opening unless it is at least 2 feet above the top of the opening.

P-2207.6.2 Vent extension above roofs: Vent pipe extensions through the roof shall terminate at least 6 inches above the high side of the penetration. Where a roof is to be used for any purpose other than weather protection, vent extensions shall run at least 7 feet above the roof.

P-2207.6.3 Vent extension through wall or overhang: Vents extending through a wall or building overhang shall terminate downward.

P-2207.6.4 Vent pipe flashing and sealing: Vent extensions through roofs shall be made water-tight by use of approved flashings. Vent

extensions in walls or soffits shall be made weather-tight by caulking or other suitable means.

P-2207.6.5 Frost closure: Localities having an average annual minimum design temperature 0 degrees F. (ASHRAE 97.5 percent column, winter, see Appendix A) shall be considered subject to frost closure. Vent terminals extending to the outside in such localities shall be at least 2 inches in diameter. When it is found necessary to increase the size of the vent terminal extension to meet this requirement, the change in diameter shall be made inside the building at least 1 foot below the roof. No increase in diameter is required in localities not subject to frost closure by the above criteria.

P-2207.6.6 Vent terminals in attic spaces: Vent terminals equipped with approved air admittance valves may be located in accessible attic spaces where the building drainage system connects to a vented sewer. Valves shall comply with ASSE 1051 as listed in Section S-26.2207, shall be installed above the attic insulation and shall be sized according to Section P-2207.12.

P-2207.7 Dry vent sizing: The vent sizing requirements set forth in Table No. P-2207.7 shall apply to all dry portions of any venting system in this document, including:

1. Individual and common vents extending from trap arms.
2. Stack vents.
3. Vent stacks, branch vents, relief vents or other dry vents.

Exceptions:

1. Kitchen sink vents and horizontal portions of a vent system below the highest flood-level rim of fixtures or fixture groups served shall be run full size of the drain to which they connect to a height above the flood-level rim.
2. Sump vents, see Section P-2207.11.

Alternatively, vents may be sized using the engineered method presented in Appendix D.

Table No. P-2207.7
MINIMUM SIZE FOR DRY VENTS

VENTING APPLICATION	MINIMUM VENT SIZE (inches)
Dry vent extension from individual fixtures, fixture groups, or waste stacks	1 1/4*
Individual soil stack vents and water closet vents	1 1/2
Combined stack vent from two or more stacks	2

*Except water closets.

P-2207.8 Wet venting

P-2207.8.1 Single-bathroom groups: A single bathroom group may be installed with the drain from an individually vented lavatory or other waste fixture serving as a wet vent for a bathtub or shower and/or for the water closet (see Figure No. P-2207.8.1), provided that:

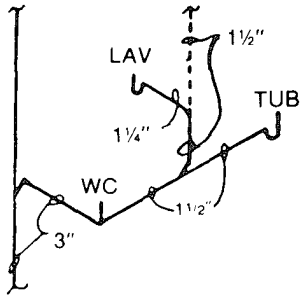
1. Not more than 1.0 d.f.u. drain into a 1 1/4-inch wet vent, not more than 2.0 d.f.u. drain into a 1 1/2-inch wet vent, or not more than 4 d.f.u. drain into a 2-inch wet vent, except as provided in Section P-2207.8.3 provided that no wet vent shall be smaller than the dry vent extension of a wet vent.
2. The horizontal branch shall connect to the water closet branch or bend, to the stack at the same center line as the water closet branch, or to the stack below the water closet branch.
3. The dry vent extension of a wet-vented circuit shall be sized in accordance with Table No. P-2207.7.
4. If a stack fitting consisting of a water closet opening and two side inlets with the same center line of the water closet opening is used, one side inlet may be used for an independent connection of a tub or shower without individual reventing, and the other may be used for an individually vented lavatory with or without an additional wet-vented tub or shower. This line serves as a wet vent for the water closet and nonindividually vented tub or shower (see Figure No. P-2207.8.1, item D).

P-2207.8.2 Double-bathroom groups: Two bathroom groups side-by-side or back-to-back may be installed in a wet vent arrangement, with the water closets connecting independently to the stack at the same level, provided the requirements of Section P-2207.8.1 are met (see Figure No. P-2207.8.2).

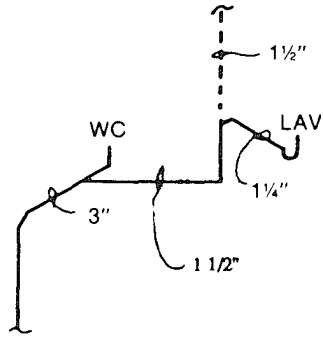
P-2207.8.3 Location of water closet connection controlling dry vent size: The manner and location in which the water closet is connected to the stack shall control the method by which the dry vent extension of the wet vent is sized:

1. If the water closet is connected to a soil stack which terminates as a stack vent, the water closet itself shall be considered stack vented (see Section P-2207.9). The dry vent extension of the wet vent shall be sized according to the d.f.u. load of the waste fixtures served (see Figure Nos. P-2207.8.1, Items A, C and D, and P-2207.8.2, Items A and B).
2. If the water closet horizontal branch is connected by an elbow on the top of a secondary stack, or is connected at lower branch intervals of a soil stack serving more than one story, the dry vent extension of the wet vent shall be sized according to the d.f.u. load of the entire horizontal branch (see Figure Nos. P-2207.8.1, Item B, and P-2207.8.2, Item C).

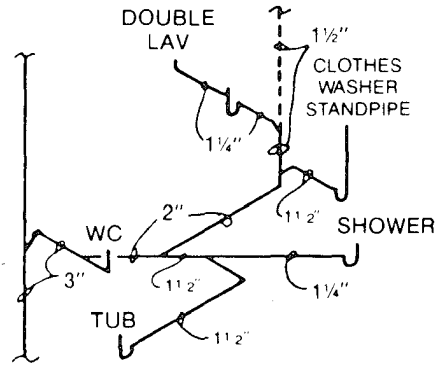
Figure No. P-2207.8.1
TYPICAL SINGLE-BATH WET-VENT ARRANGEMENTS



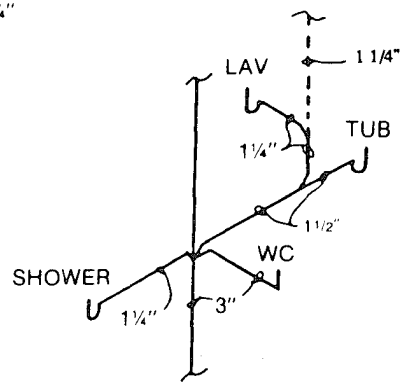
A. TYPICAL SINGLE-BATH



B. TYPICAL POWDER ROOM



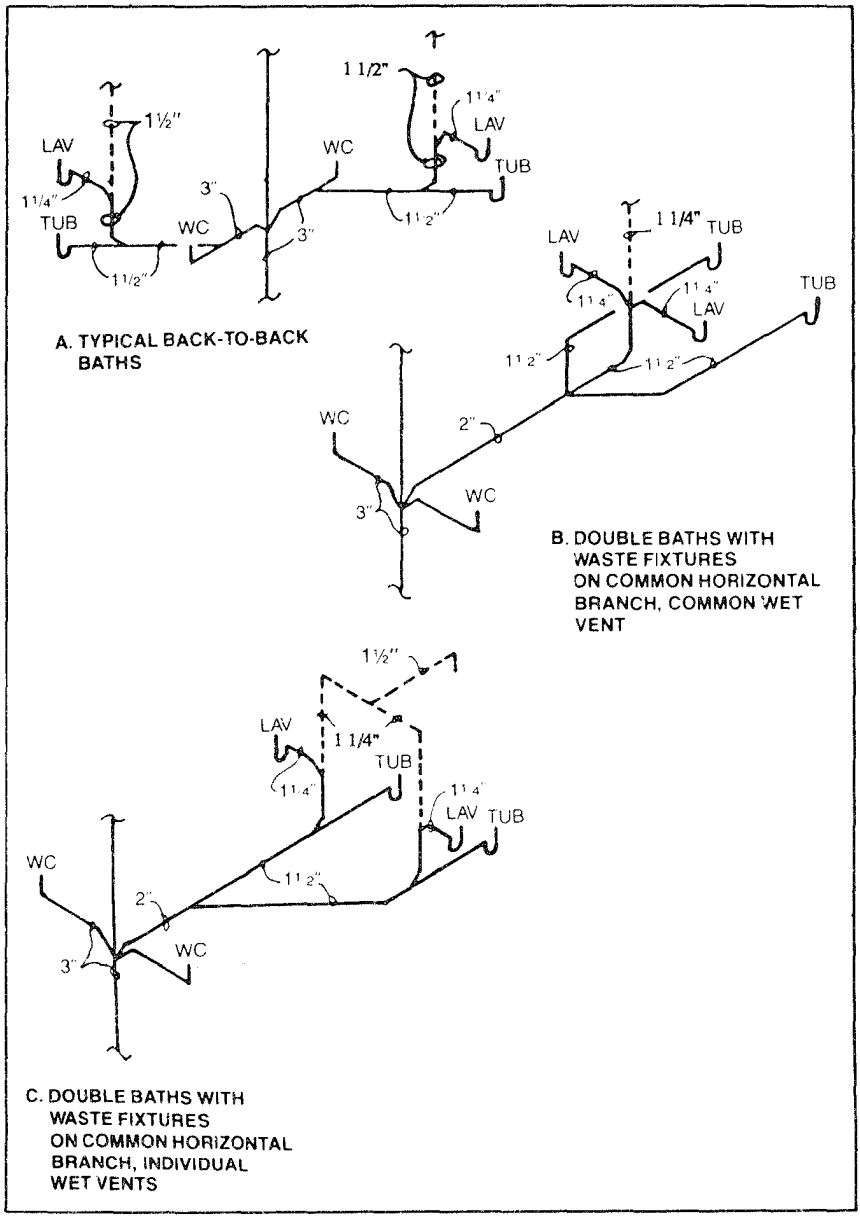
C. MORE ELABORATE SINGLE-BATH ARRANGEMENT



D. COMBINATION WET- AND STACK-VENTING WITH STACK FITTING

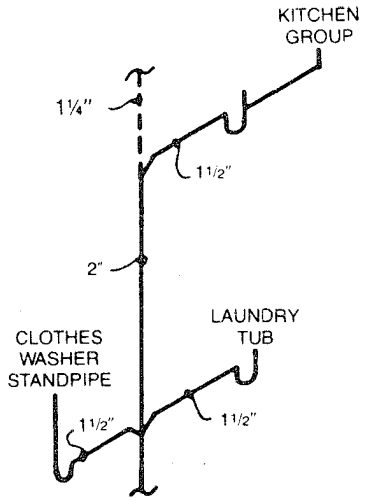
This figure is for illustration purposes only and the written text shall apply.

Figure No. P-2207.8.2
TYPICAL DOUBLE-BATH WET-VENT ARRANGEMENTS



P-2207.8.4 Waste stack serving a kitchen group: Where a waste stack receives the discharge of a kitchen group or other 3.0 d.f.u. group, it may also serve as a wet vent for a laundry group or other 3.0 d.f.u. group connected to the stack at the floor below. The minimum size of the waste stack and wet vent up to the upper branch connection shall be 2 inches (see Figure No. P-2207.8.4).

Figure No. P-2207.8.4
WASTE STACK SERVING AS WET VENT FOR LAUNDRY GROUP



This figure is for illustration purposes only and the written text shall apply.

P-2207.9 Stack venting

P-2207.9.1 General: Stack venting, with certain preconditions relating to drainage loads and ventings, fitting types and sizes, and placement of connections, shall be permitted as a system that allows fixtures and fixture groups to be independently connected to a soil or waste stack without individual fixture venting.

P-2207.9.2 Method of connection:

1. Waste fixtures shall enter the stack with either a wye and eighth bend or a sanitary tee above the water closet connection, or at the same center line as the water closet connection through multi-inlet fittings that have the smaller waste fixture inlets set 90 degrees apart from the water closet inlet (see Figure No. P-2207.9.2, Item A).

2. A side inlet or high-heel inlet connection into a water closet bend, or a connection into a water closet horizontal branch, shall be considered an independent connection to the stack (see Figure No. P-2207.9.2, Item B), provided:
   a. Only waste fixtures shall be connected.
   b. Connection of a horizontal branch serving a water closet to a soil stack shall be made only with a sanitary tee.
   c. Not more than two such independent fixture connections shall be made into each water closet fitting or branch.
3. Water closet branches that receive no additional waste fixture loads shall enter a 3-inch stack with either a wye and eighth bend or a sanitary tee.
4. A 90-degree long sweep or combination of fittings creating the same effect shall be installed at the base of soil stacks.
5. Trap arms shall in all cases comply with Table No. P-2206.7.1.

P-2207.9.3 Stack system sizing: Table Nos. P-2207.9.3a and P-2207.9.3b shall be used to size single-stack systems in dwellings of one story or more (see Figure No. P-2207.9.3).

Table No. P-2207.9.3a
MAXIMUM SOIL STACK LOADS ON A SINGLE-STACK SYSTEM

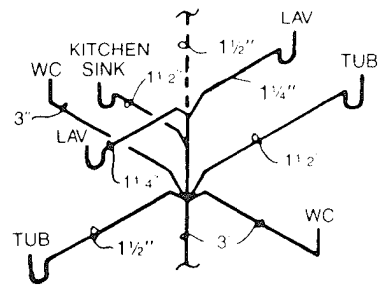
SOIL STACK SIZE (In.)	FIXTURE GROUPS PER FLOOR	MAXIMUM OF FLOORS
3	1	3
	2	2
	1	4
4	2	3

Table No. P-2207.9.3b
MAXIMUM WASTE STACK LOADS ON A SINGLE-STACK SYSTEM

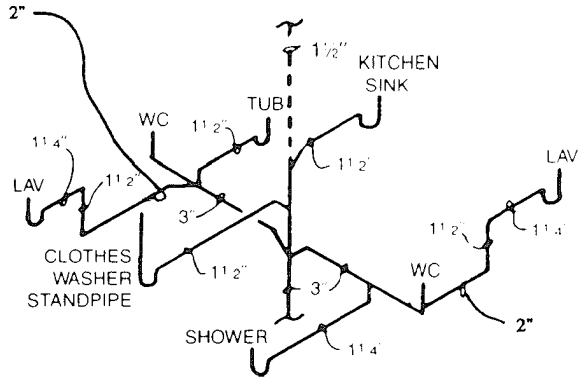
WASTE STACK SIZE (In.)	FIXTURE GROUPS PER FLOOR	MAXIMUM OF FLOORS
2	1	3
	2	2

Note: Fixtures for fixture groups in excess of the single-stack venting limits in Table Nos. P-2207.3a and P-2207.3b may also be connected to the same stack, provided they are independently vented by either dry- or wet-vent systems, and the total d.f.u. load on the drain stack as specified in Section P-2206.4.1 is not exceeded.

Figure No. P-2207.9.2
TYPICAL METHODS OF CONNECTING FIXTURE DRAINS TO STACK IN STACK-VENTED SYSTEMS



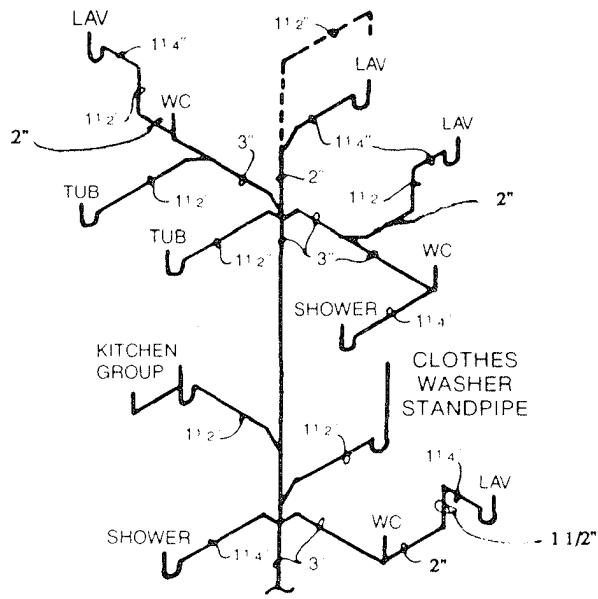
A. Waste Fixtures Connected Directly to Stack



B. Waste Fixtures Connected to Water Closet Horizontal Branch

This figure is for illustration purposes only and the written text shall apply.

Figure No. P-2207.9.3
TYPICAL SINGLE-STACK SYSTEM FOR A TWO-STORY DWELLING



This figure is for illustration purposes only and the written text shall apply.

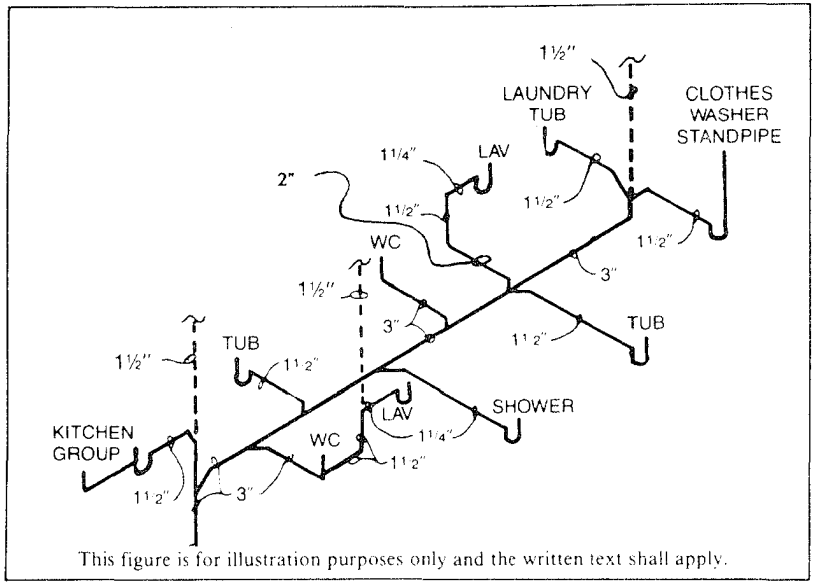
P-2207.9.4 Load limit for stack-vented waste fixtures above highest water closet, bathtub or shower: Up to three waste fixtures without individual vents may be independently connected to a 3- or 4-inch soil or waste stack above the highest water closet, bathtub or shower connection within the same branch interval (see Figure No. P-2207.9.2, Item A).

P-2207.10 Individual fixture vents not required on a neutral horizontal branch: On a uniformly sized horizontal branch, fixtures may be installed without individual vents, provided a vent is installed before the first fixture and after the last fixture connected (see Figure No. P-2207.10a). This branch may discharge into a stack serving upper levels, provided the size of the stack can accommodate the total d.f.u. load connected per Section P-2206.4.1.

Alternately, the horizontal branch may be reduced in size according to fixture loading requirements. The reduced portion shall be sized as a wet-vented system in conformance with Section P-2207.8 (see Figure No. P-2207.10b).

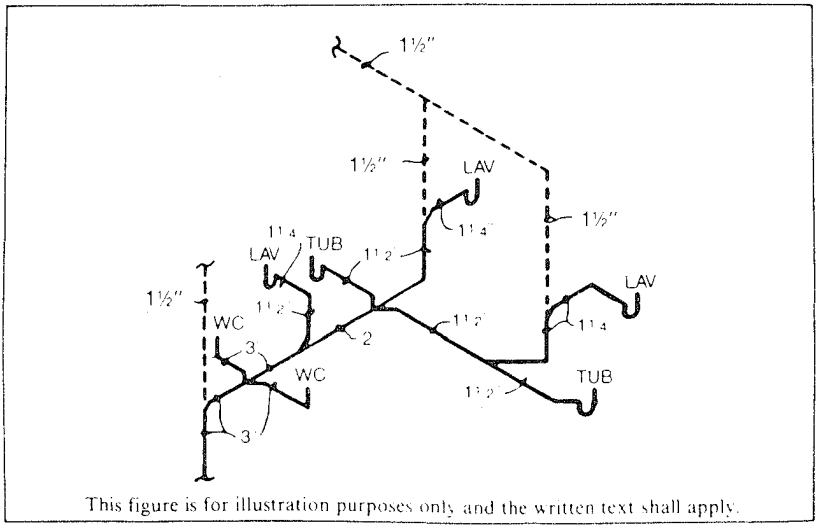
Vent sizes shall be determined from Table No. P-2207.7.

Figures No. P-2207.10a
TYPICAL UNIFORMLY SIZED HORIZONTAL BRANCH SYSTEM



This figure is for illustration purposes only and the written text shall apply.

Figures No. P-2207.10b
TYPICAL HORIZONTAL BRANCH SYSTEM REDUCING IN SIZE UTILIZING WET VENTING



This figure is for illustration purposes only and the written text shall apply.

P-2207.11 Sump vent sizes and lengths: Drainage piping below sewer level shall be vented in a similar manner to that for a gravity system. Building and sump vents, where required, shall be sized in accordance with Table No. P-2207.11.

Table No. P-2207.11
SIZE AND LENGTH OF SUMP VENTS

DISCHARGE CAPACITY OF SUMP PUMP (gpm)	VENT PIPE SIZE (Inches)		
	1 1/4	1 1/2	2
	LENGTH OF VENT (Feet)		
10	N.L.*	N.L.	N.L.
20	270	N.L.	N.L.
40	72	160	N.L.
60	31	75	270

*No practical limit.

P-2207.12 Sizing: Air admittance valves shall be sized to accommodate the fixture unit load of the branch or fixture that it serves per Table P-2207.12. Devices designed to accommodate multiple pipe size connections shall be permitted.

Table No. P-2207.12
AIR ADMITTANCE VALVE MAXIMUM LOAD LIMITATIONS FOR HORIZONTAL FIXTURE BRANCHES

NOMINAL PIPE SIZE (INCHES)	D.F.U.[1] ANY HORIZONTAL FIXTURE BRANCH
1 1/4	1
1 1/2	3
2	6[2]
3	20[2]
4	160

[1]Source: National model plumbing codes and Hunter Curve.
[2]Not more than 2 water closets or bathroom groups per interval.

SECTION P-2208–TESTING THE DRAINAGE, WASTE AND VENT SYSTEM

P-2208.1 Method of testing building sewer The building sewer shall be tested by insertion of a test plug at the point of connection with the public sewer. It shall then be filled with water and tested under a water head of not less than 10 feet. The water level at the top of the test head of water shall not show a measurable drop for at least 15 minutes.

P-2208.2 Methods of testing DWV systems

P-2208.2.1 Rough plumbing: DWV systems shall be tested upon completion of the rough piping installation by water or air with no evidence of leakage. Either test shall be applied to the drainage system in its entirety or in sections after rough piping has been installed, as follows:

1. Water Test – Each section shall be filled with water to a point no less than 10 feet above the highest fitting connection in that section, or to the highest point in the completed system. Water shall be held in the section under test for at least 15 minutes before inspection. The system shall prove leak free by visual inspection.
2. Air Test – The portion under test shall be maintained at a gauge pressure of 5 psi or 10 inches mercury column. This pressure shall be held without introduction of additional air for a period of at least 15 minutes.

P-2208.2.2 Finished plumbing: After the plumbing fixtures have been set and their traps filled with water, their connections shall be tested and proved gas-tight and/or water-tight as follows:

1. Water-tightness – Each fixture shall be filled and then drained. Traps and fixture connections shall be proven water-tight by visual inspection.
2. Gas-tightness – Where required by the local administrative authority, a final test for gas-tightness of the DWV system shall be made by the smoke or peppermint test as follows:
    a. Smoke Test – Introduce a pungent, thick smoke into the system. When the smoke appears at vent terminals, they shall be sealed and a pressure equivalent to a 1-inch water column shall be applied and maintained for the period of inspection.
    b. Peppermint Test – Introduce 2 ounces of oil of peppermint into the system. Add 10 quarts of hot water and seal all vent terminals. The odor of peppermint shall not be detected at any trap or other point in the system.

P-2208.3 Waiver of tests: Any or all of the above tests may be waived at the discretion of the local administrative authority.

Chapter 23
PLUMBING FIXTURES AND RECEPTORS

SECTION P-2301 – FIXTURES, FITTINGS AND APPURTENANCES

Plumbing fixtures, fittings and appurtenances shall be constructed from approved materials, have smooth impervious surfaces, be free from defects and concealed fouling surfaces and, except as permitted elsewhere in this code, shall conform to the standards specified in Table No. P-2301 and shall be provided with an adequate supply of potable water to flush and keep the fixtures in a clean and sanitary condition without danger of backflow or cross-connection.

Table No. P-2301
PLUMBING FIXTURES
(As listed in Section S-26.2001)

MATERIAL	STANDARD NO.
Vitreous China Fixtures	ASME/ANSI A112.19.2M-90
Trim for Water Closet Bowls, Tanks and Urinals	ASME/ANSI A112.19.5-79
Floor Drains	ASME/ANSI A112.21.1M-80
Plastic Bathtub Units	ANSI Z124.1-87
Plastic Shower Receptors and Shower Stalls	ANSI Z124.2-87
Plastic Lavatories	ANSI Z124.3-86
Plastic Water Closet Bowls and Tanks	ANSI Z124.4-86
Enameled Cast Iron Plumbing Fixtures	ASME/ANSI A112.19.1M-87
Stainless Steel Plumbing Fixtures (Residential)	ASME/ANSI A112.19.3M-87
Porcelain Enameled Formed Steel Plumbing Fixtures	ASME/ANSI A112.19.4M-84
Water Closet Flush Tank Ball Cocks	ASSE/ANSI 1002-79 (1986)
Household Dishwashing Machines	ASSE/ANSI 1006-86
Home Laundry Equipment	ASSE/ANSI 1007-73 (1986)
Household Disposers	ASSE/ANSI 1008-73 (1986)
Water Hammer Arrestors	ASSE/ANSI 1010-82
Hose Connection Vacuum Breakers	ASSE/ANSI 1011-82
Handheld Showers	ASSE/ANSI 1014-79
Individual Shower Control Valves Anti-Scald	ASSE/ANSI 1016-79
Wall Hydrants, Freezeless, Automatic Draining Anti-Backflow Types	ASSE/ANSI 1019-78
Hotwater Dispensers, Household Storage Type, Electrical	ASSE/ANSI 1023-79
Diverters for Faucets with Hose Spray Anti-Syphon Type, Residential Application	ASSE/ANSI 1025-78
Pressurized Flushing Devices for Fixtures	ASSE/ANSI 1037-86
Thermoplastic Accessible and Replaceable Plastic Tube and Tubular Fittings	ASTM F409-88
Pipe Applied Vacuum Breakers	ASSE/ANSI 1001-88
Hydraulic Performance for Water Closets and Urinals	ASME/ANSI A112.19.6-90
Whirlpool Bathtub Appliances	ASME/ANSI A112.19.7M-87
Plastic Sinks	ANSI Z124.6-1990
Suction Fittings for Use in Swimming Pools, Wading Pools, Spas, Hot Tubs and Whirlpool Bathtub Appliances	ASME/ANSI A119.19.8M-87
Water Pressure Reducing Valves for Domestic Water Supply Systems	ASSE/ANSI 1003-1982

[1]Section P-2001.1 provides for use of other approved materials in accordance with Section R-108.

SECTION P-2302 – FIXTURE ACCESSORIES

P-2302.1 Plumbing fixtures, other than water closets, shall be provided with approved strainers.

P-2302.2 Fixture supply valves and faucets shall be brass or other approved materials.

P-2302.3 Accessible continuous wastes, waste and overflow fittings, and tail pieces may be seamless drawn brass of No. 20 gauge minimum thickness.

P-2302.4 Plastic tubular fittings shall conform to ASTM F409 listed in Table P-2301.

SECTION P-2303 – TAIL PIECES

Fixture tail pieces shall be not less than 1 1/2 inches O.D. for sinks, dishwashers, laundry tubs, bathtubs and similar fixtures, and not less than 1 1/4 inches for bidets lavatories and similar fixtures.

SECTION P-2304 – ACCESS TO CONNECTIONS

Fixtures having concealed tubular traps shall be provided with an access panel or unobstructed utility space 12 inches in least dimension. Joints that are soldered, screwed, fused or solvent-welded to form a solid connection or those designs which withstand 25 psi unrestrained need not be accessible.

SECTION P-2305 – INSTALLATION

The installation of fixtures shall conform to the following:

1. Floor-outlet or floor-mounted fixtures shall be secured to the drainage connection and to the floor, when so designed, by screws, bolts, washers, nuts and similar fasteners of copper, brass or other corrosion-resistant material.
2. Wall-hung fixtures shall be rigidly supported so that strain is not transmitted to the plumbing system.
3. Where fixtures come in contact with walls or floors, the joint shall be water-tight.
4. Plumbing fixtures shall be functionally accessible.
5. The center line of water closets or bidets shall be not less than 15 inches from adjacent walls or partitions or not less than 30 inches center to center from an adjacent water closet or bidet.
6. The location of piping, fixtures or equipment shall not interfere with the operation of windows or doors.

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SECTION P-2306 – RECEPTORS

Plumbing fixtures or other receptors receiving the discharge of indirect waste pipes shall be shaped and have a capacity to prevent splashing or flooding and shall be readily accessible for inspection and cleaning.

SECTION P-2307—PROHIBITED RECEPTORS

No plumbing fixture which is used for domestic or culinary purposes shall be used to receive the discharge of an indirect waste, except that in a residence, a kitchen sink trap is acceptable for use as a receptor for a dishwasher and, similarly, a laundry tray as a receptor for a clothes-washing machine.

SECTION P-2308—DIRECTIONAL FITTINGS

Approved "wye" or other directional-type branch fittings shall be installed in fixture tail pieces connecting or receiving the discharge from food-waste disposal units, dishwashers, clothes washers, or other fixtures or appliances.

SECTION P-2309—SHOWERS

P-2309.1 General: Shower compartments shall have at least 900 square inches of floor area and be of sufficient size to inscribe a circle with a diameter not less than 30 inches. Hinged shower doors shall open outward. The wall area above built-in tubs having installed shower heads and in shower compartments shall be constructed as per Section R-502.6. Such walls shall form a water-tight joint with each other and with either the tub, receptor or shower floor.

P-2309.2 Water-supply riser: The water-supply riser from the shower valve to the shower head outlet shall be secured to the permanent structure.

P-2309.3 Shower heads: Shower heads shall be of the water-conserving type.

P-2309.4 Shower control valves: All showers shall be equipped with control valves of the pressure balance, the thermostatic mixing or the combination pressure balance/thermostatic mixing valve types with high limit stops in accordance with ASSE 1016 listed in Section S-26.2309. The high limit stops shall be set to limit water temperature to a maximum 120 degrees F.

SECTION P-2310—SHOWER RECEPTORS

P-2310.1 Construction: Shower receptors shall have a finished curb threshold not less than 1 inch below the sides and back of the receptor. The curb shall be not less than 2 inches or more than 9 inches in depth when measured from the top of the curb to the top of the drain. The finished floor shall slope uniformly toward the drain not less than 1/4 inch per foot nor more than 1/2 inch, and floor drains shall be flanged to provide a water-tight joint in the floor.

P-2310.2 Lining required: The adjoining walls and floor framing, enclosing on-site built-up shower receptors shall be lined with sheet lead or copper or other approved materials extending not less than 3 inches beyond or around the rough jambs and not less than 3 inches above

finished thresholds. Plastic liner materials shall comply with ASTM D4068 listed in Section S-26.2310.

P-2310.3 Installation: Lining materials shall be pitched 1/4 inch per foot to weep holes in the subdrain by means of a smooth, solidly formed subbase, shall be properly recessed and fastened to approved backing so as not to occupy the space required for the wall covering, and shall not be nailed or perforated at any point less than 1 inch above the finished threshold.

Lead and copper linings shall be insulated from conducting substances other than the connecting drain by 15-pound asphalt felt or its equivalent. Joints in lead and copper pans or liners shall be burned or silver brazed, respectively. Joints in plastic liner materials shall be jointed per manufacturer's recommendations.

P-2310.4 Receptor drains: An approved flanged drain shall be installed with shower subpans or linings. The flange shall be placed flush with the subbase and be equipped with a clamping ring or other device to make a water-tight connection between the lining and the drain. The flange shall have weep holes into the waste line.

SECTION P-2311 – SHOWER WALLS

Shower walls shall be finished in accordance with Section R-502.6.

SECTION P-2312 – LAVATORIES

P-2312.1 Lavatory waste outlets: Lavatories shall have waste outlets not less than 1 1/4 inch in diameter. A strainer, pop-up stopper, crossbar or other device shall be provided to restrict the clear opening of the waste outlet.

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SECTION P-2313 – WATER CLOSETS

P-2313.1 Prohibited water closets: Water closets which have an invisible seal and unventilated space or walls which are not thoroughly washed at each discharge shall be prohibited. Water closets which could permit backflow of the contents of the bowl into the flush tank shall be prohibited.

P-2313.2 Flushing devices required: Water closets shall be provided with a flush tank or similar device designed and installed to supply water in sufficient quantity and flow to flush the contents of the fixture, to cleanse the fixture and refill the fixture trap.

P-2313.3 Water supply for flush tanks: An adequate quantity of water shall be provided to flush and clean the fixture served. The water supply to flush tanks equipped for manual flushing shall be controlled by a float valve or other automatic device designed to refill the tank after each discharge and to completely shut off the water flow to the tank when the tank is filled to operational capacity. Water closets having any portion of the tank below the flood-level rim of the closet bowl shall have a ball

cock installed within a sheath or in a separate and isolated compartment of the tank. Both the sheath or compartment shall have visible discharge onto the floor in case of failure. Provision shall be made to automatically supply water to the fixture so as to refill the trap after each flushing.

P-2313.4 Flush valves in flush tanks: Flush valve seats in tanks for flushing water closets shall be at least 1 inch above the flood-level rim of the bowl connected thereto, except an approved water closet and flush tank combination designed so that when the tank is flushed and the fixture is clogged or partially clogged, the flush valve will close tightly so that water will not spill continuously over the rim of the bowl or backflow from the bowl to the tank.

P-2313.5 Overflows in flush tanks: Flush tanks shall be provided with overflows discharging to the water closet connected thereto and of sufficient size to prevent flooding the tank at the maximum rate at which the tanks are supplied with water.

P-2313.6 Water closet seats: Water closets shall be equipped with seats of smooth, nonabsorbent material and shall be properly sized for the water closet bowl type.

SECTION P-2314 – BATHTUBS

P-2314.1 Bathtub waste outlets and overflows: Bathtubs shall have outlets and overflows at least 1 1/2 inches in diameter, and the waste outlet shall be equipped with an approved stopper.

P-2314.2 Bathtub control valves: All bathtubs shall be equipped with control valves of the pressure balance, the thermostatic mixing or the combination pressure balance/thermostatic mixing valve types with high limit stops in accordance with ASSE 1016 listed in Section S-26.2314. The high limit stops shall be set to limit water temperature to a maximum 120°F.

SECTION P-2315 – SINKS

P-2315.1 Sink waste outlets: Sinks shall be provided with waste outlets not less than 1 1/2 inches in diameter. A strainer, crossbar or other device shall be provided to restrict the clear opening of the waste outlet. Sinks on which a waste grinder is installed shall have a waste opening not less than 3 1/2 inches in diameter.

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SECTION P-2316 – LAUNDRY TUBS

P-2316.1 Laundry tub waste outlet: Each compartment of a laundry tub shall be provided with a waste outlet not less than 1 1/2 inches in diameter and a strainer or crossbar to restrict the clear opening of the waste outlet.

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SECTION P-2317—FOOD-WASTE GRINDER

P-2317.1 Food-waste grinder waste outlets: Food-waste grinders shall be connected to a drain of not less than 1 1/2 inches in diameter.

P-2317.2 Water supply required: Food-waste grinders shall be provided with an adequate supply of water at a sufficient flow rate to ensure proper functioning of the unit.

SECTION P-2318—DISHWASHING MACHINES

P2318.1 Protection of water supply: Each unit shall have integral backflow protection of the water supply to the appliance.

P-2318.2 Sink and dishwasher: A sink and dishwasher may discharge through a single 1 1/2 inch trap. The discharge from the dishwasher shall be increased to a minimum of 3/4 inch and be connected with a wye fitting between the sink outlet and the trap inlet.

P-2318.3 Sink, dishwasher and food grinder: The discharge from a sink, dishwasher, and waste grinder may discharge through a single 1 1/2 inch trap. The discharge from the dishwasher shall be increased to a minimum of 3/4 inch and connected with a wye fitting between the discharge of the food-waste grinder and the trap inlet or to the head of the food grinder.

SECTION P-2319—CLOTHES WASHER

Each unit shall have integral backflow protection of the water supply to the appliance. The discharge from such a machine shall be through an air break.

SECTION P-2320—FLOOR DRAINS

Floor drains shall have waste outlets not less than 2 inches in diameter and shall be provided with a removable strainer with an open area of at least two-thirds of the cross-sectional area of the drain line to which it connects.

SECTION P-2321—WHIRLPOOL BATHTUBS

P-2321.1 Access panel: A door or panel of sufficient size shall be installed to provide access to the pump for repair and/or replacement.

P-2321.2 Piping drainage: The circulation pump shall be accessibly located above the crown weir of the trap. The pump drain line shall be properly graded to assure minimum water retention in the volute after fixture use.

P-2321.3 Leak testing: Leak testing and pump operation shall be performed in accordance with manufacturer's instructions.

P-2321.4 Manufacturer's instructions: The product shall be installed in accordance with installation instructions.

P-2321.5 Piping: Whirlpool bathtub circulation piping shall be installed to be self-draining.

SECTION P-2322 – BIDET INSTALLATIONS

P-2322.1 Water supply: The bidet shall be equipped with either an air-gap-type or vacuum-breaker-type fixture fitting.

SECTION P-2323 – FIXTURE-FITTING INSTALLATION

Faucets and diverters shall be installed so that the flow of hot water from the fittings corresponds to the left-hand side of the fitting.

Chapter 24
WATER SERVICE AND DISTRIBUTION

SECTION P-2401 – GENERAL

Every dwelling unit shall be provided with a supply of potable water in the amounts and pressures specified in this chapter. In a building where both a potable and nonpotable water-distribution system are installed, each system shall be identified by color marking, metal tag or other appropriate method. Any nonpotable outlet that could inadvertently be used for drinking or domestic purposes shall be posted.

SECTION P-2402 – PROTECTION OF POTABLE WATER SUPPLY

P-2402.1 Connections: Connections shall not be made to a potable water supply in a manner which could contaminate the water supply or provide a cross-connection between the supply and source of contamination unless an approved backflow-prevention device is provided. Cross-connections between a private water supply and a potable public supply shall not be made unless specifically approved by the health authority having jurisdiction.

P-2402.2 Backflow-prevention devices

P-2402.2.1 Air gaps: Where specified, a 1-inch-minimum air gap, measured vertically, is required between the lowest end of a water-supply outlet and the flood rim of the fixture or receptor. An air gap is required at the discharge point of a relief valve or piping. Air-gap devices shall be incorporated in dishwasher and clothes washer equipment.

P-2402.2.2 Vacuum breakers: A vacuum-breaker device is required at any water-supply outlet with a hose connection or at outlets which could be submerged and are not protected by an air gap. Typical applications include plumbing fixtures, hose bibb outlets and certain solar/storage tank installations. The vacuum breaker shall be installed per the manufacturers recommendations.

P-2402.3 Heat exchangers

P-2402.3.1 Double wall: Where a heat-exchange process takes place between a toxic substance and potable water, an approved double-walled heat exchanger shall be used. Examples include solar collector fluids (other than water) used for preheating domestic water in a tank, and desuperheaters utilizing rejected heat from an air-conditioner refrigerant to preheat domestic water.

P-2402.3.2 Single wall: A single-walled heat exchanger shall be permitted where potable water would not be contaminated in a heat-exchange process. Examples include solar installations that heat potable water directly in a collector, solar systems utilizing potable water as the collector fluid, domestic hot-water coils in boilers, and water-to-air heating coils.

SECTION P-2403—WATER SERVICE PIPING

P-2403.1 Materials: Materials for underground water-supply systems, water-service pipe and lawn sprinkler systems shall be as shown in Table No. P-2403.1. Any material subject to corrosion shall be protected when installed in corrosive soils. Approved fittings shall be used on the water-supply system or water-service piping.

Underground piping for water-service and lawn-sprinkling systems, when installed outside of the foundation walls of the building, may be of pressure-rated plastic conforming to the standards specified in Table No. P-2403.1.

Minimum working pressure rating for piping shall be 160 psi at 73 degrees F. Fittings shall be approved and compatible with the type of piping used.

Table No. P-2403.1
WATER SERVICE, SUPPLY AND DISTRIBUTION PIPING[1]
(As listed in Section S-26.2001)

MATERIAL	STANDARD NO.
Welded Copper Water Tube (WK, WL, WM)	ASTM B447-89
Cast Copper Alloy Solder-Joint Pressure Fittings	ASME B16.18-84
Steel Pipe, Black and Hot Dipped, Zinc Coated Welded and Seamless	ASTM A53-88a
Ductile Iron Pressure Pipe	ASTM A377-84
Seamless Red Brass Pipe, Standard Sizes	ASTM B43-88
Seamless Copper Tube	ASTM B75-86
Seamless Copper Watertube Type K, L, and M	ASTM B88-89a
Seamless Brass Type	ASTM B135-86a
ABS Plastic Pipe, Sch. 40 and 80	ASTM D1527-89
PVC Plastic Pipe, Sch. 40, 80 and 120	ASTM D1785-89
Polyethylene Plastic Pipe, Sch. 40	ASTM D2104-89el
Polyethylene Plastic Pipe (SDR-PR) Controlled ID	ASTM D2239-89el
PVC Pressure Rated Pipe (SDR Series)	ASTM D2241-89
ABS Plastic Pipe (SDR-PR)	ASTM D2282-89
PVC Plastic Pipe Fittings, Sch. 40	ASTM D2466-89
Socket Type PVC Plastic Pipe Fittings, Sch. 80	ASTM D2467-89el
ABS Plastic Pipe Fittings, Sch. 40	ASTM D2468-89
Plastic Insert Fittings for P.E. Plastic Pipe	ASTM D2609-89
Polybutylene (PB) Plastic Pipe (SDR-PR)	ASTM D2662-89
Polybutylene (PB) Plastic Tubing	ASTM D2666-89
Polyethylene (PE) Plastic Tubing	ASTM D2737-89
CPVC Plastic Hot and Cold Water Distribution Systems	ASTM D2846-89el
Butt Heat Fusion P.E. Fittings for P.E. Plastic Pipe and Tubing	ASTM D3261-88a
P.B. Plastic Hot Water Distribution Systems	ASTM D3309-89a
Socket Type CPVC Plastic Pipe Fittings, Sch. 40	ASTM F438-89a
Socket Type CPVC Plastic Pipe Fittings, Sch. 80	ASTM F439-89el
CPVC Plastic Pipe, Sch. 40 and 80	ASTM F441-89el
CPVC Plastic Pipe (SDR-PR)	ASTM F442-89el
Plastic Insert Fittings for P.B. Tubing	ASTM F845-88
Polyethylene (PE) Plastic Pipe Controlled OD	ASTM D2447-88
Polyethylene (PE) Plastic Pipe (SDR-PR)	ASTM D3000-89

[1]Section P-2001.1 provides for use of other approved materials in accordance with Section R-108.

P-2403.2 Pressure: Minimum average static pressure (as determined by the local water authority) at the building entrance for either public or private water service shall be 40 psi.

The minimum pressure at the point of outlet discharge shall not be less than a flow pressure of 8 psi for all fixtures except where manufacturers require a higher pressure. In determining the minimum pressure, allowance shall be made for pressure losses during maximum demand periods. Pressure and flow requirements to special fixtures, such as low one-piece toilets, shall be determined prior to sizing the piping system.

Maximum average static pressure shall be 80 psi. Where main pressure exceeds 80 psi, an approved pressure-reducing valve shall be installed in the water-service pipe near its entrance to the building.

P-2403.3 Thermal expansion: In addition to the required pressure relief valve, an approved device for thermal expansion control shall be installed whenever the building supply pressure is greater than the required relief valve pressure setting or when any device is installed that prevents pressure relief through the building supply.

P-2403.4 Size: The water-service pipe shall be of sufficient size to furnish water to the dwelling in required quantities and pressures, but in no case shall be less than 3/4 inch nominal diameter. Exact sizing to account for total demand and for pressure drop due to friction loss may be determined by standard engineering practice (see Appendix E) or by tables in Section P-2409.6. Total demand in water-supply fixture units shall be determined from Table Nos. P-2409.2 and P-2409.3.

P-2403.5 Installation

P-2403.5.1 Trench installation: Trenching, pipe installation and backfilling shall be in conformance with Section P-2204. Water-service pipes may be laid in the same trench with a building sewer constructed of materials listed in Section P-2202.1. If the building sewer is constructed of material not approved for use within the building as listed in Section P-2202.1, the water-service pipe shall be placed on a solid ledge at least 12 inches above and to one side of the highest point in the sewer line.

P-2403.5.2 Polyethylene plastic piping installation: Polyethylene pipe shall be cut square with the ends chamfered to remove sharp edges. Pipe that has been kinked shall not be installed. The installed radius of pipe curvature shall not be less than 30 pipe diameters or the coil radius when bending with the coil. Coiled pipe shall not be bent beyond straight. Bends shall not be permitted within ten pipe diameters of any fitting or valve. Compression type couplings and fittings shall be used when installing 1 1/2 inch and larger pipe. Stiffeners that extend beyond the clamp or nut shall not be used. Polyethylene pipe shall not be flared.

P-2403.6 Soil and groundwater: The installation of water-service piping, fittings, valves, appurtenances and gaskets shall be prohibited in soil and groundwater that is contaminated with solvents, fuels, organic compounds or other detrimental materials which will cause permeation, corrosion, degradation or structural failure of the water-service material.

Where detrimental conditions are suspected by or brought to the attention of the building official, a chemical analysis of the soil and groundwater conditions shall be required to ascertain the acceptability of the water-service material for the specific installation.

Where a detrimental condition exists, approved alternate materials or alternate routing shall be required.

SECTION P-2404 – JOINTS AND CONNECTIONS

P-2404.1 Tightness: Joints and connections in the plumbing system shall be gas-tight and water-tight for the intended use or required test pressure.

P-2404.2 Joint requirements

P-2404.2.1 Threaded pipe joints: Threaded joints shall conform to American National Taper Pipe Thread specifications. Pipe ends shall be deburred and all chips removed. Pipe joint compound shall be used only on male threads.

P-2404.2.2 Soldered joints: Soldered joints in tubing shall be made with fittings approved for water piping. Surfaces to be soldered shall be cleaned bright. The joints shall be properly fluxed and made with approved solder. Pipe and fittings used in the water-supply system shall have a maximum of 8 percent lead. Solders and fluxes used in potable water-supply systems shall have a maximum of 0.2 percent lead.

P-2404.2.3 Flared joints: Flared joints in water tubing shall be made with approved fittings. The tube shall be reamed and then expanded with a proper flaring tool.

P-2404.2.4 Plastic pipe joints: Joints in plastic piping shall be made with approved fittings by solvent cementing, heat fusion, corrosion-resistant metal clamps with insert fittings, compression connections, or other approved manufactured systems.

P-2404.2.5 Pressure lock fittings: Joints within the building between copper pipe, polybutylene tubing, CPVC tubing, or other approved material, in any combination with compatible outside diameters, may be made with the use of approved push-in mechanical fittings of a pressure-lock design.

P-2404.2.6 Joints between different materials: Joints between different materials in the plumbing system shall be as approved by the administrative authority.

P-2404.2.7 Joints between dissimilar metal pipe: Joints between ferrous (iron-based) piping and nonferrous metallic piping (typically copper) shall be made with a dielectric fitting or other nonmetallic connection to prevent deterioration of the joint by electrolysis.

SECTION P-2405—UNDER CONCRETE SLABS

Inaccessible water-distribution piping under slabs shall be copper water tube minimum Type M, brass, cast-iron pressure pipe or galvanized

steel pipe, chlorinated polyvinyl chloride (CPVC) or polybutylene (PB) plastic pipe or tubing — all to be installed with approved fittings or bends. Any material subject to corrosion shall be protected when used in corrosive soils. The minimum pressure rating for plastic pipe or tubing shall be 100 psi at 180 degrees F.

SECTION P-2406 — CHANGES IN DIRECTION

Changes in direction in copper tube may be made with bends having a radius of not less than four diameters of the tube, providing such bends are made by use of forming equipment which does not deform or create loss in cross-sectional area of the tube.

SECTION P-2407 — UNDERGROUND JOINTS

Joints in polybutylene (PB) plastic pipe or tubing underground or under a concrete floor slab shall be installed using heat fusion, in accordance with the manufacturers recommendations and Appendix X2.2.1.9 of ASTM D3309 listed in Section S-26.2407. Joints in copper pipe or tube installed in a concrete floor slab or under a concrete floor slab on grade shall be installed using wrought-copper fittings and brazed joints.

SECTION P-2408 – VALVES

P-2408.1 Service valve: Each dwelling unit shall be provided with an accessible main shutoff valve near the entrance of the water service. The valve shall be of a fullway type (minimal restriction to flow), with provision for drainage such as a bleed orifice or installation of a separate drain valve. Additionally, the water service shall be valved at the curb or property line in accordance with local water authority requirements.

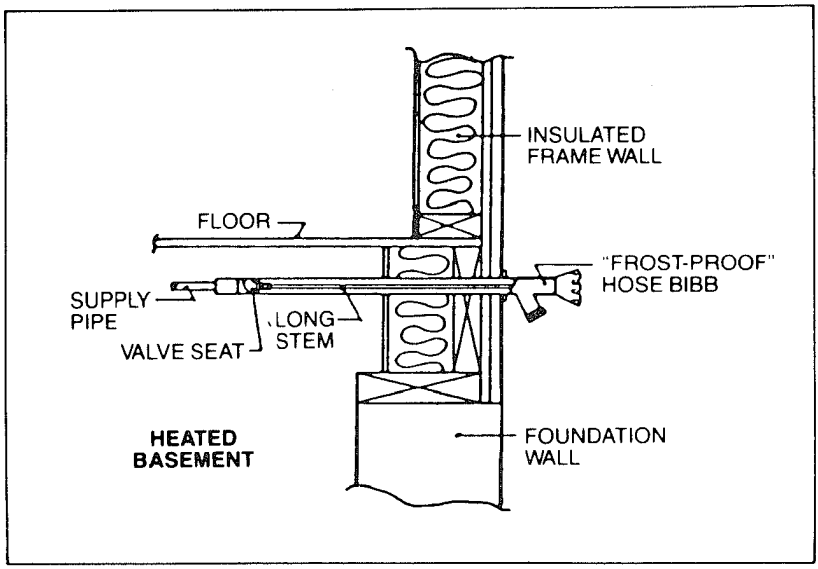
P-2408.2 Water heater valve: A readily accessible fullway valve shall be installed in the cold-water supply pipe to each water heater at or near the water heater.

P-2408.3 Individual fixture, riser and branch valves: Valves or stops to individual fixtures, appliances, risers and branches may be installed, but shall not be required. Where installed, such valves or stops shall be accessible.

P-2408.4 Hose bibb: Hose bibbs subject to freezing, including the "frost-proof" type, shall be equipped with an accessible stop-and-waste-type valve inside the building so that they may be controlled and/or drained during cold periods.

Exception: Frost-proof hose bibbs installed such that the stem extends through the building insulation into an open heated or semiconditioned space need not be separately valved (see Figure No. P-2408.4).

Figure No. P-2408.4
TYPICAL FROST-PROOF HOSE BIBB INSTALLATION
NOT REQUIRING SEPARATE VALVE



P-2408.5 Relief valves

P-2408.5.1 Pressure-relief valves: Pressure-relief valves shall have a relief rating adequate to meet the pressure conditions for equipment protected. In tanks, they shall be installed directly into a tank tapping or in a water line close to the tank. They shall be set to open at least 25 psi above the system pressure but not over 150 psi. The relief-valve setting shall not exceed the tank's rated working pressure.

P-2408.5.2 Temperature-relief valves: Temperature-relief valves shall have a relief rating adequate to meet the temperature conditions of the equipment protected. They shall be installed so that the temperature-sensing element is immersed in the hot test water, usually within the top 6 inches of the tank. The valve shall be set to open at a maximum temperature of 210 degrees F.

P-2408.5.3 Combination pressure/temperature-relief valves: Combination pressure/temperature-relief valves shall comply with all the requirements of separate pressure- and temperature-relief valves.

P-2408.5.4 Installation of relief valves: No check or shutoff valve shall be installed between a relief valve and a tank or heating equipment. The discharge pipe shall not be smaller than the relief-valve outlet, shall not be trapped, and shall terminate with an air gap into a plumbing fixture, floor drain, or other suitable point of discharge.

P-2408.5.5 Relief valves required on water heaters: Equipment used for heating water or storing hot water shall be protected by relief valves in accordance with one of the following:

1. A separate pressure-relief valve and a separate temperature-relief valve.
2. A combination pressure and temperature-relief valve.
3. An energy cutoff device (high limit) plus a pressure-relief valve or a pressure/temperature-relief valve.

P-2408.5.6 Relief valves required on pressure tanks: Water-pressure tanks shall be provided with a pressure-relief valve set at a pressure not in excess of the tank working pressure.

Exceptions:

1. Water systems with an integral pressure-reducing valve need not have a separate pressure-relief valve.
2. The pressure-relief valve on the water heater fulfills this requirement as long as the pressure tank rating is not exceeded by the relief-valve setting and no valve is installed in the piping between the water heater and the pressure tank.

SECTION P-2409—WATER-DISTRIBUTION SYSTEM

P-2409.1 Materials: Water-distribution piping within dwelling units shall be as shown in Table No. P-2403.1. ABS, PVC and P.E. Plastic may be used for cold water only. CPVC and P.B. Plastic may be used for both hot and cold water.

Minimum working pressure rating for hot-water piping shall be 100 psi at 180 degrees F. Fittings shall be approved and compatible with the type of piping being used.

P-2409.2 Determining water-supply fixture units: Supply load in the building water-distribution system shall be determined by total load on the pipe being sized, in terms of water-supply fixture units (w.s.f.u.), as shown in Table No. P-2409.2. For less common fixtures not listed, choose a w.s.f.u. value of a fixture with similar flow characteristics.

Example: Add up the total number of fixture units for various fixture groupings plus any individual fixtures that are in addition to a grouping. For example: The w.s.f.u. load on the water-service and hot- and cold-water main distribution piping for a two and one-half bath house with an additional lavatory in a dressing room, kitchen sink with dishwasher, and standpipe for clothes washer is calculated as follows:

	Hot Main	Cold Main	Combined Service
2 1/2-bath group	2.8	4.2	5.6
Extra lavatory	0.5	0.5	0.7
Kitchen group	1.9	1.0	2.5
Clothes washer	1.0	1.0	1.4
TOTAL	6.2	6.7	10.2

Table No. P-2409.2
WATER-SUPPLY FIXTURE-UNIT VALUES FOR VARIOUS PLUMBING FIXTURES AND FIXTURE GROUPS

TYPE OF FIXTURE OR GROUP OF FIXTURES	WATER-SUPPLY FIXTURE-UNIT VALUE (w.s.f.u.)		
	Hot	Cold	Combined
Bathtub (with/without overhead shower head)	1.0	1.0	1.4
Clothes washer	1.0	1.0	1.4
Dishwasher	1.4	—	1.4
Hose Bibb (sill cock)*	—	2.5	2.5
Kitchen sink	1.0	1.0	1.4
Lavatory	0.5	0.5	0.7
Laundry tub	1.0	1.0	1.4
Shower stall	1.0	1.0	1.4
Water closet (tank type)	—	2.2	2.2
Full-bath group with bathtub (with/without shower head) or shower stall	1.5	2.7	3.6
Half bath group (water closet and lavatory)	0.5	2.5	2.6
Kitchen group (dishwasher and sink with/without garbage grinder)	1.9	1.0	2.5
Laundry group (clothes washer standpipe and laundry tub)	1.8	1.8	2.5
Multiple-bath groups:			
1 1/2 baths	2.0	3.3	4.4
2 baths	2.6	3.9	5.2
2 1/2 baths	2.8	4.2	5.6
3 baths	3.2	4.7	6.3
3 1/2 baths	3.4	5.1	6.8
Additional 1 1/2 bath if part of group	0.3	0.6	0.8

*The fixture unit value 2.5 assumes a flow demand of 2.5 gpm, such as for an individual lawn sprinkler device. If a hose bibb/sill cock will be required to furnish a greater flow rate, the equivalent fixture-unit value may he obtained from Tahble No P. 2409.3 or from Figure No. E.2 of Appendix E.

P-2409.3 Estimating supply demand: Maximum supply demand in gallons per minute (gpm) in the service pipe or in various parts of the water-distribution system shall be determined from Table No. P-2409.3 after computing fixture unit loads from Table No. P-2409.2. For supply outlets likely to impose a continuous demand, such as a hose bibb or lawn sprinkler system, estimate this continuous supply separately and add to the gpm demand for fixtures supplied by the pipe to be sized.

Table No. P-2409.3
DEMAND FLOW RATE AS A FUNCTION OF FIXTURE UNIT LOAD

LOAD* (w.s.f.u.)	DEMAND* (gpm)
2	2.0
3	3.0
4	3.8
5	4.5
6	5.1
7	5.8
8	6.5
9	7.2
10	7.7
12	9.0
14	10.4
16	11.6
18	12.7
20	14.0
25	16.8
30	19.5

*Interpolation may be used to obtain intermediate values.

P-2409.4 Size of fixture branches: The minimum sizes for fixture branches shall be determined from Table No. P-2409.4.

Table No. P-2409.4
MINIMUM SIZES OF FIXTURE BRANCHES**** (Fixtures Water-supply Pipes)*

TYPE OF FIXTURE OR OUTLET	NOMINAL PIPE SIZE (IN.)
Bathtub (with/without shower head) Clothes-washer supply fitting Kitchen sink** Laundry tub (one or two compartment) Shower head Wall hydrant/sill cock/hose bibb	3/8
Bar sink Bidet Dishwasher Lavatory Water closet (close-coupled tank type)***	1/4

*Table applies to water-conserving fixtures and supply fittings having branches not greater than 10 feet in length. If length is greater than 10 feet, increase one pipe size. For special fixtures or fittings, size according to manufacturer's recommendations.

**Cold branch may be 1/4 inch.

***Also see Section P-2403.2 or according to manufacturer's specifications.

****Table not applicable to manifold systems. See Section P-2409.7.

P-2409.5 Size of fixture group mains: Fixture group main (secondary branch) piping within a fixture group area may be sized according to Table No. P-2409.5.

Table No. P-2409.5
SIZE OF FIXTURE GROUP MAINS
(Secondary Branches)
ACCORDING TO NUMBER AND SIZE OF
FIXTURE BRANCH PIPES*

FIXTURE GROUP MAIN SIZE	NUMBER AND SIZE OF FIXTURE BRANCH PIPES CONNECTED
3/8"	Two 1/4"
1/2"	Three 3/8" or Two 3/8" plus two 1/4" or One 3/8" plus four 1/4"

*Table not applicable to manifold systems. See Section P-2409.7.

P-2409.6 Size of water-service mains, branch mains and risers: The size of water-service mains, branch mains and risers shall be determined according to water-supply demand (gpm), available water pressure (psi) and friction loss due to developed length of pipe (feet), including equivalent length of fittings according to standard engineering practice (see Appendix E). Alternately, sizes may be determined from Table Nos. P-2409.6a through P-2409.6d, which assume a nominal static pressure of 40 psi or greater at the main shut-off valve, using the following procedure:

1. Determine the total fixture unit load (w.s.f.u.) served by the pipe interval to be sized (refer to Table No. P-2409.2). Working downstream from the farthest fixture or fixture group, add the fixture-unit values and note the totals for each riser, branch or main to be sized. Where fixture groups are being added, use the reduced w.s.f.u. values for fixture groups in Table No. P-2409.2 which take into account probability factors of simultaneous use. Individual fixture branches and fixture-group mains should be sized from Table Nos. P-2409.4 and P-2409.5 rather than Table Nos. P-2409.6a through P-2409.6d.
2. Determine pipe size for each interval from the w.s.f.u. values obtained in Step 1 using Table Nos. P-2409.6a through P-2409.6d, depending on the appropriate piping material being installed. (If preferred, w.s.f.u.'s may be converted to gpm using Table No. P-2409.3, as both w.s.f.u. and gpm values are provided in Table Nos. P-2409.6a through P-2409.6d.)
3. Repeat the above steps, as applicable, for each piping interval where additional loads connect, based on total w.s.f.u. load (or

the corresponding gpm) at that point, until all mains, branch mains and risers have been sized back to the water heater (hot), and service valve (cold). This procedure may also be used to size the service pipe.

Table No. P-2409.6a
PIPE SIZING BASED ON VELOCITY LIMITATION FOR COPPER WATER TUBE[1,2,4]

NOMINAL PIPE SIZE (IN.)	TYPE K		TYPE L		TYPE M	
	CARRYING CAPACITY					
	gpm	w.s.f.u.	gpm	w.s.f.u.	gpm	w.s.f.u.
1/2	5.44	6	5.81	7	6.34	8
3/4	10.9	15	12.1	17	12.9	20
1	19.4	30	20.6	32	21.8	35
1 1/4	30.3	54	31.3	57	32.6	61

[1]The relation between carrying capacities in gpm and w.s.f.u. is based on Table No. E.4 and Figure No. E.1 of Appendix E.
[2]Table based on velocities as follows:
Copper—8 fps Steel—10 fps Plastics—12 fps
Where local experience or manufacturer's recommendations specify lower velocities, the carrying capacities shall be reduced accordingly.
[3]Capacities for polybutylene (PB) SDR 11 pipe in sizes 3/4, 1 and 1 1/4 inches are approximately the same as listed for Schedule 40 PE and CPVC pipe in Table No. P-2409.6d.
[4]Values are based on materials which conform to the following standards, as listed in Section S-26.2409:
Copper water tube — ASTM B88
Schedule 40 steel pipe — ASTM A53
Polybutylene SDR 11 — ASTM D3309
CPVC Schedule 40 — ASTM F441
Polyethylene Schedule 40 — ASTM D2447

Table No. P-2409.6b
PIPE SIZING BASED ON VELOCITY LIMITATION FOR STEEL PIPE — STANDARD WALL SCHEDULE 40[1,2,4]

NOMINAL PIPE SIZE (IN.)	CARRYING CAPACITY	
	gpm	w.s.f.u.
1/2	9.46	13
3/4	16.6	25
1	26.9	46
1 1/4	46.6	115

See Table No. P-2409.6a for notes.

Table No. P-2409.6c
PIPE SIZING BASED ON VELOCITY LIMITATION FOR POLYBUTYLENE (PB) TUBING[3] — SDR 11[1,2,4] AND CHLORINATED POLYVINYL CHLORIDE (CPVC) TUBING SDR 11[1,2,4]

NOMINAL PIPE SIZE (IN.)	CARRYING CAPACITY	
	gpm	w.s.f.u.
1/2	7.36	9
3/4	15.0	22
1	24.9	41
1 1/4	37.2	75

See Table No. P-2409.6a for notes.

Table No. P-2409.6d
PIPE SIZING BASED ON VELOCITY LIMITATION FOR CHLORINATED POLYVINYL CHLORIDE (CPVC) PIPE — SCHEDULE 40[1,2,4] AND POLYETHLENE (PE) PIPE — SCHEDULE 40[1,2,4]

NOMINAL PIPE SIZE (IN.)	CARRYING CAPACITY	
	gpm	w.s.f.u.
1/2	11.4	16
3/4	19.9	31
1	32.2	60
1 1/4	56.0	155

See Table No. P-2409.6a for notes.

P-2409.7 Manifold parallel water distribution systems

P-2409.7.1 General: Hot and cold manifold parallel water distribution systems with individual distribution lines to each fixture or fixture fittings shall be sized and installed per Sections P-2409.7 through P-2409.7.8.

P-2409.7.2 Sizing of manifolds: Manifold shall be sized per Table No. P-2409.7.2 Total GPM is the demand of all outlets.

Table No. P-2409.7.2
MANIFOLD SIZING

PLASTIC		METALLIC	
Nominal Size ID (inches)	*Maximum GPM	Nominal Size ID (inches)	*Maximum GPM
3/4	17	3/4	11
1	29	1	20
1 1/4	46	1 1/4	31
1 1/2	66	1 1/2	44

*Based on velocity limitation: plastic — 12 fps; metal — 8 fps.
Note: Reference shall be made to Table P-2409.3 for WFSU.

P-2409.7.3 Minimum size: The minimum size of individual distribution lines shall be 3/8 inch.

Exceptions:

1. Certain fixtures such as one-piece water closets and whirlpool bathtubs shall require a larger size when specified by the manufacturer.
2. If a water heater is fed from the end of a cold water manifold, the manifold shall be one size larger than the water heater feed.

P-2409.7.4 Maximum length: The maximum length of individual distribution lines shall be 60 feet nominal.

P-2409.7.5 Orientation: Manifolds shall be permitted to be installed in a horizontal or vertical position.

P-2409.7.6 Support: Piping bundles shall be secured per manufacturer's instructions and supported every 4 feet. Bundles that change direction 45 degrees or greater shall be protected from chaffing at point of contact with framing members by sleeving or wrapping.

P-2409.7.7 Valving: Fixture valves, when installed, shall be located either at the fixture or at the manifold. If installed at the manifold, they shall be labeled indicating the fixture served.

P-2409.7.8 Hose bibb bleed: A readily accessible air bleed shall be installed in hose bibb supplies at the manifold or at the bibb exit point.

SECTION P-2410 – SUPPORT

Pipe and tubing support shall conform to Section P-2005.

SECTION P-2411 – WATER HEATER

P-2411.1 General: Every dwelling shall have an approved automatic water heater or other type domestic water-heating system sufficient to supply hot water to plumbing fixtures and appliances intended for bathing, washing or culinary purposes. Storage tanks shall be constructed of noncorrosive metal or be lined with noncorrosive material.

P-2411.2 Tank sizing: Table No. P-2411.2 may be used as a guide in determining minimum water heater tank size.

P-2411.3 Prohibited locations: Water heaters, which depend on the combustion of fuel, shall not be installed in sleeping rooms, bathrooms, clothes closets, or in closets or confined spaces opening into bathrooms or bedrooms.

Exception: Direct vent-type water heaters.

SECTION P-2412 – TESTING WATER-SUPPLY SYSTEMS

Upon completion of a section or of the entire water-supply system, it shall be tested under a water pressure not less than 100 psi for 30 minutes with no evidence of leakage. The water used for tests shall be obtained from a potable source of supply.

Table No. P-2411.2
GUIDELINES FOR WATER HEATER SIZING

Fuel		Gas	Elect	Oil	Gas	Elect	Oil	Gas	Elect	Oil	Gas	Elect	Oil
Number of Bedrooms		1			2			3			—		
1 to 1 1/2 Baths	Storage (gal)	20	20	30	30	30	30	30	40	30	—	—	—
	Input (Btuh or kw)	27K	2.5	70K	36K	3.5	70K	36K	4.5	70K	—	—	—
	Draw (gph)	43	30	89	60	44	89	60	58	89	—	—	—
	Recovery (gph)	23	10	59	30	14	59	30	18	59	—	—	—
Number of Bedrooms		2			3			4			5		
2 to 2 1/2 Baths	Storage (gal)	30	40	30	40	50	30	40	50	30	50	66	30
	Input (Btuh or kw)	36K	4.5	70K	36K	5.5	70K	38K	5.5	70K	47K	5.5	70K
	Draw (gph)	60	58	89	70	72	89	72	72	89	90	88	89
	Recovery (gph)	30	18	59	30	22	59	32	22	59	40	22	59
Number of Bedrooms		3			4			5			6		
3 to 3 1/2 Baths	Storage (gal)	40	50	30	50	66	30	50	66	30	50	80	40
	Input (Btuh or kw)	38K	5.5	70K	38K	5.5	70K	47K	5.5	70K	50K	5.5	70K
	Draw (gph)	72	72	89	82	88	89	90	88	89	92	102	99
	Recovery (gph)	32	22	59	32	22	59	40	22	59	42	22	59

Note: Storage capacity, input and the recovery requirements indicated in the table are typical and may vary with each individual manufacturer. Any combinations of these requirements to produce the 1 hour draw stated will be satisfactory. Recovery is based on 100°F water temperature rise.

Chapter 25
SEWERS AND PRIVATE OR INDIVIDUAL SEWAGE DISPOSAL SYSTEMS

SECTION P-2501 – GENERAL

P-2501.1 Mandatory connection to public sewer: A permit shall not be issued for the installation, alteration or repair of a private sewage disposal system or part thereof where a connection with a public sewer is available. "Available" shall be deemed to be a parcel of land abutting on a street, alley or easement.

P-2501.2 Mandatory connection to a sewage system: Plumbing fixtures and drainage piping shall be connected to a public sewer or an approved private or individual sewage disposal system.

Building sewers and private sewage disposal systems shall conform to the requirements of this chapter and other related requirements of this code.

P-2501.3 Materials: Brick, block, concrete and mortar used in the construction of private sewage disposal systems shall have a minimum compressive strength as specified in Sections R-302 and R-304.

P-2501.4 Prohibited connections: Rain, surface or subsurface water shall not be connected to or discharge into a drainage system, sanitary sewer system or individual sewage disposal system.

Cesspools, septic tanks, seepage pits and drain fields shall not be connected to public sewers or to building sewers leading to public sewers.

SECTION P-2502 – BUILDING SEWER SIZE

P-2502.1 Required size: The size of building sewer shall be determined in accordance with Table No. P-2206.4.2.

P-2502.2 Installation: Building sewers shall be installed at a uniform slope of not less than 1/4 inch per foot and may be reduced to 1/8 inch per foot in accordance with Section P-2206.4.2 toward the point of disposal and shall be laid on a firm bed of approved materials. Cleanouts shall be placed at the junction of the building drain and building sewer and at intervals not to exceed 100 feet in straight runs.

SECTION P-2503 – DISPOSAL SYSTEMS

P-2503.1 General: The type of private sewage disposal system shall be determined on the basis of location, soil porosity, and groundwater level as determined by the authority having jurisdiction.

P-2503.2 Excavations: Excavations shall not extend into the water table to a depth where sewage may contaminate underground water stratum that is usable for domestic purposes.

P-2503.3 Water table: Where the groundwater level extends to less than 12 feet of the ground surface or where the upper soil is porous and the underlying stratum is rock or impervious soil, a septic tank and disposal field system shall be installed.

P-2503.4 Additional capacity: Private sewage disposal systems shall be designed so that additional seepage pits or subsurface drain fields, equivalent to at least 50 percent of the required original system, may be installed.

P-2503.5 Absorption capacity of soil: In order to determine the absorption qualities of questionable soils other than those listed in Table No. P-2507, the proposed site shall be subjected to percolation tests acceptable to the administrative authority.

SECTION P-2504 – LOCATION

Private sewage disposal systems shall be located as set forth in Table No. P-2504.

Table No. P-2504
LOCATION OF SEWAGE DISPOSAL SYSTEM

MINIMUM HORIZONTAL DISTANCE IN CLEAR REQUIRED FROM	BUILDING SEWER	SEPTIC TANK	DISPOSAL FIELD	SEEPAGE PIT OR CESSPOOL
Buildings or structures[1]	2 feet	5 feet	8 feet	8 feet
Property line adjoining private property	Clear	5 feet	5 feet	8 feet
Water-supply wells	50 feet[2]	50 feet	50 feet	100 feet
Streams	50 feet	50 feet	50 feet	100 feet
Large trees		10 feet		10 feet
Seepage pits or cesspools		5 feet	5 feet	12 feet
Disposal field		5 feet	4 feet[3]	5 feet
Domestic water line	1 foot	5 feet	5 feet	5 feet
Distribution box			5 feet	5 feet

NOTE: When disposal fields and/or seepage pits are installed in sloping ground, the minimum horizontal distance between any part of the leaching system and ground surface shall be 15 feet.

[1] Including porches and steps whether covered or uncovered, breezeways, roofed porte cocheres, roofed patios, carports, covered walks, covered driveways and similar structures or appurtenances.

[2] All nonmetallic drainage piping shall clear domestic water-supply wells by at least 50 feet. This distance may be reduced to not less than 25 feet when approved-type metallic piping is installed.
Where special hazards are involved, the distance required shall be increased as may be directed by the building official or public health authority.

[3] Plus 2 feet for each additional foot or depth in excess of 1 foot below the bottom of the drain line.

SECTION P-2505 – SEPTIC TANK CAPACITY

The liquid capacity of septic tanks shall be not less than the amounts set forth in Table No. P-2505.

Septic tank sizes in this table include sludge storage capacity and the connection of domestic food-waste disposal units.

Table No. P-2505
MINIMUM CAPACITY OF SEPTIC TANKS

SINGLE-FAMILY DWELLINGS NUMBER OF BEDROOMS	SEPTIC TANK CAPACITY IN GALLONS
1 or 2	750
3	1,000
4	1,200
5 or 6	1,500
Two-family dwellings, one bedroom each[1]	1,200

[1]Extra bedrooms 150 gallons each.

SECTION P-2506 – SEPTIC TANK DESIGN AND CONSTRUCTION

P-2506.1 General: Septic tanks shall be water-tight and designed to produce clarified effluent and provide adequate space for sludge and scum accumulations.

P-2506.2 Materials: Septic tanks shall be constructed of durable and corrosion-resistive materials. They shall be structurally designed to withstand all anticipated earth or other loads and shall be installed level and on a solid bed.

Septic tanks may conform to the requirements of this section or other design procedures acceptable to the authority having jurisdiction.

The walls, floors and covers of unreinforced, precast or cast-in-place concrete septic tanks shall have a minimum specified compressive strength of not less than 2,500 psi and a thickness of not less than 5 inches. The length of any unreinforced wall section shall not exceed 6 feet, and covers shall be reinforced in accordance with Table No. P-2506.2. Septic tanks shall be designed in accordance with recognized engineering principles where the ground covering the tank is more than 3 feet in depth.

Table No. P-2506.2
SEPTIC TANK REINFORCEMENTS FOR
5-INCH-THICK COVERS

EXTENT OF REINFORCEMENT[1]	ALLOWABLE SPAN IN FEET AND INCHES
1/2 @ 18" o.c.	2' -9"
1/2 @ 12" o.c.	3' -4"
1/2 @ 6" o.c.	4' -9"
1/2 @ 3" o.c.	6' -6"

[1]Reinforcement shall be located in the bottom of slab with 2 inches of concrete coverage.

P-2506.3 Design: Septic tanks shall have not less than two compartments. The inlet compartment shall have not less than two-thirds of the total capacity of the tank nor less than 500 gallons liquid capacity and shall be not less than 3 feet in width and 5 feet in length. The liquid depth shall be not less than 2 feet 6 inches nor more than 6 feet. The secondary compartment shall have a capacity of not less than 250 gallons or more than one-third of the total capacity.

P-2506.4 Access: Access to septic tanks shall be provided by not less than two manholes, 20 inches in minimum dimensions, or by removable cover slabs having equivalent dimensions. Access manholes shall be located over the inlet and outlet compartments.

P-2506.5 Inlet and outlet pipes: Inlet and outlet pipes and baffles shall extend 4 inches above and not less than 12 inches below the water surface. The invert of the inlet pipe shall be not less than 2 inches above the invert of the outlet pipe. Inlet and outlet pipe fittings, baffles and compartment partitions shall have free vent area above the water surface equal to the required area of the sewer.

P-2506.6 Tank dimensions: Septic tank depth shall be not less than 9 inches greater than the liquid depth and the cover shall be not less than 2 inches above the back vent openings.

P-2506.7 Partitions and baffles: Partitions or baffles between compartments shall be of durable material and shall extend not less than 4 inches above the liquid level. An inverted fitting equivalent in size to the tank inlet, but in no case less than 4 inches in size, shall be installed in the inlet compartment side of the baffles with the bottom of the fitting placed midway in the depth of the liquid.

P-2506.8 Corrosion protection: The upper part of concrete septic tanks shall be protected from corrosion by coating the inside with an approved bituminous coating. The coating shall extend to not less than 4 inches below the water line.

SECTION P-2507 – DISPOSAL AREA

Disposal fields and seepage pits shall be placed in the types of soils set forth in Table No. P-2507 without exceeding the area therein. The effective absorption area in seepage pits shall include the sidewall area below the inlet.

Table No. P-2507
RATED ABSORPTION CAPACITIES OF FIVE TYPICAL SOILS

TYPE OF SOIL	REQUIRED SQ. FT. OF LEACHING AREA/100 GALS. OF SEPTIC TANK CAPACITY	MAX. ABSORPTION CAPACITY GALS./SQ. FT. OF LEACHING AREA
(1) Coarse sand or gravel	20	5
(2) Fine sand	25	4
(3) Sandy loam or sandy clay	40	2.5
(4) Clay with considerable sand or gravel	60	1.66
(5) Clay with small amount of sand or gravel	90	1.11

SECTION P-2508 – DRAIN LINES

P-2508.1 Distribution lines: Distribution lines shall be constructed of open joint or perforated tile, or approved perforated plastic pipe, bituminous fiber pipe having adequate openings for distribution of the effluent into the trench areas and shall be laid on crushed stone, gravel, slag or similar filter materials having voids varying in size from 3/4 inch to 2 1/2 inches. The filter material shall have a depth, under the drains, of not less than 12 inches and shall provide not less than 2 inches of cover over the drains. The upper half of the open joints shall be covered with roofing felt and the filter material shall be covered with porous material prior to backfill.

P-2508.2 Drain line trenches: Drain line trenches shall not be more than 100 feet in length and have a width of not more than 36 inches or less than 18 inches. The trenches shall be spaced at not less than 6 feet on center and have sufficient depth to provide 12 inches of earth over the lines. The clear distance between trenches shall be not less than 4 feet plus 2 feet for each additional foot of depth in excess of 1 foot below the bottom of the drain line. The slope of the lines shall be not more than 6 inches per 100 feet or less than 3 inches per 100 feet.

SECTION P-2509—SEEPAGE PITS

Seepage pits shall conform to the following requirements:

1. Seepage pits shall be circular and shall have excavated diameters of not less than 4 feet. The pits shall be lined with burned clay brick, concrete brick, concrete circular cesspool blocks or other approved materials having minimum compressive strengths of 2,500 psi.
2. Linings shall be laid with staggered, tight joints on a firm foundation and have a thickness of not less than 4 inches. Except for approved precast concrete circular sections, brick or block shall not be greater in height than their width. Brick or block greater than 12 inches in length shall have chamfered matching ends and be scored to provide for seepage. Hollow tile or concrete units shall not be used. Excavation voids behind the brick or block lining shall be progressively backfilled and tamped while the lining is being installed.
3. Seepage pit walls shall extend a minimum of 10 feet below the inlet, exclusive of the arch.
4. Masonry arched covers shall be laid either dry or in cement mortar conforming to Section P-2501. Cement mortar, not less than 2 inches thick, shall be applied over the cover and shall extend 6 inches beyond the walls.
5. Reinforced concrete covers shall conform to Section P-2506 and shall be reinforced in two directions. The covers shall extend not less than 3 inches beyond the walls and be provided with not less than a 9-inch diameter inspection hole. The covers shall be coated on the underside with approved bituminous compound.
6. The top arch or cover shall be not less than 18 inches and not more than 4 feet below the surface of the ground.
7. Vented inlet fittings shall be provided and so installed as to prevent the inflow from damaging the walls.
8. When overflow seepage pits are added to existing installations, the effluent shall leave the existing pit through an approved vented leg extending at least 12 inches downward into the existing pit, and the overflow pit shall have its outlet flow line not less than 6 inches below the inlet.

SECTION P-2510—COMBINED SEEPAGE PITS AND DISPOSAL FIELDS

P-2510.1 Filter material: In combining seepage pits and disposal fields, the filter material shall be located not less than 5 feet from the seepage pits and the interconnecting pipes shall be water-tight.

P-2510.2 Distribution boxes: Where two or more drain lines or seepage pits are installed, distribution boxes of sufficient size to receive lateral lines shall be constructed at the head of each disposal field. The inverts of all outlets shall be level and the invert of the inlets shall be not less than 1 inch above the outlet.

P-2510.3 Laterals: Laterals from distribution boxes to the disposal fields, where the grade exceeds 6 inches per 100 feet shall have water-tight joints.

Part VI -- Electrical

The electrical requirements shall conform to NFiPA 70A listed in Section S-26.6000.

Part VII -- Energy Conservation

The energy conservation requirements shall conform to the CABO Model Energy Code listed in Section S-26.7000.

Prefabricated housing units, except those units in the category of manufactured homes, otherwise known as mobile homes, shall meet the requirements of this section.

Part VIII – Standards

Chapter 26
STANDARDS

SECTION S-26.000 – GENERAL

The following is a listing of standards which are referenced in this code, the date of the standard and the promulgating agency of the standard. The specific subsection of the code in which each standard is referenced is also identified. The digits following the decimal in the section numbers of this chapter refer to that section of this code where the standards are referenced.

SECTION S-26.001 – ABBREVIATIONS

The abbreviations preceding these standards shall have the following meaning and are the organizations issuing the standards and publications listed.

AA — Aluminum Association
818 Connecticut Avenue, NW, Washington, D.C. 20006

AAMA — American Architectural Manufacturers Association
2700 River Road, Des Plaines, IL 60018

ACCA — Air Conditioning Contractors of America
1228 17th Street, NW, Washington, D.C. 20036

ACI — American Concrete Institute
P.O. Box 19150, Detroit, MI 48219

AHA — American Hardboard Association
887-B Wilmette Road, Palatine, IL 60067

AISC — American Institute of Steel Construction
400 N. Michigan Avenue, Chicago, IL 60611

AISI — American Iron and Steel Institute
1000 16th Street, NW, Washington, D.C. 20036

ANSI — American National Standards Institute
1430 Broadway, New York, NY 10018

APA — American Plywood Association
P.O. Box 11700, Tacoma, WA 98411

ASCE — American Society of Civil Engineers
345 E. 47th Street, New York, NY 10017

ASME — American Society of Mechanical Engineers
United Engineering Center, 345 E. 47th Street
New York, NY 10017

ASSE — American Society of Sanitary Engineering
P.O. Box 40362, Bay Village, OH 44140

ASTM — American Society for Testing and Materials
1916 Race Street, Philadelphia, PA 19103

AWPA — American Wood Preservers Association
P.O. Box 849, Stevensville, MD 21666

AWPB — American Wood Preservers Bureau
P.O. Box 6085, Arlington, VA 22206

BIA — Brick Institute of America
11490 Commerce Park Drive, Suite 300, Reston, VA 22091

CABO — Council of American Building Officials
5203 Leesburg Pike, Suite 708, Falls Church, VA 22041

CISPI — Cast Iron Soil Pipe Institute
1499 Chain Bridge Road, McLean, VA 22101

CPSC — Consumer Products Safety Commission
Office of the Secretary, Washington, D.C. 20207

CSSB — Cedar Shake and Shingle Bureau
515 116th Avenue, NE, Suite 275, Bellevue, WA 98004

CWC — Canadian Wood Council
55 Metcalfe Street, Suite 1550, Ottawa, Ontario
Canada K1P6L5

DOC — U.S. Department of Commerce
National Bureau of Standards, Washington, D.C. 20234

FM — Factory Mutual Engineering Corporation
1151 Boston Providence Turnpike, Norwood, MA 02062

FS — Federal Specification
Department of Commerce, Washington, D.C. 20230

GA — Gypsum Association
1603 Orrington Avenue, Suite 1210, Evanston, IL 60201

HPMA — Hardwood Plywood Manufacturers Association
P.O. Box 2789, Reston, VA 22090

NAHB — National Association of Home Builders
15th and M Streets, NW, Washington, D.C. 20005

NCMA — National Concrete Masonry Association
2302 Horse Pen Road, P.O. Box 781, Herndon, VA 22070

NFiPA — National Fire Protection Association
Batterymarch Park, Quincy, MA 02269

NFoPA — National Forest Products Association
1250 Connecticut Avenue, NW, Washington, D.C. 20036

NWWDA — National Wood Window and Door Association
1400 E. Touhy Avenue, Suite G-54, Des Plaines, IL 60018

PTI — Post-Tensioning Institute
1717 W. Northern Ave., Suite 218, Phoenix, AZ 85021-5469

SFPA — Southern Forest Products Association
P.O. Box 52468, New Orleans, LA 70152

SMACNA — Sheet Metal and Air Conditioning Contractors
National Association, Inc.
4201 Lafayette Center Drive, Chantilly, VA 22021

SPI — Society of the Plastics Industry
355 Lexington Avenue, New York, NY 10017

TPI — Truss Plate Institute
583 D'Onofrio Drive, Suite 200, Madison, WI 53719

UL — Underwriters Laboratories Inc.
333 Pfingsten Road, Northbrook, IL 60062

WRI — Wire Reinforcement Institute, Inc.
1101 Connecticut Ave., NW, Suite 700
Washington, D.C. 20036-4303

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ASTM

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C62 — 1989	Building Brick (Solid Masonry Units Made From Clay or Shale) ..... "Def. of Solid Masonry"
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CPSC

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ASTM

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FM

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4880—1972	Factory Mutual Building Corner Fire Test	R-216.1, R-216.3

NFiPA

259—1987	Potential Heat of Building Materials, Standard Method of Test for	R-216.2.5

✱ UL

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ASTM

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ASTM

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ASTM

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AWPA

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NFoPA

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NFoPA

Technical Report No. 7—1987	The Permanent Wood Foundation System, Basic Requirements R-303

PTI

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WRI

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ACI

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ACI/ASCE

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AWPA

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BIA

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DOC

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NCMA

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NFoPA

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NFoPA

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NFoPA

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NFoPA

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AWPA

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USDA Forest Service

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ASTM

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NAHB

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NFoPA

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AA

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AISC

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AISI

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ACI/ASCE

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AISC

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ASTM

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A641—1982	Specification for Zinc-Coated (Galvanized) Steel Wire	Table No. R-404.14.1
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BIA

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NCMA

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ASTM

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ASTM

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AAMA

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AAMA

101—1988 Voluntary Specification for Aluminum Prime Windows and Sliding Glass Doors.....R-412

ASTM

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NWWDA

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APA

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DOC

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HPMA

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ANSI

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ASTM

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C841—1987	Specification for Installation of Interior Lathing and Furring	R-502.4
C842—1985	Specification for Application of Interior Gypsum Plaster	R-502.4
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CSSB

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CSSB—1985	Grading and Packing Rules for Certi-Split Red Cedar Shakes (Revised October 1, 1985)	R-502.7

CSSB—1984	Grading and Packing Rules for Certigrade Red Cedar Shingles (Revised February 1, 1984)	R-502.7
CSSB—1990	Grading Rules for Certi-Sawn Taper-Sawn Red Cedar Shakes (Revised May 30, 1990)	R-502.7

GA

216—1989	Recommended Specification for Application and Finishing of Gypsum Board	R-502.5

HPMA

HP—1983	Hardwood and Decorative Plywood	R-502.7

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ASTM

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AHA

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AAMA

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CSSB

CSSB—1985	Grading and Packing Rules for Certi-Split Red Cedar Shakes (Revised October 1, 1985)	R-503.5
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CSSB—1990	Grading Rules for Certi-Sawn Taper-Sawn Red Cedar Shakes (Revised May 30, 1990)	R-503.5
CSSB—1989	Cedar Shake and Single Bureau Design and Application Manual for Exterior and Interior Walls	R-503.10

NFoPA

Technical Report No. 7—1987	The Permanent Wood Foundation System, Basic Requirements	R-503.4

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CWC

CWC—1987 Canadian Dimension Lumber Data Book R-601.2

HPMA

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NFoPA

NFoPA—1986 National Design Specification for Wood
(1987) NDS(supp) Construction (with Supplement of Design Values
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SFPA

SFPA—1989 Southern Pine Maximum Spans for Joists
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NAHB

NAHB—1982 NAHB Research Report; Design Tables –
Fabrication Guide, Off-Center Spliced
Floor Joists R-602.2.1

TPI

BWT—1976 Bracing Wood Trusses: Commentary
and Recommendations R-602.9

PCT—1980 Design Specification for Metal Plate Connected
Parallel Chord Wood Trusses R-602.9

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Wood Trusses R-602.9

TPI—1985 Design Specification for Metal Plate Connected
Wood Trusses R-602.9

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AWPA

C22—1988 Lumber and Plywood for Permanent Wood
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by Pressure Process R-604.3

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NFoPA

Technical Report No. 7—1987	The Permanent Wood Foundation System, Basic Requirements R-604.3

SECTION S-26.605 – FLOORS – METAL

AA

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AISC

AISC—1978	Specification for the Design, Fabrication and Erection of Structural Steel for Buildings R-605

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APA

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DOC

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HPMA

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ANSI

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CWC

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NFoPA

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SFPA

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ASCE

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TPI

BWT—1976	Bracing Wood Trusses: Commentary and Recommendations	R-702.9
PCT—1980	Design Specification for Metal Plate Connected Parallel Chord Wood Trusses	R-702.9
QST—1989	Quality Standard for Metal Plate Connected Wood Trusses	R-702.9
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ANSI

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AA

SAS30—1986	Specifications for Aluminum Structures	R-705.2

AISC

AISC—1978 Specification for the Design, Fabrication and Erection of Structural Steel for Buildings R-705.1

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AA

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ASTM

A239—1973 Test Method for Locating the Thinnest Spot in a Zinc (Galvanized) Coating on Iron or Steel Articles by the Preece Test (Copper Sulfate Dip) (Reapproved 1983) R-801.3

A361—1985 Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process for Roofing and Siding R-801.3

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B209—1989 Specification for Aluminum and Aluminum-Alloy Sheet and Plate R-801.3

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B250—1987 Specification for General Requirements for Wrought Copper-Alloy Wire ..... R-801.3 *

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CSSB

CSSB—1985 Grading and Packing Rules for Certi-Split Red Cedar Shakes (Revised October 1, 1985) R-801.3

CSSB—1984 Grading and Packing Rules for Certigrade Red Cedar Shingles (Revised February 1, 1984) R-801.3

CSSB—1990 Grading Rules for Certi-Sawn Taper-Sawn Cedar Shakes (Revised May 30, 1990) ..... R-801 *

UL

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ASTM

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CSSB

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CSSB

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ANSI

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AGA		
7—90	AGA Requirements for Gas Convenience Outlets	Def. of "Convenience Outlet, Gas"
ASTM		
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E136—1982	Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°F	Def. of "Noncombustible Material"
UL		
103	Chimneys, Factory-Built, Residential Type and Building Heating Appliances	Def of "H.T. Chimney
441	Gas Vents	Def. "Type B and Type BW Vents"
641	Low-Temperature Venting Systems, Type L	Def. of "Type L Vents"

SECTION S-26.1101–HEATING AND COOLING EQUIPMENT

ACCA		
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ANSI		
Z21.47—1983	Gas-Fired Central Furnaces (Except Direct Vent and Separated Combustion System Central Furnaces), with Addenda Z21.47a-1985 and Z21.47b-1986	M-1101.2.1
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ANSI/ASHRAE		
15—89	Safety Code for Mechanical Refrigeration	M-1101.4.1

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ACCA		
Manual D—1984	Duct Design and Residential Winter and Summer Air Conditioning and Equipment Selection	M-1102.2.1

ASTM

A525 — 1991	Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process M-1102.1
C411 — 1982	Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation (Reapproved 1987) M-1102.1.2
D1784 — 1990	Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds M-1102.1
D2412 — 1987	Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading M-1102.1

SMACNA

SMACNA — 1988	Installation Standards for Residential Heating and Air Conditioning Systems M-1102.2.1

UL

181 — 1990	Factory Made Air Ducts and Connectors M-1102.1.1

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ASTM

A53 — 1990	Specification for Pipe, Steel, Black, and Hot-Dipped, Zinc-Coated Welded and Seamless ..... Table M-1304.1
A106 — 1990	Specification for Seamless Carbon Steel Pipe for High Temperature Service ..... Table M-1304.1
A254 — 1991	Specification for Copper-Brazed Steel Tubing ..... Table M-1304.1
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B75 — 1986	Specification for Seamless Copper Tube ..... Table M-1304.1
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F877 — 1989 Specification for Crosslinked Polyethylene (PEX) Tubing Plastic Hot- and Cold-Water Distribution Systems.....Table M-1304.1

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ANSI

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ANSI

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ASSE

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ASSE

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ASTM

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ASSE

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SECTION S-26.2407 — UNDERGROUND JOINTS

ASTM

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NFiPA

70A—1990 Electrical Code for One - and Two - Family Dwellings ..... Part VI

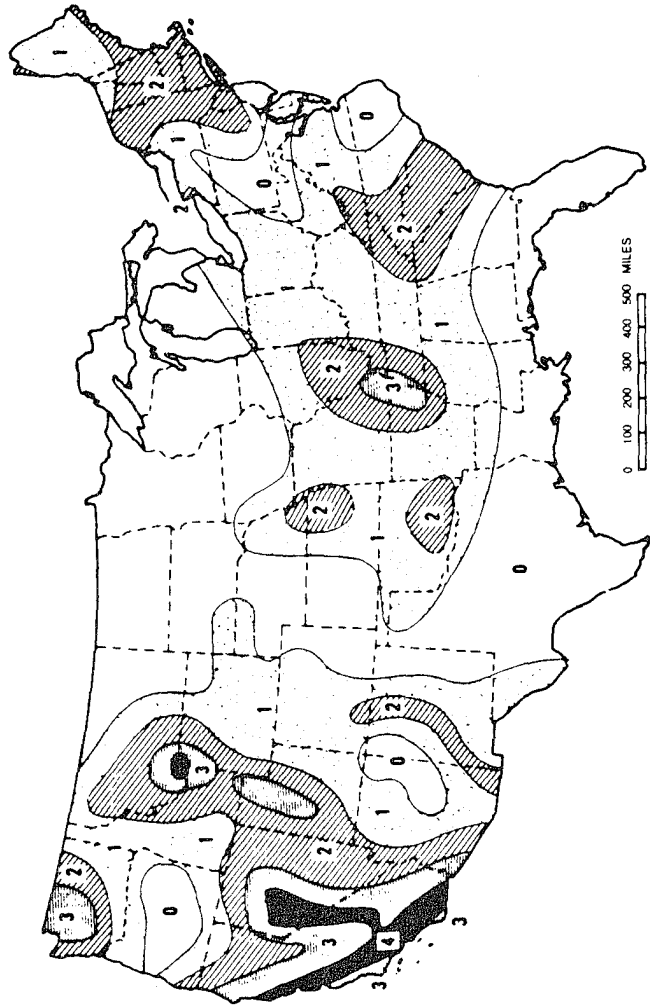
SECTION S-26.7000 — ENERGY CODE

CABO

CABO—1992 Model Energy Code.....Part VII

Appendix A

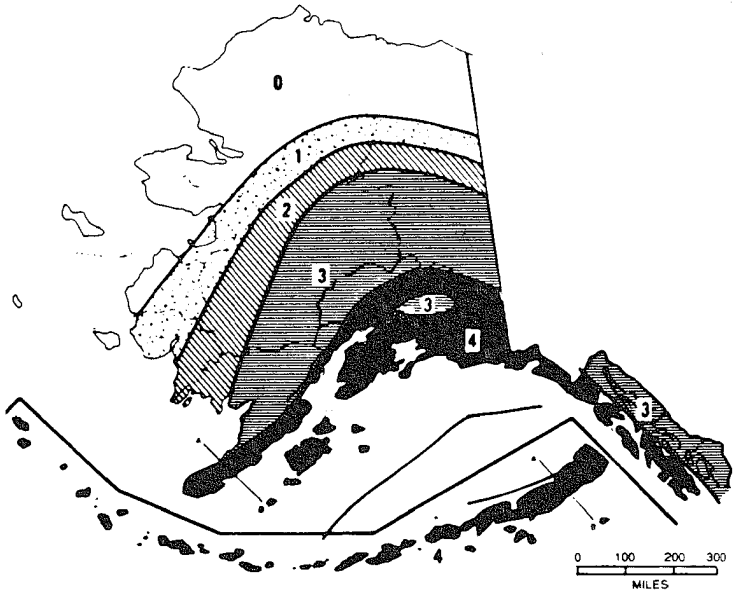
This appendix contains maps showing seismic risk, wind data, weathering probability, snow loads, termite infestation, weathering decay, and winter temperature isolines.



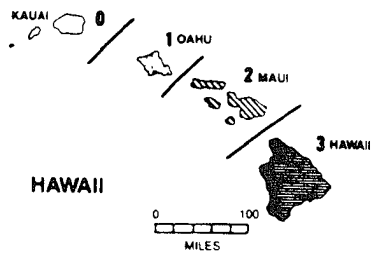
Seismic Risk Map

(Continued)

Seismic Risk Map—(Continued)



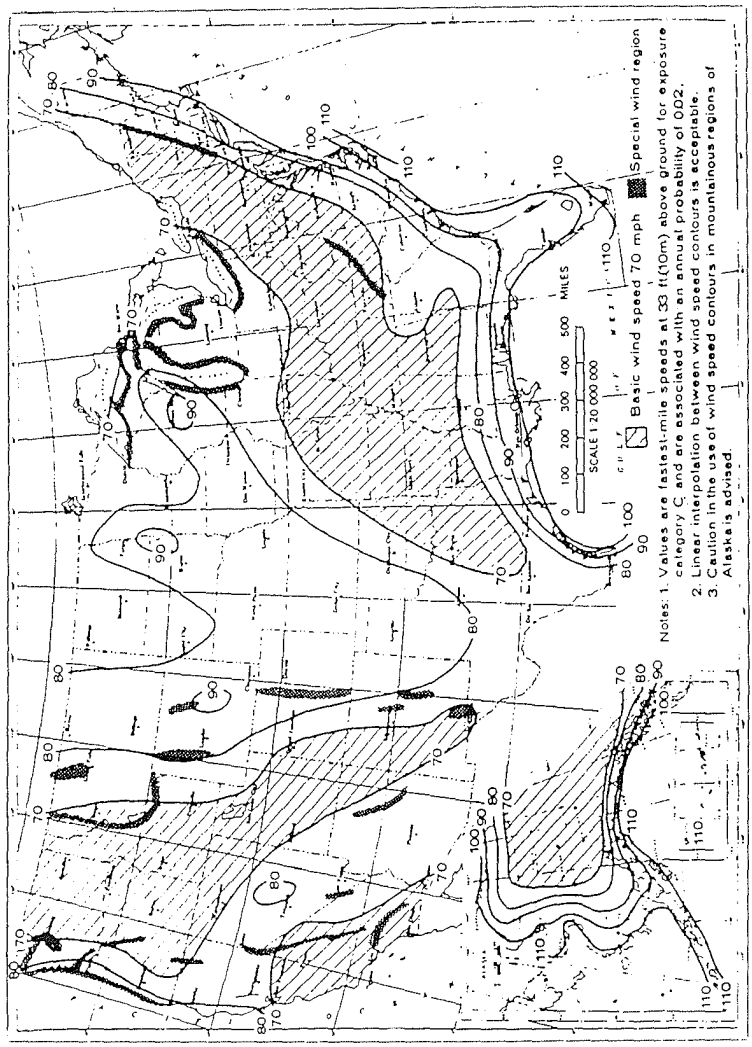
ALASKA



HAWAII

PUERTO RICO

Basic Wind Speed Map



DESIGN WIND LOADS (Pounds Per Square Foot)

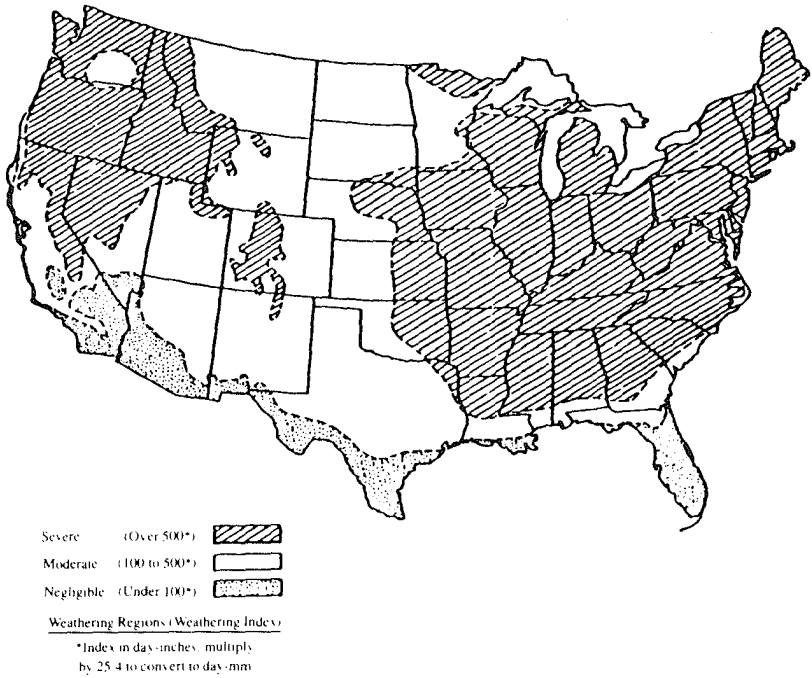
EXPOSURE CLASSIFICATION	BASIC WIND SPEED (mph)	BUILDING HEIGHT					
		ONE STORY		TWO STORY		THREE STORY	
		WALLS	ROOF UPLIFT	WALLS	ROOF UPLIFT	WALLS	ROOF UPLIFT
A/B	80	N/A	N/A	N/A	N/A	N/A	N/A
	90	N/A	N/A	N/A	N/a	N/A	20
	100	N/A	N/A	N/A	21	N/A	25
C	70	N/A	N/A	N/A	N/A	N/A	N/A
	80	N/A	20	N/A	22	N/A	25
	90	N/A	26	N/A	28	N/A	31
	100	N/A	32	32	35	35	39
	110	35	38	38	42	43	47
D	70	N/A	20	N/A	22	N/A	24
	80	N/A	27	N/A	28	N/a	31
	90	32	37	36	40	39	43
	100	442	46	44	49	49	53
	110	50	55	54	59	59	64

NOTES:

1 Select exposure classification from the descriptions below:
Exposure A/B - Urban and suburban areas, wooded areas, or other terrain which numerous closely spaced obstructions having the size of single-family dwellings or larger in the upwind direction for a distance of at least 1500 fee.
Exposure C - Open terrain with scattered obstructions having heights generally less than 30 feet.
Exposure D - Flat, unobstructed areas exposed to wind flowing over large bodies of water extending inland from the shoreline a distance of 1500 feet.

2. Wind speeds may be obtained from Basic Wind Speed map. Wind speeds represent the following: 70 = 0 to 70 mph; 80 = 71 to 80 mph; 90 = 81 to 90 mph; 100 = 91 to 100 mph; 110 = 101 to 110 mph. Hawaii has a basic wind speed of 80 mph and Puerto Rico has a basic wind speed of 95 mph.
3. Building heights used to determine design wind loads are: One story = 20 feet; Two story = 30 feet; and Three story = 50 feet. Interpolation between building height values and between map contours is acceptable.
4. Uplift loads act normal to the roof or overhang.
5. N/A = No design is required in accordance with Sections 402.3 and 702.10 of the code.
6. Buildings over 50 feet in height, or with unusual constructions or geometric shapes, with overhanging eave projections greater than 24 inches, or located in special wind regions or localities shall be designed in accordance with the provisions of ASCE 7-88.

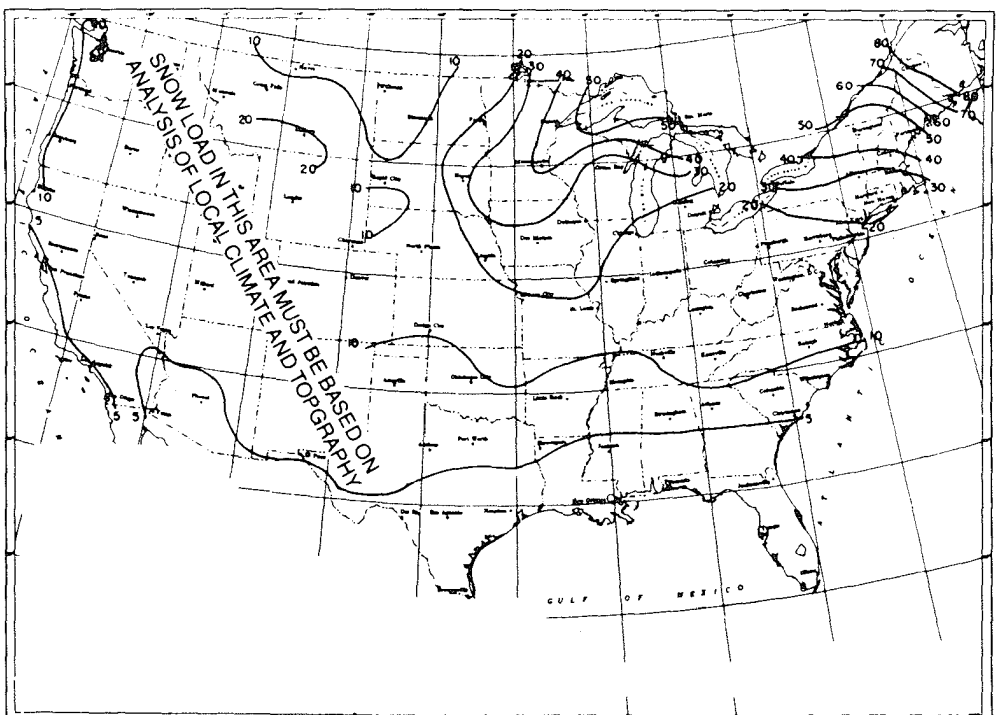
WEATHERING PROBABILITY MAP FOR CONCRETE



Notes:

1. Lines defining areas are approximate only. Local conditions may be more or less severe than indicated by the region classification.
2. Data needed to determine the weathering index for any locality may be found or estimated from the tables of Local Climatological Data, published by the Weather Bureau, U.S. Department of Commerce.

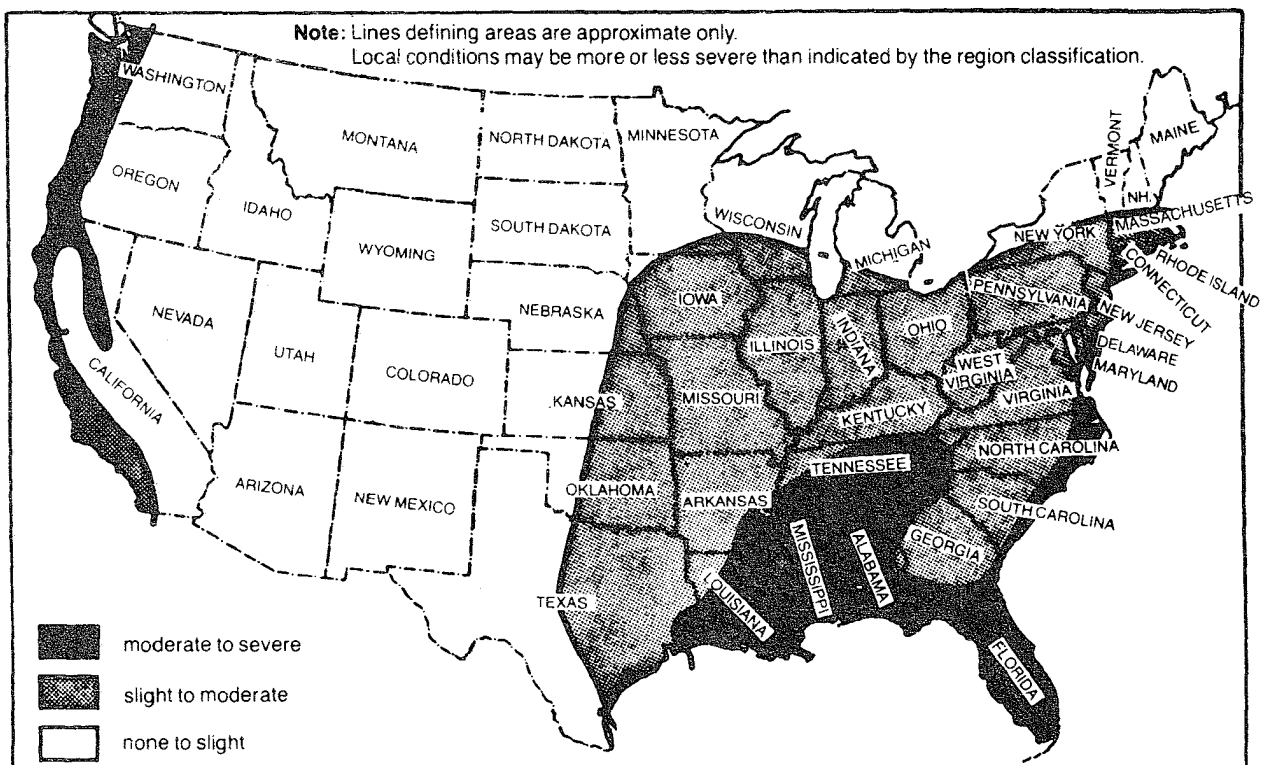
SNOW LOAD MAP



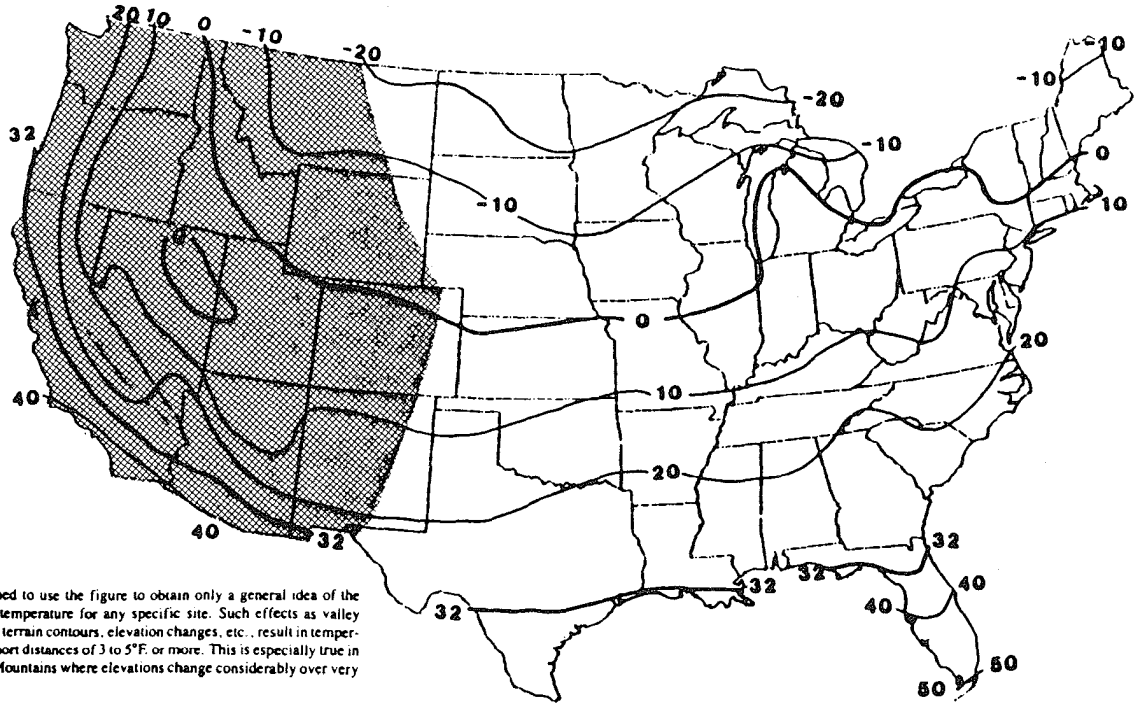
Estimated Ground Snow Load in Lbs./Sq. Ft.
50-year Mean Recurrence Interval

TERMITE INFESTATION PROBABILITY MAP

DECAY PROBABILITY MAP



ISOLINES OF THE 97½% WINTER (DEC., JAN. AND FEB.) DESIGN TEMPERATURES (°F.)



One should be cautioned to use the figure to obtain only a general idea of the 97½% winter design temperature for any specific site. Such effects as valley drainage, wind breaks, terrain contours, elevation changes, etc., result in temperature variations over short distances of 3 to 5°F or more. This is especially true in the area of the Rocky Mountains where elevations change considerably over very short distances.

ASHRAE Handbook of Fundamentals, 1985
Air Force Manual 88-29, Engineering Weather Data, July 1, 1978

Appendix B

This appendix contains in the order listed below span tables for joists and rafters as well as tables containing design values for joists and rafters.

SPANS FOR JOISTS AND RAFTERS

DESIGN VALUES FOR JOIST AND RAFTERS

Table No. 6-A
ALLOWABLE SPANS FOR FLOOR JOISTS

40 Lbs Per Sq. Ft. Live Load
(All rooms except those used for sleeping areas and attic floors.)
Strength – Live Load of 40 lbs. per sq. ft. plus dead load of 10 lbs. per sq. ft. determines the fiber stress value shown.

DESIGN CRITERIA:
Deflection – For 40 lbs. per sq. ft. live load.
Limited to span in inches divided by 360.

JOIST SIZE	SPACING (IN)	Modulus of Elasticity, "E", in 1,000,000 psi									
(IN)	(IN)	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3
2x6	12.0	6.9 450	7.3 520	7.9 590	8.2 660	8.6 720	8.10 780	9.2 830	9.6 890	9.9 940	10.0 990
	13.7	6.6 470	7.0 550	7.5 620	7.9 690	8.2 750	8.6 810	8.9 870	9.1 930	9.4 980	9.7 1040
	16.0	6.2 500	6.7 580	7.0 650	7.5 720	7.9 790	8.0 860	8.4 920	8.7 980	8.10 1040	9.1 1090
	19.2	5.9 530	6.3 610	6.7 690	7.0 770	7.3 840	7.7 910	7.10 970	8.1 1040	8.4 1100	8.7 1160
	24.0	5.4 570	5.9 660	6.2 750	6.6 830	6.9 900	7.0 980	7.3 1050	7.6 1120	7.9 1190	7.11 1250
	32.0					6.2 1010	6.5 1090	6.7 1150	6.10 1230	7.0 1300	7.3 1390
2x8	12.0	8.11 450	9.7 520	10.2 590	10.9 660	11.3 720	11.8 780	12.1 830	12.6 890	12.10 940	13.2 990
	13.7	8.6 470	9.2 550	9.9 620	10.3 690	10.9 750	11.2 810	11.7 870	11.11 930	12.3 980	12.7 1040
	16.0	8.1 500	8.9 580	9.3 650	9.9 720	10.2 790	10.7 850	11.0 920	11.4 980	11.8 1040	12.0 1090
	19.2	7.7 530	8.2 610	8.9 690	9.2 770	9.7 840	10.0 910	10.4 970	10.8 1040	11.0 1100	11.3 1160
	24.0	7.1 570	7.7 660	8.1 750	8.6 830	8.11 900	9.3 980	9.7 1050	9.11 1120	10.2 1190	10.6 1250
	32.0					8.1 990	8.5 1080	8.9 1170	9.0 1230	9.3 1300	9.6 1370
2x10	12.0	11.4 450	12.3 520	13.0 590	13.8 660	14.4 720	14.11 780	15.5 830	15.11 890	16.5 940	16.10 990
	13.7	10.10 470	11.8 550	12.5 620	13.1 690	13.8 750	14.3 810	14.9 870	15.3 930	15.8 980	16.1 1040
	16.0	10.4 500	11.1 580	11.10 650	12.5 720	13.0 790	13.6 850	14.0 920	14.6 980	14.11 1040	15.3 1090
	19.2	9.9 530	10.6 610	11.1 690	11.8 770	12.3 840	12.9 910	13.2 970	13.7 1040	14.0 1100	14.5 1160
	24.0	9.0 570	9.9 660	10.4 750	10.10 830	11.4 900	11.10 980	12.3 1050	12.8 1120	13.0 1190	13.4 1250
	32.0					10.4 1000	10.9 1080	11.1 1150	11.6 1240	11.10 1310	12.2 1380
2x12	12.0	13.10 450	14.11 520	15.10 590	16.8 660	17.5 720	18.1 780	18.9 830	19.4 890	19.11 940	20.6 990
	13.7	13.3 470	14.3 550	15.2 620	15.11 690	16.8 750	17.4 810	17.11 870	18.6 930	19.1 980	19.7 1040
	16.0	12.7 500	13.6 580	14.4 650	15.2 720	15.10 790	16.5 860	17.0 920	17.7 980	18.1 1040	18.7 1090
	19.2	11.10 530	12.9 610	13.6 690	14.3 770	14.11 840	15.6 910	16.0 970	16.7 1040	17.0 1100	17.6 1160
	24.0	11.0 570	11.10 660	12.7 750	13.3 830	13.10 900	14.4 980	14.11 1050	15.4 1120	15.10 1190	16.3 1250
	32.0					12.7 1000	13.1 1080	13.6 1150	13.11 1220	14.4 1300	14.9 1380

NOTE: The extreme fiber stress in bending, "Fb", in pounds per square inch is shown below each span.

Table No. 6-A (cont.)

HOW TO USE TABLES: Enter Table with span of joists (upper figure in each square). Determine size and spacing (first column) based on stress grade (lower figure in each square) and modulus of elasticity (top row) of lumber to be used

JOIST SIZE (IN)	SPACING (IN)	Modulus of Elasticity, "E", in 1,000,000 psi								
		1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.2	2.4
2x6	12.0	10.3 1040	10.6 1090	10.9 1140	10.11 1190	11.2 1230	11.4 1280	11.7 1320	11.11 1410	12.3 1490
	13.7	9.10 1090	10.0 1140	10.3 1190	10.6 1240	10.8 1290	10.10 1340	11.1 1380	11.5 1470	11.9 1560
	16.0	9.4 1150	9.6 1200	9.9 1250	9.11 1310	10.2 1360	10.4 1410	10.6 1460	10.10 1550	11.2 1640
	19.2	8.9 1220	9.0 1280	9.2 1330	9.4 1390	9.6 1440	9.8 1500	9.10 1550	10.2 1650	10.6 1750
	24.0	8.2 1310	8.4 1380	8.6 1440	8.8 1500	8.10 1550	9.0 1610	9.2 1670	9.6 1780	9.9 1880
	32.0	7.5 1450	7.7 1520	7.9 1590	7.11 1660	8.0 1690	8.2 1760	8.4 1840	8.7 1950	8.10 2060
2x8	12.0	13.6 1040	13.10 1090	14.2 1140	14.5 1190	14.8 1230	15.0 1280	15.3 1320	15.9 1410	16.2 1490
	13.7	12.11 1090	13.3 1140	13.6 1190	13.10 1240	14.1 1290	14.4 1340	14.7 1380	15.0 1470	15.6 1560
	16.0	12.3 1150	12.7 1200	12.10 1250	13.1 1310	13.4 1360	13.7 1410	13.10 1460	14.3 1550	14.8 1640
	19.2	11.7 1220	11.10 1280	12.1 1330	12.4 1390	12.7 1440	12.10 1500	13.0 1550	13.5 1650	13.10 1750
	24.0	10.9 1310	11.0 1380	11.3 1440	11.5 1500	11.8 1550	11.11 1610	12.1 1670	12.6 1780	12.10 1880
	32.0	9.9 1450	10.0 1520	10.2 1570	10.5 1650	10.7 1700	10.10 1790	11.0 1840	11.4 1950	11.8 2070
2x10	12.0	17.3 1040	17.8 1090	18.0 1140	18.5 1190	18.9 1230	19.1 1280	19.5 1320	20.1 1410	20.8 1490
	13.7	16.6 1090	16.11 1140	17.3 1190	17.7 1240	17.11 1290	18.3 1340	18.7 1380	19.2 1470	19.9 1560
	16.0	15.8 1150	16.0 1200	16.5 1250	16.9 1310	17.0 1360	17.4 1410	17.8 1460	18.3 1550	18.9 1640
	19.2	14.9 1220	15.1 1280	15.5 1330	15.9 1390	16.0 1440	16.4 1500	16.7 1550	17.2 1650	17.8 1750
	24.0	13.8 1310	14.0 1380	14.4 1440	14.7 1500	14.11 1550	15.2 1610	15.5 1670	15.11 1780	16.5 1880
	32.0	12.5 1440	12.9 1520	13.0 1580	13.3 1640	13.6 1700	13.9 1770	14.0 1830	14.6 1970	14.11 2080
2x12	12.0	21.0 1040	21.6 1090	21.11 1140	22.5 1190	22.10 1230	23.3 1280	23.7 1320	24.5 1410	25.1 1490
	13.7	20.1 1090	20.6 1140	21.0 1190	21.5 1240	21.10 1290	22.3 1340	22.7 1380	23.4 1470	24.0 1560
	16.0	19.1 1150	19.6 1200	19.11 1250	20.4 1310	20.9 1360	21.1 1410	21.6 1460	22.2 1550	22.10 1640
	19.2	17.11 1220	18.4 1280	18.9 1330	19.2 1390	19.6 1440	19.10 1500	20.2 1550	20.10 1650	21.6 1750
	24.0	16.8 1310	17.0 1380	17.5 1440	17.9 1500	18.1 1550	18.5 1610	18.9 1670	19.4 1780	19.11 1880
	32.0	15.2 1450	15.6 1520	15.10 1580	16.2 1650	16.5 1700	16.9 1770	17.0 1830	17.7 1950	18.1 2070

NOTE: The extreme fiber stress in bending, "Fb", in pounds per square inch is shown below each span

Table No. 6-B
ALLOWABLE SPANS FOR FLOOR JOISTS

30 Lbs. Per Sq. Ft. Live Load
(All rooms used for sleeping areas and attic floors)
Strength – Live load of 30 lbs. per sq. ft. plus dead load of 10 lbs. per sq. ft. determines the fiber stress value shown.

DESIGN CRITERIA:
Deflection – For 30 lbs. per sq. ft. live load.
Limited to span in inches divided by 360.

JOIST SIZE	SPACING (IN)	Modulus of Elasticity, "E", in 1,000,000 psi									
		0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3
2x6	12.0	7-5 440	8-0 510	8-6 570	8-11 640	9-4 700	9-9 750	10-1 810	10-5 860	10-9 910	11-0 960
	13.7	7-1 460	7-8 530	8-2 600	8-7 670	8-11 730	9-4 790	9-8 840	10-0 900	10-3 950	10-6 1010
	16.0	6-9 480	7-3 560	7-9 630	8-2 700	8-6 770	8-10 830	9-2 890	9-6 950	9-9 1000	10-0 1060
	19.2	6-4 510	6-10 600	7-3 670	7-8 740	8-0 810	8-4 880	8-8 940	8-11 1010	9-2 1070	9-5 1130
	24.0	5-11 550	6-4 640	6-9 720	7-1 800	7-5 880	7-9 950	8-0 1020	8-3 1080	8-6 1150	8-9 1210
	32.0					6-9 960	7-0 1040	7-3 1110	7-6 1190	7-9 1270	7-11 1330
2x8	12.0	9-10 440	10-7 510	11-3 570	11-10 640	12-4 700	12-10 750	13-4 810	13-9 860	14-2 910	14-6 960
	13.7	9-4 460	10-1 530	10-9 600	11-4 670	11-10 730	12-3 790	12-9 840	13-2 900	13-6 950	13-11 1010
	16.0	8-11 480	9-7 560	10-2 630	10-9 700	11-3 770	11-8 830	12-1 890	12-6 950	12-10 1000	13-2 1060
	19.2	8-5 510	9-0 600	9-7 670	10-1 740	10-7 810	11-0 880	11-4 940	11-9 1010	12-1 1070	12-5 1130
	24.0	7-9 550	8-5 640	8-11 720	9-4 800	9-10 880	10-2 950	10-7 1020	10-11 1080	11-3 1150	11-6 1210
	32.0					8-11 970	9-3 1040	9-7 1120	9-11 1200	10-2 1260	10-6 1340
2x10	12.0	12-6 440	13-6 510	14-4 570	15-1 640	15-9 700	16-5 750	17-0 810	17-6 860	18-0 910	18-6 960
	13.7	11-11 460	12-11 530	13-8 600	14-5 670	15-1 730	15-8 790	16-3 840	16-9 900	17-3 950	17-9 1010
	16.0	11-4 480	12-3 560	13-0 630	13-8 700	14-4 770	14-11 830	15-5 890	15-11 950	16-5 1000	16-10 1060
	19.2	10-8 510	11-6 600	12-3 670	12-11 740	13-6 810	14-0 880	14-6 940	15-0 1010	15-5 1070	15-10 1130
	24.0	9-11 550	10-8 640	11-4 720	11-11 800	12-6 880	13-0 950	13-6 1020	13-11 1080	14-4 1150	14-8 1210
	32.0					11-4 960	11-10 1050	12-3 1120	12-8 1200	13-0 1260	13-4 1330
2x12	12.0	15-2 440	16-5 510	17-5 570	18-4 640	19-2 700	19-11 750	20-8 810	21-4 860	21-11 910	22-6 960
	13.7	14-7 460	15-8 530	16-8 600	17-6 670	18-4 730	19-1 790	19-9 840	20-5 900	21-0 950	21-7 1010
	16.0	13-10 480	14-11 560	15-10 630	16-8 700	17-5 770	18-1 830	18-9 890	19-4 950	19-11 1000	20-6 1060
	19.2	13-0 510	14-0 600	14-11 670	15-8 740	16-5 810	17-0 880	17-8 940	18-3 1010	18-9 1070	19-3 1130
	24.0	12-1 550	13-0 640	13-10 720	14-7 800	15-2 880	15-10 950	16-5 1020	16-11 1080	17-5 1150	17-11 1210
	32.0					13-10 970	14-4 1040	14-11 1130	15-4 1190	15-10 1270	16-3 1340

NOTE: The extreme fiber stress in bending, "Fb", in pounds per square inch is shown below each span.

Table No. 6-B (cont).

HOW TO USE TABLES: Enter Table with span of joists (upper figure in each square). Determine size and spacing (first column) based on stress grade (lower figure in each square) and modulus of elasticity (top row) of lumber to be used.

JOIST SIZE	SPACING (IN)	Modulus of Elasticity, "E", in 1,000,000 psi								
		1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.2	2.4
2x6	12.0	11-3 1010	11-7 1060	11-10 1100	12-0 1150	12-3 1200	12-6 1240	12-9 1280	13-1 1370	13-6 1450
	13.7	10-10 1060	11-1 1110	11-3 1160	11-6 1200	11-9 1250	11-11 1300	12-2 1340	12-7 1430	12-11 1510
	16.0	10-3 1110	10-6 1160	10-9 1220	10-11 1270	11-2 1320	11-4 1360	11-7 1410	11-11 1500	12-3 1590
	19.2	9-8 1180	9-10 1240	10-1 1290	10-4 1350	10-6 1400	10-8 1450	10-10 1500	11-3 1600	11-7 1690
	24.0	8-11 1270	9-2 1330	9-4 1390	9-7 1450	9-9 1510	9-11 1560	10-1 1620	10-5 1720	10-9 1820
	32.0	8-2 1410	8-4 1470	8-6 1530	8-8 1590	8-10 1650	9-0 1710	9-2 1780	9-6 1910	9-9 2010
2x8	12.0	14-11 1010	15-3 1060	15-7 1100	15-10 1150	16-2 1200	16-6 1240	16-9 1280	17-4 1370	17-10 1450
	13.7	14-3 1060	14-7 1110	14-11 1160	15-2 1200	15-6 1250	15-9 1300	16-0 1340	16-7 1430	17-0 1510
	16.0	13-6 1110	13-10 1160	14-2 1220	14-5 1270	14-8 1320	15-0 1360	15-3 1410	15-9 1500	16-2 1590
	19.2	12-9 1180	13-0 1240	13-4 1290	13-7 1350	13-10 1400	14-1 1450	14-4 1500	14-9 1600	15-3 1690
	24.0	11-10 1270	12-1 1330	12-4 1390	12-7 1450	12-10 1510	13-1 1560	13-4 1620	13-9 1720	14-2 1820
	32.0	10-9 1410	11-0 1470	11-3 1540	11-5 1590	11-8 1660	11-11 1730	12-1 1780	12-6 1900	12-10 2010
2x10	12.0	19-0 1010	19-5 1060	19-10 1100	20-3 1150	20-8 1200	21-0 1240	21-5 1280	22-1 1370	22-9 1450
	13.7	18-2 1060	18-7 1110	19-0 1160	19-4 1200	19-9 1250	20-1 1300	20-5 1340	21-1 1430	21-9 1510
	16.0	17-3 1110	17-8 1160	18-0 1220	18-5 1270	18-9 1320	19-1 1360	19-5 1410	20-1 1500	20-8 1590
	19.2	16-3 1180	16-7 1240	17-0 1290	17-4 1350	17-8 1400	18-0 1450	18-3 1500	18-10 1600	19-5 1690
	24.0	15-1 1270	15-5 1330	15-9 1390	16-1 1450	16-5 1510	16-8 1560	17-0 1620	17-6 1720	18-0 1820
	32.0	13-8 1400	14-0 1470	14-4 1540	14-7 1590	14-11 1660	15-2 1720	15-5 1780	15-11 1890	16-5 2020
2x12	12.0	23-1 1010	23-7 1060	24-2 1100	24-8 1150	25-1 1200	25-7 1240	26-0 1280	26-10 1370	27-8 1450
	13.7	22-1 1060	22-7 1110	23-1 1160	23-7 1200	24-0 1250	24-5 1300	24-10 1340	25-8 1430	26-5 1510
	16.0	21-0 1110	21-6 1160	21-11 1220	22-5 1270	22-10 1320	23-3 1360	23-7 1410	24-5 1500	25-1 1590
	19.2	19-9 1180	20-2 1240	20-8 1290	21-1 1350	21-6 1400	21-10 1450	22-3 1500	22-11 1600	23-7 1690
	24.0	18-4 1270	18-9 1330	19-2 1390	19-7 1450	19-11 1510	20-3 1560	20-8 1620	21-4 1720	21-11 1820
	32.0	16-8 1400	17-0 1460	17-5 1530	17-9 1590	18-1 1650	18-5 1720	18-9 1780	19-4 1890	19-11 2010

NOTE. The extreme fiber stress in bending, "Fb", in pounds per square inch is shown below each span

Table No. 7-A
ALLOWABLE SPANS FOR CEILING JOISTS

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

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

JOIST SIZE (IN)	SPACING (IN)	Modulus of Elasticity, "E", in 1,000,000 psi									
		0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3
2×4	12 0	5 5 430	5 10 500	6 2 560	6 6 630	6 10 680	7 1 740	7 4 790	7 7 850	7 10 900	8 0 950
	13 7	5 2 450	5 7 520	5 11 590	6 3 650	6 6 720	6 9 770	7 0 830	7 3 880	7 6 940	7 8 990
	16 0	4 11 470	5 4 550	5 8 620	5 11 690	6 2 750	6 5 810	6 8 870	6 11 930	7 1 990	7 3 1040
	19 2	4 8 500	5 0 580	5 4 660	5 7 730	5 10 800	6 1 870	6 3 930	6 6 990	6 8 1050	6 10 1110
	24 0	4 4 540	4 8 630	4 11 710	5 2 790	5 5 860	5 8 930	5 10 1000	6 0 1070	6 2 1130	6 4 1190
2×6	12 0	8 6 430	9 2 500	9 9 560	10 3 630	10 9 680	11 2 740	11 7 790	11 11 850	12 3 900	12 7 950
	13 7	8 2 450	8 9 520	9 4 590	9 10 650	10 3 720	10 8 770	11 1 830	11 5 880	11 9 940	12 1 990
	16 0	7 9 470	8 4 550	8 10 620	9 4 690	9 9 750	10 2 810	10 6 870	10 10 930	11 2 990	11 5 1040
	19 2	7 3 500	7 10 580	8 4 660	8 9 730	9 2 800	9 6 870	9 10 930	10 2 990	10 6 1050	10 9 1110
	24 0	6 9 540	7 3 630	7 9 710	8 2 790	8 6 860	8 10 930	9 2 1000	9 6 1070	9 9 1130	10 0 1190
2×8	12 0	11 3 430	12 1 500	12 10 560	13 6 630	14 2 680	14 8 740	15 3 790	15 9 850	16 2 900	16 7 950
	13 7	10 9 450	11 7 520	12 3 590	12 11 650	13 6 720	14 1 770	14 7 830	15 0 880	15 6 940	15 11 990
	16 0	10 2 470	11 0 550	11 8 620	12 3 690	12 10 750	13 4 810	13 10 870	14 3 930	14 8 990	15 1 1040
	19 2	9 7 500	10 4 580	11 0 660	11 7 730	12 1 800	12 7 870	13 0 930	13 5 990	13 10 1050	14 2 1110
	24 0	8 11 540	9 7 630	10 2 710	10 9 790	11 3 860	11 8 930	12 1 1000	12 6 1070	12 10 1130	13 2 1190
2×10	12 0	14 4 430	15 5 500	16 5 560	17 3 630	18 0 680	18 9 740	19 5 790	20 1 850	20 8 900	21 2 950
	13 7	13 8 450	14 9 520	15 8 590	16 6 650	17 3 720	17 11 770	18 7 830	19 2 880	19 9 940	20 3 990
	16 0	13 0 470	14 0 550	14 11 620	15 8 690	16 5 750	17 0 810	17 8 870	18 3 930	18 9 990	19 3 1040
	19 2	12 3 500	13 2 580	14 0 660	14 9 730	15 5 800	16 0 870	16 7 930	17 2 990	17 8 1050	18 1 1110
	24 0	11 4 540	12 3 630	13 0 710	13 8 790	14 4 860	14 11 930	15 5 1000	15 11 1070	16 5 1130	16 10 1190

NOTE: The extreme fiber stress in bending, "Fb", in pounds per square inch is shown below each span.

Table No. 7-A (cont.)

HOW TO USE TABLES: Enter Table with span of joists (upper figure in each square). Determine size and spacing (first column) based on stress grade (lower figure in each square) and modulus of elasticity (top row) of lumber to be used.

JOIST SIZE	SPACING (IN)	Modulus of Elasticity, "E", in 1,000,000 psi								
		1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.2	2.4
2x4	12.0	8-3 990	8-5 1040	8-7 1090	8-9 1130	8-11 1170	9-1 1220	9-3 1260	9-7 1340	9-10 1420
	13.7	7-10 1040	8-1 1090	8-3 1140	8-5 1180	8-7 1230	8-8 1270	8-10 1320	9-2 1400	9-5 1490
	16.0	7-6 1090	7-8 1140	7-10 1200	8-0 1240	8-1 1290	8-3 1340	8-5 1390	8-8 1480	8-11 1570
	19.2	7-0 1160	7-2 1220	7-4 1270	7-6 1320	7-8 1370	7-9 1420	7-11 1470	8-2 1570	8-5 1660
	24.0	6-6 1250	6-8 1310	6-10 1370	7-0 1420	7-1 1480	7-3 1530	7-4 1590	7-7 1690	7-10 1790
2x6	12.0	12-11 990	13-3 1040	13-6 1090	13-9 1130	14-1 1170	14-4 1220	14-7 1260	15-0 1340	15-6 1420
	13.7	12-4 1040	12-8 1090	12-11 1140	13-2 1180	13-5 1230	13-8 1270	13-11 1320	14-4 1400	14-9 1490
	16.0	11-9 1090	12-0 1140	12-3 1200	12-6 1240	12-9 1290	13-0 1340	13-3 1390	13-8 1480	14-1 1570
	19.2	11-1 1160	11-4 1220	11-7 1270	11-9 1320	12-0 1370	12-3 1420	12-5 1470	12-10 1570	13-3 1660
	24.0	10-3 1250	10-6 1310	10-9 1370	10-11 1420	11-2 1480	11-4 1530	11-7 1590	11-11 1690	12-3 1790
2x8	12.0	17-0 990	17-5 1040	17-10 1090	18-2 1130	18-6 1170	18-10 1220	19-2 1260	19-10 1340	20-5 1420
	13.7	16-3 1040	16-8 1090	17-0 1140	17-5 1180	17-9 1230	18-0 1270	18-4 1320	18-11 1400	19-6 1490
	16.0	15-6 1090	15-10 1140	16-2 1200	16-6 1240	16-10 1290	17-2 1340	17-5 1390	18-0 1480	18-6 1570
	19.2	14-7 1160	14-11 1220	15-3 1270	15-6 1320	15-10 1370	16-1 1420	16-5 1470	16-11 1570	17-5 1660
	24.0	13-6 1250	13-10 1310	14-2 1370	14-5 1420	14-8 1480	15-0 1530	15-3 1590	15-9 1690	16-2 1790
2x10	12.0	21-9 990	22-3 1040	22-9 1090	23-2 1130	23-8 1170	24-1 1220	24-6 1260	25-3 1340	26-0 1420
	13.7	20-9 1040	21-3 1090	21-9 1140	22-2 1180	22-7 1230	23-0 1270	23-5 1320	24-2 1400	24-10 1490
	16.0	19-9 1090	20-2 1140	20-8 1200	21-1 1240	21-6 1290	21-10 1340	22-3 1390	22-11 1480	23-8 1570
	19.2	18-7 1160	19-0 1220	19-5 1270	19-10 1320	20-2 1370	20-7 1420	20-11 1470	21-7 1570	22-3 1660
	24.0	17-3 1250	17-8 1310	18-0 1370	18-5 1420	18-9 1480	19-1 1530	19-5 1590	20-1 1690	20-8 1790

NOTE: The extreme fiber stress in bending, "Fb", in pounds per square inch is shown below each span.

Table No. 7-B
ALLOWABLE SPAN FOR CEILING JOISTS

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

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

JOIST SIZE	SPACING (IN)	Modulus of Elasticity, "E", in 1,000,000 psi									
		0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3
2x4	12.0	6-2 560	6-8 660	7-1 740	7-6 820	7-10 900	8-1 970	8-5 1040	8-8 1110	8-11 1170	9-2 1240
	13.7	5-11 590	6-5 690	6-9 770	7-2 860	7-6 940	7-9 1010	8-1 1090	8-4 1160	8-7 1230	8-9 1300
	16.0	5-8 620	6-1 720	6-5 810	6-9 900	7-1 990	7-5 1070	7-8 1140	7-11 1220	8-1 1290	8-4 1360
	19.2	5-4 660	5-9 770	6-1 870	6-5 960	6-8 1050	6-11 1130	7-2 1220	7-5 1300	7-8 1370	7-10 1450
	24.0	4-11 710	5-4 830	5-8 930	5-11 1030	6-2 1130	6-5 1220	6-8 1310	6-11 1400	7-1 1480	7-3 1560
2x6	12.0	9-9 560	10-6 660	11-2 740	11-9 820	12-3 900	12-9 970	13-3 1040	13-8 1110	14-1 1170	14-5 1240
	13.7	9-4 590	10-0 690	10-8 770	11-3 860	11-9 940	12-3 1010	12-8 1090	13-1 1160	13-5 1230	13-10 1300
	16.0	8-10 620	9-6 720	10-2 810	10-8 900	11-2 990	11-7 1070	12-0 1140	12-5 1220	12-9 1290	13-1 1360
	19.2	8-4 660	9-0 770	9-6 870	10-0 960	10-6 1050	10-11 1130	11-4 1220	11-8 1300	12-0 1370	12-4 1450
	24.0	7-9 710	8-4 830	8-10 930	9-4 1030	9-9 1130	10-2 1220	10-6 1310	10-10 1400	11-2 1480	11-5 1560
2x8	12.0	12-10 560	13-10 660	14-8 740	15-6 820	16-2 900	16-10 970	17-5 1040	18-0 1110	18-6 1170	19-0 1240
	13.7	12-3 590	13-3 690	14-1 770	14-10 860	15-6 940	16-1 1010	16-8 1090	17-2 1160	17-9 1230	18-2 1300
	16.0	11-8 620	12-7 720	13-4 810	14-1 900	14-8 990	15-3 1070	15-10 1140	16-4 1220	16-10 1290	17-3 1360
	19.2	11-0 660	11-10 770	12-7 870	13-3 960	13-10 1050	14-5 1130	14-11 1220	15-5 1300	15-10 1370	16-3 1450
	24.0	10-2 710	11-0 830	11-8 930	12-3 1030	12-10 1130	13-4 1220	13-10 1310	14-3 1400	14-8 1480	15-1 1560
2x10	12.0	16-5 560	17-8 660	18-9 740	19-9 820	20-8 900	21-6 970	22-3 1040	22-11 1110	23-8 1170	24-3 1240
	13.7	15-8 590	16-11 690	17-11 770	18-11 860	19-9 940	20-6 1010	21-3 1090	21-11 1160	22-7 1230	23-3 1300
	16.0	14-11 620	16-0 720	17-0 810	17-11 900	18-9 990	19-6 1070	20-2 1140	20-10 1220	21-6 1290	22-1 1360
	19.2	14-0 660	15-1 770	16-0 870	16-11 960	17-8 1050	18-4 1130	19-0 1220	19-7 1300	20-2 1370	20-9 1450
	24.0	13-0 710	14-0 830	14-11 930	15-8 1030	16-5 1130	17-0 1220	17-8 1310	18-3 1400	18-9 1480	19-3 1560

NOTE: The extreme fiber stress in bending, "Fb", in pounds per square inch is shown below each span.

Table No. 7-B (cont.)

HOW TO USE TABLES: Enter Table with span of joists (upper figure in each square). Determine size and spacing (first column) based on stress grade (lower figure in each square) and modulus of elasticity (top row) of lumber to be used.

JOIST SIZE	SPACING (IN)	Modulus of Elasticity, "E", in 1,000,000 psi								
		1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.2	2.4
2x4	12.0	9-5 1300	9-8 1360	9-10 1420	10-0 1480	10-3 1540	10-5 1600	10-7 1650	10-11 1760	11-3 1860
	13.7	9-0 1360	9-3 1420	9-5 1490	9-7 1550	9-9 1610	10-0 1670	10-2 1730	10-6 1840	10-9 1950
	16.0	8-7 1430	8-9 1500	8-11 1570	9-1 1630	9-4 1690	9-6 1760	9-8 1820	9-11 1940	10-3 2050
	19.2	8-1 1520	8-3 1590	8-5 1660	8-7 1730	8-9 1800	8-11 1870	9-1 1930	9-4 2060	9-8 2180
	24.0	7-6 1640	7-8 1720	7-10 1790	8-0 1870	8-1 1940	8-3 2010	8-5 2080	8-8 2220	8-11 2350
2x6	12.0	14-9 1300	15-2 1360	15-6 1420	15-9 1480	16-1 1540	16-4 1600	16-8 1650	17-2 1760	17-8 1860
	13.7	14-2 1360	14-6 1420	14-9 1490	15-1 1550	15-5 1610	15-8 1670	15-11 1730	16-5 1840	16-11 1950
	16.0	13-5 1430	13-9 1500	14-1 1570	14-4 1630	14-7 1690	14-11 1760	15-2 1820	15-7 1940	16-1 2050
	19.2	12-8 1520	12-11 1590	13-3 1660	13-6 1730	13-9 1800	14-0 1870	14-3 1930	14-8 2060	15-2 2180
	24.0	11-9 1640	12-0 1720	12-3 1790	12-6 1870	12-9 1940	13-0 2010	13-3 2080	13-8 2220	14-1 2350
2x8	12.0	19-6 1300	19-11 1360	20-5 1420	20-10 1480	21-2 1540	21-7 1600	21-11 1650	22-8 1760	23-4 1860
	13.7	18-8 1360	19-1 1420	19-6 1490	19-11 1550	20-3 1610	20-8 1670	21-0 1730	21-8 1840	22-4 1950
	16.0	17-9 1430	18-2 1500	18-6 1570	18-11 1630	19-3 1690	19-7 1760	19-11 1820	20-7 1940	21-2 2050
	19.2	16-8 1520	17-1 1590	17-5 1660	17-9 1730	18-2 1800	18-5 1870	18-9 1930	19-5 2060	19-11 2180
	24.0	15-6 1640	15-10 1720	16-2 1790	16-6 1870	16-10 1940	17-2 2010	17-5 2080	18-0 2220	18-6 2350
2x10	12.0	24-10 1300	25-5 1360	26-0 1420	26-6 1480	27-1 1540	27-6 1600	28-0 1650	28-11 1760	29-9 1860
	13.7	23-9 1360	24-4 1420	24-10 1490	25-5 1550	25-10 1610	26-4 1670	26-10 1730	27-8 1840	28-6 1950
	16.0	22-7 1430	23-2 1500	23-8 1570	24-1 1630	24-7 1690	25-0 1760	25-5 1820	26-3 1940	27-1 2050
	19.2	21-3 1520	21-9 1590	22-3 1660	22-8 1730	23-2 1800	23-7 1870	23-11 1930	24-9 2060	25-5 2180
	24.0	19-9 1640	20-2 1720	20-8 1790	21-1 1870	21-6 1940	21-10 2010	22-3 2080	22-11 2220	23-8 2350

NOTE: The extreme fiber stress in bending, "Fb", in pounds per square inch is shown below each span.

Table No. 7-C
ALLOWABLE SPAN FOR CEILING JOISTS

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

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

JOIST SIZE	SPACING (IN)	Modulus of Elasticity, "E", in 1,000,000 psi									
		0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3
2x4	12 0	6 10 340	7 4 400	7 10 450	8 3 500	8-7 540	8-11 590	9-3 630	9 7 670	9-10 710	10-1 750
	13 7	6 6 360	7 0 410	7 6 470	7 10 520	8-3 570	8 7 610	8 10 660	9-2 700	9 5 740	9 8 780
	16 0	6 2 380	6 8 440	7 1 490	7 6 550	7 10 600	8 1 650	8 5 690	8 8 740	8 11 780	9 2 830
	19 2	5 10 400	6 3 460	6 8 520	7 0 580	7 4 630	7 8 690	7 11 740	8 2 790	8 5 830	8 8 880
	24 0	5 5 430	5 10 500	6 2 560	6 6 630	6 10 680	7 1 740	7 4 790	7 7 850	7 10 900	8 0 950
2x6	12 0	10 9 340	11 7 400	12 3 450	12 11 500	13 6 540	14 1 590	14 7 630	15 0 670	15 6 710	15 11 750
	13 7	10 3 360	11 1 410	11 9 470	12 4 520	12 11 570	13 5 610	13 11 660	14 4 700	14 9 740	15 2 780
	16 0	9 9 380	10 6 440	11 2 490	11 9 550	12 3 600	12 9 650	13 3 690	13 8 740	14 1 780	14 5 830
	19 2	9 2 400	9 10 460	10 6 520	11 1 580	11 7 630	12 0 690	12 5 740	12 10 790	13 3 830	13 7 880
	24 0	8 6 430	9 2 500	9 9 560	10 3 630	10 9 680	11 2 740	11 7 790	11 11 850	12 3 900	12 7 950
2x8	12 0	14 2 340	15 3 400	16 2 450	17 0 500	17 10 540	18 6 590	19 2 630	19 10 670	20 5 710	20 11 750
	13 7	13 6 360	14 7 410	15 6 470	16 3 520	17 0 570	17 9 610	18 4 660	18 11 700	19 6 740	20 0 780
	16 0	12 10 380	13 10 440	14 8 490	15 6 550	16 2 600	16 10 650	17 5 690	18 0 740	18 6 780	19 0 830
	19 2	12 1 400	13 0 460	13 10 520	14 7 580	15 3 630	15 10 690	16 5 740	16 11 790	17 5 830	17 11 880
	24 0	11 3 430	12 1 500	12 10 560	13 6 630	14 2 680	14 8 740	15 3 790	15 9 850	16 2 900	16 7 950
2x10	12 0	18 0 340	19 5 400	20 8 450	21 9 500	22 9 540	23 8 590	24 6 630	25 3 670	26 0 710	26 9 750
	13 7	17 3 360	18 7 410	19 9 470	20 9 520	21 9 570	22 7 610	23 5 660	24 2 700	24 10 740	25 7 780
	16 0	16 5 380	17 8 440	18 9 490	19 9 550	20 8 600	21 6 650	22 3 690	22 11 740	23 8 780	24 3 830
	19 2	15 5 400	16 7 460	17 8 520	18 7 580	19 5 630	20 2 690	20 11 740	21 7 790	22 3 830	22-10 880
	24 0	14 4 430	15 5 500	16 5 560	17 3 630	18 0 680	18 9 740	19 5 790	20 1 850	20 8 900	21 2 950

NOTE The extreme fiber stress in bending, "Fb", in pounds per square inch is shown below each span.

Table No. 7-C (cont.)

HOW TO USE TABLES: Enter Table with span of joists (upper figure in each square). Determine size and spacing (first column) based on stress grade (lower figure in each square) and modulus of elasticity (top row) of lumber to be used

JOIST SIZE	SPACING (IN)	Modulus of Elasticity, "E", in 1,000,000 psi								
(IN)	(IN)	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.2	2.4
2x4	12.0	10-4 790	10-7 830	10-10 860	11-1 900	11-3 930	11-6 970	11-8 1000	12-1 1070	12-5 1130
	13.7	9-11 820	10-2 860	10-4 900	10-7 940	10-9 970	11-0 1010	11-2 1050	11-6 1110	11-10 1180
	16.0	9-5 870	9-8 910	9-10 950	10-0 990	10-3 1030	10-5 1060	10-7 1100	10-11 1170	11-3 1240
	19.2	8-10 920	9-1 970	9-3 1010	9-5 1050	9-8 1090	9-10 1130	10-0 1170	10-4 1250	10-7 1320
	24.0	8-3 990	8-5 1040	8-7 1090	8-9 1130	8-11 1170	9-1 1220	9-3 1260	9-7 1340	9-10 1420
2x6	12.0	16-3 790	16-8 830	17-0 860	17-4 900	17-8 930	18-0 970	18-4 1000	18-11 1070	19-6 1130
	13.7	15-7 820	15-11 860	16-3 900	16-7 940	16-11 970	17-3 1010	17-6 1050	18-1 1110	18-8 1180
	16.0	14-9 870	15-2 910	15-6 950	15-9 990	16-1 1030	16-4 1060	16-8 1100	17-2 1170	17-8 1240
	19.2	13-11 920	14-3 970	14-7 1010	14-10 1050	15-2 1090	15-5 1130	15-8 1170	16-2 1250	16-8 1320
	24.0	12-11 990	13-3 1040	13-6 1090	13-9 1130	14-1 1170	14-4 1220	14-7 1260	15-0 1340	15-6 1420
2x8	12.0	21-5 790	21-11 830	22-5 860	22-11 900	23-4 930	23-9 970	24-2 1000	24-11 1070	25-8 1130
	13.7	20-6 820	21-0 860	21-5 900	21-11 940	22-4 970	22-9 1010	23-1 1050	23-10 1110	24-7 1180
	16.0	19-6 870	19-11 910	20-5 950	20-10 990	21-2 1030	21-7 1060	21-11 1100	22-8 1170	23-4 1240
	19.2	18-4 920	18-9 970	19-2 1010	19-7 1050	19-11 1090	20-4 1130	20-8 1170	21-4 1250	21-11 1320
	24.0	17-0 990	17-5 1040	17-10 1090	18-2 1130	18-6 1170	18-10 1220	19-2 1260	19-10 1340	20-5 1420
2x10	12.0	27-5 790	28-0 830	28-7 860	29-2 900	29-9 930	30-4 970	30-10 1000	31-10 1070	32-9 1130
	13.7	26-2 820	26-10 860	27-5 900	27-11 940	28-6 970	29-0 1010	29-6 1050	30-5 1110	31-4 1180
	16.0	24-10 870	25-5 910	26-0 950	26-6 990	27-1 1030	27-6 1060	28-0 1100	28-11 1170	29-9 1240
	19.2	23-5 920	23-11 970	24-6 1010	25-0 1050	25-5 1090	25-11 1130	26-4 1170	27-3 1250	28-0 1320
	24.0	21-9 990	22-3 1040	22-9 1090	23-2 1130	23-8 1170	24-1 1220	24-6 1260	25-3 1340	26-0 1420

NOTE: The extreme fiber stress in bending, "Fb", in pounds per square inch is shown below each span.

Table No. 7-D
ALLOWABLE SPAN FOR CEILING JOISTS

10 Lbs. Per Sq. Ft. Live Load
(No attic storage and roof slope not steeper than 3 in 12)

(Gypsum Ceiling)

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

JOIST SIZE	SPACING (IN)	Modulus of Elasticity, "E", in 1,000,000 psi									
		0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3
2x4	12.0	7-10 450	8-5 520	8-11 590	9-5 650	9-10 710	10-3 770	10-7 830	10-11 880	11-3 930	11-7 980
	13.7	7-6 470	8-1 540	8-7 610	9-0 680	9-5 740	9-9 800	10-2 860	10-6 920	10-9 970	11-1 1030
	16.0	7-1 490	7-8 570	8-1 650	8-7 720	8-11 780	9-4 850	9-8 910	9-11 970	10-3 1030	10-6 1080
	19.2	6-8 520	7-2 610	7-8 690	8-1 760	8-5 830	8-9 900	9-1 970	9-4 1030	9-8 1090	9-11 1150
	24.0	6-2 560	6-8 660	7-1 740	7-6 820	7-10 900	8-1 970	8-5 1040	8-8 1110	8-11 1170	9-2 1240
2x6	12.0	12-3 450	13-3 520	14-1 590	14-9 650	15-6 710	16-1 770	16-8 830	17-2 880	17-8 930	18-2 980
	13.7	11-9 470	12-8 540	13-5 610	14-2 680	14-9 740	15-5 800	15-11 860	16-5 920	16-11 970	17-5 1030
	16.0	11-2 490	12-0 570	12-9 650	13-5 720	14-1 780	14-7 850	15-2 910	15-7 970	16-1 1030	16-6 1080
	19.2	10-6 520	11-4 610	12-0 690	12-8 760	13-3 830	13-9 900	14-3 970	14-8 1030	15-2 1090	15-7 1150
	24.0	9-9 560	10-6 660	11-2 740	11-9 820	12-3 900	12-9 970	13-3 1040	13-8 1110	14-1 1170	14-5 1240
2x8	12.0	16-2 450	17-5 520	18-6 590	19-6 650	20-5 710	21-2 770	21-11 830	22-8 880	23-4 930	24-0 980
	13.7	15-6 470	16-8 540	17-9 610	18-8 680	19-6 740	20-3 800	21-0 860	21-8 920	22-4 970	22-11 1030
	16.0	14-8 490	15-10 570	16-10 650	17-9 720	18-6 780	19-3 850	19-11 910	20-7 970	21-2 1030	21-9 1080
	19.2	13-10 520	14-11 610	15-10 690	16-8 760	17-5 830	18-2 900	18-9 970	19-5 1030	19-11 1090	20-6 1150
	24.0	12-10 560	13-10 660	14-8 740	15-6 820	16-2 900	16-10 970	17-5 1040	18-0 1110	18-6 1170	19-0 1240
2x10	12.0	20-8 450	22-3 520	23-8 590	24-10 650	26-0 710	27-1 770	28-0 830	28-11 880	29-9 930	30-7 980
	13.7	19-9 470	21-3 540	22-7 610	23-9 680	24-10 740	25-10 800	26-10 860	27-8 920	28-6 970	29-3 1030
	16.0	18-9 490	20-2 570	21-6 650	22-7 720	23-8 780	24-7 850	25-5 910	26-3 970	27-1 1030	27-9 1080
	19.2	17-8 520	19-0 610	20-2 690	21-3 760	22-3 830	23-2 900	23-11 970	24-9 1030	25-5 1090	26-2 1150
	24.0	16-5 560	17-8 660	18-9 740	19-9 820	20-8 900	21-6 970	22-3 1040	22-11 1110	23-8 1170	24-3 1240

NOTE: The extreme fiber stress in bending, "Fb", in pounds per square inch is shown below each span.

Table No. 7-D (cont.)

HOW TO USE TABLES: Enter Table with span of joists (upper figure in each square). Determine size and spacing (first column) based on stress grade (lower figure in each square) and modulus of elasticity (top row) of lumber to be used.

JOIST SIZE	SPACING (IN)	Modulus of Elasticity, "E", in 1,000,000 psi								
		1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.2	2.4
2×4	12.0	11-10 1030	12-2 1080	12-5 1130	12-8 1180	12-11 1220	13-2 1270	13-4 1310	13-9 1400	14-2 1480
	13.7	11-4 1080	11-7 1130	11-10 1180	12-1 1230	12-4 1280	12-7 1320	12-9 1370	13-2 1460	13-7 1550
	16.0	10-9 1140	11-0 1190	11-3 1240	11-6 1290	11-9 1340	11-11 1390	12-2 1440	12-6 1540	12-11 1630
	19.2	10-2 1210	10-4 1270	10-7 1320	10-10 1380	11-0 1430	11-3 1480	11-5 1530	11-9 1630	12-2 1730
	24.0	9-5 1300	9-8 1360	9-10 1420	10-0 1480	10-3 1540	10-5 1600	10-7 1650	10-11 1760	11-3 1860
2×6	12.0	18-8 1030	19-1 1080	19-6 1130	19-11 1180	20-3 1220	20-8 1270	21-0 1310	21-8 1400	22-4 1480
	13.7	17-10 1080	18-3 1130	18-8 1180	19-0 1230	19-5 1280	19-9 1320	20-1 1370	20-9 1460	21-4 1550
	16.0	16-11 1140	17-4 1190	17-8 1240	18-1 1290	18-5 1340	18-9 1390	19-1 1440	19-8 1540	20-3 1630
	19.2	15-11 1210	16-4 1270	16-8 1320	17-0 1380	17-4 1430	17-8 1480	17-11 1530	18-6 1630	19-1 1730
	24.0	14-9 1300	15-2 1360	15-6 1420	15-9 1480	16-1 1540	16-4 1600	16-8 1650	17-2 1760	17-8 1860
2×8	12.0	24-7 1030	25-2 1080	25-8 1130	26-2 1180	26-9 1220	27-2 1270	27-8 1310	28-7 1400	29-5 1480
	13.7	23-6 1080	24-0 1130	24-7 1180	25-1 1230	25-7 1280	26-0 1320	26-6 1370	27-4 1460	28-1 1550
	16.0	22-4 1140	22-10 1190	23-4 1240	23-10 1290	24-3 1340	24-8 1390	25-2 1440	25-11 1540	26-9 1630
	19.2	21-0 1210	21-6 1270	21-11 1320	22-5 1380	22-10 1430	23-3 1480	23-8 1530	24-5 1630	25-2 1730
	24.0	19-6 1300	19-11 1360	20-5 1420	20-10 1480	21-2 1540	21-7 1600	21-11 1650	22-8 1760	23-4 1860
2×10	12.0	31-4 1030	32-1 1080	32-9 1130	33-5 1180	34-1 1220	34-8 1270	35-4 1310	36-5 1400	37-6 1480
	13.7	30-0 1080	30-8 1130	31-4 1180	32-0 1230	32-7 1280	33-2 1320	33-9 1370	34-10 1460	35-10 1550
	16.0	28-6 1140	29-2 1190	29-9 1240	30-5 1290	31-0 1340	31-6 1390	32-1 1440	33-1 1540	34-1 1630
	19.2	26-10 1210	27-5 1270	28-0 1320	28-7 1380	29-2 1430	29-8 1480	30-2 1530	31-2 1630	32-1 1730
	24.0	24-10 1300	25-5 1360	26-0 1420	26-6 1480	27-1 1540	27-6 1600	28-0 1650	28-11 1760	29-9 1860

NOTE The extreme fiber stress in bending, "Fb", in pounds per square inch is shown below each span.

Table No. 7-E
ALLOWABLE SPAN FOR LOW OR HIGH SLOPE RAFTERS

20 Lbs. Per Sq. Ft. Live Load
(Supporting Gypsum Ceiling)

DESIGN CRITERIA:
Strength – 15 lbs. per sq. ft. dead load plus 20 lbs. per sq. ft. live load determines fiber stress.
Deflection – For 20 lbs. per sq. ft. live load. Limited to span in inches divided by 240.

HOW TO USE TABLES: Enter table with span of rafters (upper figure in each square). Determine size and spacing (first column) based on stress grade (top row) and modulus of elasticity (lower figure in each square) of lumber to be used.

RAFTER SIZE	SPACING (IN)	Allowable Extreme Fiber Stress in Bending, "F_b" (psi)										
		300	400	500	600	700	800	900	1000	1100	1200	1300
2×6	12.0	6 7 0 12	7 7 0 19	8 6 0 26	9 4 0 35	10 0 0 44	10 9 0 54	11 5 0 64	12 0 0 75	12 7 0 86	13 2 0 98	13 8 1 11
	13.7	6 2 0 12	7 1 0 18	7 11 0 25	8 8 0 33	9 5 0 41	10 0 0 50	10 8 0 60	11 3 0 70	11 9 0 81	12 4 0 92	12 10 1 04
	16.0	5 8 0 11	6 7 0 16	7 4 0 23	8 1 0 30	8 8 0 38	9 4 0 46	9 10 0 55	10 5 0 65	10 11 0 75	11 5 0 85	11 10 0 96
	19.2	5 2 0 10	6 0 0 15	6 9 0 21	7 4 0 27	7 11 0 35	8 6 0 42	9 0 0 51	9 6 0 59	9 11 0 68	10 5 0 78	10 10 0 88
	24.0	4 8 0 09	5 4 0 13	6 0 0 19	6 7 0 25	7 1 0 31	7 7 0 38	8 1 0 45	8 6 0 53	8 11 0 61	9 4 0 70	9 8 0 78
2×8	12.0	8 8 0 12	10 0 0 19	11 2 0 26	12 3 0 35	13 3 0 44	14 2 0 54	15 0 0 64	15 10 0 75	16 7 0 86	17 4 0 98	18 0 1 11
	13.7	8 1 0 12	9 4 0 18	10 6 0 25	11 6 0 33	12 5 0 41	13 3 0 50	14 0 0 60	14 10 0 70	15 6 0 81	16 3 0 92	16 10 1 04
	16.0	7 6 0 11	8 8 0 16	9 8 0 23	10 7 0 30	11 6 0 38	12 3 0 46	13 0 0 55	13 8 0 65	14 4 0 75	15 0 0 85	15 7 0 96
	19.2	6 10 0 10	7 11 0 15	8 10 0 21	9 8 0 27	10 6 0 35	11 2 0 42	11 10 0 51	12 6 0 59	13 1 0 68	13 8 0 78	14 3 0 88
	24.0	6 2 0 09	7 1 0 13	7 11 0 19	8 8 0 25	9 4 0 31	10 0 0 38	10 7 0 45	11 2 0 53	11 9 0 61	12 3 0 70	12 9 0 78
2×10	12.0	11 1 0 12	12 9 0 19	14 3 0 26	15 8 0 35	16 11 0 44	18 1 0 54	19 2 0 64	20 2 0 75	21 2 0 86	22 1 0 98	23 0 1 11
	13.7	10 4 0 12	11 11 0 18	13 4 0 25	14 8 0 33	15 10 0 41	16 11 0 50	17 11 0 60	18 11 0 70	19 10 0 81	20 8 0 92	21 6 1 04
	16.0	9 7 0 11	11 1 0 16	12 4 0 23	13 6 0 30	14 8 0 38	15 8 0 46	16 7 0 55	17 6 0 65	18 4 0 75	19 2 0 85	19 11 0 96
	19.2	8 9 0 10	10 1 0 15	11 3 0 21	12 4 0 27	13 4 0 35	14 3 0 42	15 2 0 51	15 11 0 59	16 9 0 68	17 6 0 78	18 2 0 88
	24.0	7 10 0 09	9 0 0 13	10 1 0 19	11 1 0 25	11 11 0 31	12 9 0 38	13 6 0 45	14 3 0 53	15 0 0 61	15 8 0 70	16 3 0 78
2×12	12.0	13 5 0 12	15 6 0 19	17 4 0 26	19 0 0 35	20 6 0 44	21 11 0 54	23 3 0 64	24 7 0 75	25 9 0 86	26 11 0 98	28 0 1 11
	13.7	12 7 0 12	14 6 0 18	16 3 0 25	17 9 0 33	19 3 0 41	20 6 0 50	21 9 0 60	23 0 0 70	24 1 0 81	25 2 0 92	26 2 1 04
	16.0	11 8 0 11	13 5 0 16	15 0 0 23	16 6 0 30	17 9 0 38	19 0 0 46	20 2 0 55	21 3 0 65	22 4 0 75	23 3 0 85	24 3 0 96
	19.2	10 8 0 10	12 3 0 15	13 9 0 21	15 0 0 27	16 3 0 35	17 4 0 42	18 5 0 51	19 5 0 59	20 4 0 68	21 3 0 78	22 2 0 88
	24.0	9 6 0 09	11 0 0 13	12 3 0 19	13 5 0 25	14 6 0 31	15 6 0 38	16 6 0 45	17 4 0 53	18 2 0 61	19 0 0 70	19 10 0 78

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

Table No. 7-E (cont.)

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

HOW TO USE TABLES: Enter table with span of rafters (upper figure in each square). Determine size and spacing (last column) based on stress grade (top row) and modulus of elasticity (lower figure in each square) of lumber to be used.

Allowable Extreme Fiber Stress in Bending, "F_b" (psi)											RAFTER SPACING (IN)	RAFTER SIZE (IN)
1400	1500	1600	1700	1800	1900	2000	2100	2200	2400	2700		
14 2 1.24	14 8 1 37	15 2 1 51	15 8 1 66	16 1 1 81	16 7 1 96	17 0 2 12	17 5 2 28	17 10 2 44			12 0	
13-3 1.16	13 9 1 29	14 2 1 42	14 8 1 55	15 1 1 69	15 6 1 83	15 11 1 98	16 3 2 13	16 8 2 28	17 5 2 60		13 7	
12-4 1 07	12 9 1 19	13 2 1 31	13 7 1 44	13 11 1 56	14 4 1 70	14 8 1 83	15 1 1 97	15 5 2 11	16 1 2 41		16 0	2×6
11 3 0.98	11 7 1 09	12 0 1 20	12 4 1 31	12 9 1 43	13 1 1 55	13 5 1 67	13 9 1 80	14 1 1 93	14 8 2 20		19 2	
10-0 0 88	10 5 0 97	10-9 1 07	11 1 1 17	11 5 1 28	11 8 1 39	12 0 1 50	12 4 1 61	12 7 1 73	13 2 1 97	13 11 2 35	24 0	
18-9 1 24	19-5 1 37	20 0 1 51	20-8 1 66	21 3 1 81	21 10 1 96	22 4 2 12	22 11 2 28	23 6 2 44			12 0	
17-6 1 16	18-2 1 29	18-9 1 42	19 4 1 55	19 10 1 69	20 5 1 83	20 11 1 98	21 5 2 13	21 11 2 28	22 11 2 60		13 7	
16-3 1 07	16-9 1 19	17 4 1 31	17 10 1 44	18-5 1 56	18 11 1 70	19 5 1 83	19 10 1 97	20 4 2 11	21 3 2 41		16 0	2×8
14-10 0.98	15-4 1 09	15-10 1 20	16 4 1 31	16-9 1 43	17 3 1 55	17 8 1 67	18 2 1 80	18 7 1 93	19 5 2 20		19 2	
13 3 0.88	13-8 0.97	14-2 1 07	14 7 1 17	15 0 1 28	15 5 1 39	15 10 1 50	16 3 1 61	16 7 1 73	17 4 1 97	18 5 2 35	24 0	
23-11 1.24	24-9 1 37	25-6 1 51	26-4 1 66	27 1 1 81	27 10 1 96	28 7 2 12	29 3 2 28	29 11 2 44			12 0	
22-4 1.16	23-2 1 29	23-11 1 42	24-7 1 55	25-4 1 69	26 0 1 83	26 8 1 98	27 4 2 13	28 0 2 28	29 3 2 60		13 7	
20-8 1 07	21-5 1 19	22 1 1 31	22 10 1 44	23 5 1 56	24 1 1 70	24 9 1 83	25 4 1 97	25 11 2 11	27 1 2 41		16 0	2×10
18-11 0.98	19-7 1 09	20-2 1 20	20 10 1 31	21 5 1 43	22 0 1 55	22 7 1 67	23 2 1 80	23 8 1 93	24 9 2 20		19 2	
16-11 0.88	17-6 0.97	18-1 1 07	18-7 1 17	19-2 1 28	19 8 1 39	20 2 1 50	20 8 1 61	21 2 1 73	22 1 1 97	23 5 2 35	24 0	
29-1 1.24	30-1 1 37	31-1 1 51	32-0 1 66	32 11 1 81	33 10 1 96	34 9 2 12	35 7 2 28	36 5 2 44			12 0	
27-2 1 16	28-2 1 29	29 1 1 42	29 11 1 55	30 10 1 69	31 8 1 83	32 6 1 98	33 3 2 13	34 1 2 28	35 7 2 60		13 7	
25-2 1 07	26-0 1 19	26-11 1 31	27 9 1 44	28 6 1 56	29 4 1 70	30 1 1 83	30 10 1 97	31 6 2 11	32 11 2 41		16 0	2×12
23-0 0.98	23-9 1 09	24-7 1 20	25-4 1 31	26 0 1 43	26 9 1 55	27 5 1 67	28 2 1 80	28 9 1 93	30 1 2 20		19 2	
20-6 0.88	21-3 0.97	21 11 1 07	22 8 1 17	23 3 1 28	23 11 1 39	24 7 1 50	25 2 1 61	25 9 1 73	26 11 1 97	28 6 2 35	24 0	

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

Table No. 7-F
ALLOWABLE SPAN FOR LOW OR HIGH SLOPE RAFTERS

30 Lbs. Per Sq. Ft. Live Load
(Supporting Gypsum Ceiling)

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

HOW TO USE TABLES: Enter table with span of rafters (upper figure in each square). Determine size and spacing (first column) based on stress grade (top row) and modulus of elasticity (lower figure in each square) of lumber to be used.

RAFTER SIZE	SPACING (IN)	Allowable Extreme Fiber Stress in Bending, "F_b" (psi)										
		300	400	500	600	700	800	900	1000	1100	1200	1300
2x6	12.0	5.10 0.13	6.8 0.19	7.6 0.27	8.2 0.36	8.10 0.45	9.6 0.55	10.0 0.66	10.7 0.77	11.1 0.89	11.7 1.01	12.1 1.14
	13.7	5.5 0.12	6.3 0.18	7.0 0.25	7.8 0.33	8.3 0.42	8.10 0.52	9.5 0.61	9.11 0.72	10.5 0.83	10.10 0.95	11.3 1.07
	16.0	5.0 0.11	5.10 0.17	6.6 0.24	7.1 0.31	7.8 0.39	8.2 0.48	8.8 0.57	9.2 0.67	9.7 0.77	10.0 0.88	10.5 0.99
	19.2	4.7 0.10	5.4 0.15	5.11 0.22	6.6 0.28	7.0 0.36	7.6 0.44	7.11 0.52	8.4 0.61	8.9 0.70	9.2 0.80	9.6 0.90
	24.0	4.1 0.09	4.9 0.14	5.4 0.19	5.10 0.25	6.3 0.32	6.8 0.39	7.1 0.46	7.6 0.54	7.10 0.63	8.2 0.72	8.6 0.81
2x8	12.0	7.8 0.13	8.10 0.19	9.10 0.27	10.10 0.36	11.8 0.45	12.6 0.55	13.3 0.66	13.11 0.77	14.8 0.89	15.3 1.01	15.11 1.14
	13.7	7.2 0.12	8.3 0.18	9.3 0.25	10.1 0.33	10.11 0.42	11.8 0.52	12.5 0.61	13.1 0.72	13.8 0.83	14.4 0.95	14.11 1.07
	16.0	6.7 0.11	7.8 0.17	8.7 0.24	9.4 0.31	10.1 0.39	10.10 0.48	11.6 0.57	12.1 0.67	12.8 0.77	13.3 0.88	13.9 0.99
	19.2	6.1 0.10	7.0 0.15	7.10 0.22	8.7 0.28	9.3 0.36	9.10 0.44	10.6 0.52	11.0 0.61	11.7 0.70	12.1 0.80	12.7 0.90
	24.0	5.5 0.09	6.3 0.14	7.0 0.19	7.8 0.25	8.3 0.32	8.10 0.39	9.4 0.46	9.10 0.54	10.4 0.63	10.10 0.72	11.3 0.81
2x10	12.0	9.9 0.13	11.3 0.19	12.7 0.27	13.9 0.36	14.11 0.45	15.11 0.55	16.11 0.66	17.10 0.77	18.8 0.89	19.6 1.01	20.4 1.14
	13.7	9.1 0.12	10.6 0.18	11.9 0.25	12.11 0.33	13.11 0.42	14.11 0.52	15.10 0.61	16.8 0.72	17.6 0.83	18.3 0.95	19.0 1.07
	16.0	8.5 0.11	9.9 0.17	10.11 0.24	11.11 0.31	12.11 0.39	13.9 0.48	14.8 0.57	15.5 0.67	16.2 0.77	16.11 0.88	17.7 0.99
	19.2	7.8 0.10	8.11 0.15	9.11 0.22	10.11 0.28	11.9 0.36	12.7 0.44	13.4 0.52	14.1 0.61	14.9 0.70	15.5 0.80	16.1 0.90
	24.0	6.11 0.09	8.0 0.14	8.11 0.19	9.9 0.25	10.6 0.32	11.3 0.39	11.11 0.46	12.7 0.54	13.2 0.63	13.9 0.72	14.4 0.81
2x12	12.0	11.10 0.13	13.8 0.19	15.4 0.27	16.9 0.36	18.1 0.45	19.4 0.55	20.6 0.66	21.8 0.77	22.8 0.89	23.9 1.01	24.8 1.14
	13.7	11.1 0.12	12.10 0.18	14.4 0.25	15.8 0.33	16.11 0.42	18.1 0.52	19.3 0.61	20.3 0.72	21.3 0.83	22.2 0.95	23.1 1.07
	16.0	10.3 0.11	11.10 0.17	13.3 0.24	14.6 0.31	15.8 0.39	16.9 0.48	17.9 0.57	18.9 0.67	19.8 0.77	20.6 0.88	21.5 0.99
	19.2	9.5 0.10	10.10 0.15	12.1 0.22	13.3 0.28	14.4 0.36	15.4 0.44	16.3 0.52	17.1 0.61	17.11 0.70	18.9 0.80	19.6 0.90
	24.0	8.5 0.09	9.8 0.14	10.10 0.19	11.10 0.25	12.10 0.32	13.8 0.39	14.6 0.46	15.4 0.54	16.1 0.63	16.9 0.72	17.5 0.81

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

Table No. 7-F (cont.)

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

HOW TO USE TABLES: Enter table with span of rafters (upper figure in each square). Determine size and spacing (last column) based on stress grade (top row) and modulus of elasticity (lower figure in each square) of lumber to be used.

Allowable Extreme Fiber Stress in Bending, "F_b" (psi).											RAFTER SPACING (IN)	SIZE (IN)
1400	1500	1600	1700	1800	1900	2000	2100	2200	2400	2700		
12-6 1 28	13 0 1 41	13-5 1 56	13 10 1 71	14 2 1 86	14 7 2 02	15-0 2 18	15 4 2 34	15-8 2 51			12 0	
11 9 1 19	12 2 1 32	12 6 1 46	12 11 1 60	13 3 1 74	13-8 1 89	14 0 2 04	14 4 2 19	14-8 2 35			13 7	
10-10 1 10	11 3 1 22	11 7 1 35	11 11 1 48	12 4 1 61	12 8 1 75	13-0 1 89	13 3 2 03	13-7 2 18	14-2 2 48		16 0	2x6
9-11 1 01	10-3 1 12	10-7 1 23	10 11 1 35	11 3 1 47	11 6 1 59	11 10 1 72	12 2 1 85	12-5 1 99	13-0 2 26		19 2	
8-10 0 90	9-2 1 00	9 6 1 10	9 9 1 21	10 0 1 31	10 4 1 43	10 7 1 54	10-10 1 66	11 1 1 78	11-7 2 02	12 4 2 41	24 0	
16 6 1 28	17 1 1 41	17 8 1 56	18 2 1 71	18 9 1 86	19 3 2 02	19 9 2 18	20-3 2 34	20-8 2 51			12 0	
15-5 1 19	16 0 1 32	16-6 1 46	17 0 1 60	17 6 1 74	18 0 1 89	18-5 2 04	18 11 2 19	19 4 2 35			13 7	
14 4 1 10	14 10 1 22	15 3 1 35	15 9 1 48	16 3 1 61	16 8 1 75	17 1 1 89	17 6 2 03	17 11 2 18	18-9 2 48		16 0	2x8
13 1 1 01	13-6 1 12	13 11 1 23	14-5 1 35	14 10 1 47	15-2 1 59	15-7 1 72	16 0 1 85	16-4 1 99	17 1 2 26		19 2	
11 8 0 90	12 1 1 00	12 6 1 10	12 10 1 21	13 3 1 31	13-7 1 43	13 11 1 54	14 4 1 66	14-8 1 78	15 3 2 02	16-3 2 41	24 0	
21 1 1 28	21 10 1 41	22 6 1 56	23 3 1 71	23 11 1 86	24 6 2 02	25 2 2 16	25 10 2 34	26-5 2 51			12 0	
19-8 1 19	20-5 1 32	21 1 1 46	21 9 1 60	22 4 1 74	22 11 1 89	23 7 2 04	24 2 2 19	24-8 2 35			13 7	
18-3 1 10	18 11 1 22	19-6 1 35	20-1 1 48	20-8 1 61	21 3 1 75	21 10 1 89	22 4 2 03	22 10 2 18	23 11 2 48		16 0	2x10
16-8 1 01	17 3 1 12	17 10 1 23	18 4 1 35	18 11 1 47	19 5 1 59	19 11 1 72	20-5 1 85	20-10 1 99	21 10 2 26		19 2	
14-11 0 90	15-5 1 00	15-11 1 10	16-5 1 21	16-11 1 31	17 4 1 43	17 10 1 54	18-3 1 66	18 8 1 78	19-6 2 02	20-8 2 41	24 0	
25-7 1 28	26-6 1 41	27 5 1 56	28-3 1 71	29 1 1 86	29 10 2 02	30-7 2 18	31 4 2 34	32 1 2 51			12 0	
24-0 1 19	24 10 1 32	25 7 1 46	26-5 1 60	27 2 1 74	27 11 1 89	28-8 2 04	29 4 2 19	30-0 2 35			13 7	
22 2 1 10	23-0 1 22	23-9 1 35	24-5 1 48	25 2 1 61	25 10 1 75	26-6 1 89	27 2 2 03	27 10 2 18	29 1 2 48		16 0	2x12
20-3 1 01	21 0 1 12	21 8 1 23	22 4 1 35	23 0 1 47	23 7 1 59	24-2 1 72	24 10 1 85	25-5 1 99	26-6 2 26		19 2	
18-1 0 90	18 9 1 00	19-4 1 10	20-0 1 21	20-6 1 31	21-1 1 43	21 8 1 54	22 2 1 66	22 8 1 78	23-9 2 02	25 2 2 41	24 0	

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

Table No. 7-G
ALLOWABLE SPAN FOR LOW OR HIGH SLOPE RAFTERS

40 Lbs. Per Sq. Ft. Live Load
(Supporting Gypsum Ceiling)

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

HOW TO USE TABLES: Enter table with span of rafters (upper figure in each square). Determine size and spacing (first column) based on stress grade (top row) and modulus of elasticity (lower figure in each square) of lumber to be used.

RAFTER SIZE	SPACING (IN)	Allowable Extreme Fiber Stress in Bending, "F_b" (psi). 300	400	500	600	700	800	900	1000	1100	1200	1300
2x6	12.0	5-3 0.12	6-1 0.19	6-9 0.27	7-5 0.35	8-0 0.44	8-7 0.54	9-1 0.65	9-7 0.76	10-0 0.88	10-6 1.00	10-11 1.13
	13.7	4-11 0.12	5-8 0.18	6-4 0.25	6-11 0.33	7-6 0.42	8-0 0.51	8-6 0.61	8-11 0.71	9-5 0.82	9-10 0.93	10-3 1.05
	16.0	4-6 0.11	5-3 0.17	5-10 0.23	6-5 0.31	6-11 0.39	7-5 0.47	7-10 0.56	8-3 0.66	8-8 0.76	9-1 0.86	9-5 0.98
	19.2	4-2 0.10	4-9 0.15	5-4 0.21	5-10 0.28	6-4 0.35	6-9 0.43	7-2 0.51	7-7 0.60	7-11 0.69	8-3 0.79	8-8 0.89
	24.0	3-8 0.09	4-3 0.14	4-9 0.19	5-3 0.25	5-8 0.31	6-1 0.38	6-5 0.46	6-9 0.54	7-1 0.62	7-5 0.71	7-9 0.80
2x8	12.0	6-11 0.12	8-0 0.19	8-11 0.27	9-9 0.35	10-7 0.44	11-3 0.54	12-0 0.65	12-7 0.76	13-3 0.88	13-10 1.00	14-5 1.13
	13.7	6-6 0.12	7-6 0.18	8-4 0.25	9-2 0.33	9-11 0.42	10-7 0.51	11-2 0.61	11-10 0.71	12-5 0.82	12-11 0.93	13-6 1.05
	16.0	6-0 0.11	6-11 0.17	7-9 0.23	8-6 0.31	9-2 0.39	9-9 0.47	10-4 0.56	10-11 0.66	11-6 0.76	12-0 0.86	12-6 0.98
	19.2	5-6 0.10	6-4 0.15	7-1 0.21	7-9 0.28	8-4 0.35	8-11 0.43	9-6 0.51	10-0 0.60	10-6 0.69	10-11 0.79	11-5 0.89
	24.0	4-11 0.09	5-8 0.14	6-4 0.19	6-11 0.25	7-6 0.31	8-0 0.38	8-6 0.46	8-11 0.54	9-4 0.62	9-9 0.71	10-2 0.80
2x10	12.0	8-10 0.12	10-2 0.19	11-5 0.27	12-6 0.35	13-6 0.44	14-5 0.54	15-3 0.65	16-1 0.76	16-11 0.88	17-8 1.00	18-4 1.13
	13.7	8-3 0.12	9-6 0.18	10-8 0.25	11-8 0.33	12-7 0.42	13-6 0.51	14-3 0.61	15-1 0.71	15-10 0.82	16-6 0.93	17-2 1.05
	16.0	7-8 0.11	8-10 0.17	9-10 0.23	10-10 0.31	11-8 0.39	12-6 0.47	13-3 0.56	13-11 0.66	14-8 0.76	15-3 0.86	15-11 0.98
	19.2	7-0 0.10	8-1 0.15	9-0 0.21	9-10 0.28	10-8 0.35	11-5 0.43	12-1 0.51	12-9 0.60	13-4 0.69	13-11 0.79	14-6 0.89
	24.0	6-3 0.09	7-2 0.14	8-1 0.19	8-10 0.25	9-6 0.31	10-2 0.38	10-10 0.46	11-5 0.54	11-11 0.62	12-6 0.71	13-0 0.80
2x12	12.0	10-9 0.12	12-5 0.19	13-10 0.27	15-2 0.35	16-5 0.44	17-6 0.54	18-7 0.65	19-7 0.76	20-6 0.88	21-5 1.00	22-4 1.13
	13.7	10-0 0.12	11-7 0.18	12-11 0.25	14-2 0.33	15-4 0.42	16-5 0.51	17-5 0.61	18-4 0.71	19-3 0.82	20-1 0.93	20-11 1.05
	16.0	9-3 0.11	10-9 0.17	12-0 0.23	13-2 0.31	14-2 0.39	15-2 0.47	16-1 0.56	17-0 0.66	17-9 0.76	18-7 0.86	19-4 0.98
	19.2	8-6 0.10	9-10 0.15	10-11 0.21	12-0 0.28	12-11 0.35	13-10 0.43	14-8 0.51	15-6 0.60	16-3 0.69	17-0 0.79	17-8 0.89
	24.0	7-7 0.09	8-9 0.14	9-10 0.19	10-9 0.25	11-7 0.31	12-5 0.38	13-2 0.46	13-10 0.54	14-6 0.62	15-2 0.71	15-9 0.80

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

Table No. 7-G (cont.)

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

HOW TO USE TABLES: Enter table with span of rafters (upper figure in each square). Determine size and spacing (last column) based on stress grade (top row) and modulus of elasticity (lower figure in each square) of lumber to be used.

Allowable Extreme Fiber Stress in Bending, "F_b" (psi).											RAFTER SPACING (IN)	SIZE (IN)
1400	1500	1600	1700	1800	1900	2000	2100	2200	2400	2700		
11-4 1.26	11-9 1.40	12-1 1.54	12-6 1.68	12-10 1.83	13-2 1.99	13-6 2.15	13-10 2.31	14-2 2.48			12.0	
10-7 1.18	11-0 1.31	11-4 1.44	11-8 1.57	12-0 1.72	12-4 1.86	12-8 2.01	13-0 2.16	13-3 2.32			13.7	
9-10 1.09	10-2 1.21	10-6 1.33	10-10 1.46	11-1 1.59	11-5 1.72	11-9 1.86	12-0 2.00	12-4 2.15	12-10 2.45		16.0	2x6
8-11 0.99	9-3 1.10	9-7 1.22	9-10 1.33	10-2 1.45	10-5 1.57	10-8 1.70	11-0 1.83	11-3 1.96	11-9 2.23		19.2	
8-0 0.89	8-3 0.99	8-7 1.09	8-10 1.19	9-1 1.30	9-4 1.41	9-7 1.52	9-10 1.63	10-0 1.75	10-6 2.00	11-1 2.38	24.0	
14-11 1.26	15-5 1.40	16-0 1.54	16-5 1.68	16-11 1.83	17-5 1.99	17-10 2.15	18-3 2.31	18-9 2.48			12.0	
14-0 1.18	14-6 1.31	14-11 1.44	15-5 1.57	15-10 1.72	16-3 1.86	16-8 2.01	17-1 2.16	17-6 2.32			13.7	
12-11 1.09	13-5 1.21	13-10 1.33	14-3 1.46	14-8 1.59	15-1 1.72	15-5 1.86	15-10 2.00	16-3 2.15	16-11 2.45		16.0	2x8
11-10 0.99	12-3 1.10	12-7 1.22	13-0 1.33	13-5 1.45	13-9 1.57	14-1 1.70	14-6 1.83	14-10 1.96	15-5 2.23		19.2	
10-7 0.89	10-11 0.99	11-3 1.09	11-8 1.19	12-0 1.30	12-4 1.41	12-7 1.52	12-11 1.63	13-3 1.75	13-10 2.00	14-8 2.38	24.0	
19-1 1.26	19-9 1.40	20-4 1.54	21-0 1.68	21-7 1.83	22-2 1.99	22-9 2.15	23-4 2.31	23-11 2.48			12.0	
17-10 1.18	18-5 1.31	19-1 1.44	19-8 1.57	20-2 1.72	20-9 1.86	21-4 2.01	21-10 2.16	22-4 2.32			13.7	
16-6 1.09	17-1 1.21	17-8 1.33	18-2 1.46	18-9 1.59	19-3 1.72	19-9 1.86	20-2 2.00	20-8 2.15	21-7 2.45		16.0	2x10
15-1 0.99	15-7 1.10	16-1 1.22	16-7 1.33	17-1 1.45	17-7 1.57	18-0 1.70	18-5 1.83	18-11 1.96	19-9 2.23		19.2	
13-6 0.89	13-11 0.99	14-5 1.09	14-10 1.19	15-3 1.30	15-8 1.41	16-1 1.52	16-6 1.63	16-11 1.75	17-8 2.00	18-9 2.38	24.0	
23-2 1.26	24-0 1.40	24-9 1.54	25-6 1.68	26-3 1.83	27-0 1.99	27-8 2.15	28-5 2.31	29-1 2.48			12.0	
21-8 1.18	22-5 1.31	23-2 1.44	23-11 1.57	24-7 1.72	25-3 1.86	25-11 2.01	26-7 2.16	27-2 2.32			13.7	
20-1 1.09	20-9 1.21	21-5 1.33	22-1 1.46	22-9 1.59	23-5 1.72	24-0 1.86	24-7 2.00	25-2 2.15	26-3 2.45		16.0	2x12
18-4 0.99	19-0 1.10	19-7 1.22	20-2 1.33	20-9 1.45	21-4 1.57	21-11 1.70	22-5 1.83	23-0 1.96	24-0 2.23		19.2	
16-5 0.89	17-0 0.99	17-6 1.09	18-1 1.19	18-7 1.30	19-1 1.41	19-7 1.52	20-1 1.63	20-6 1.75	21-5 2.00	22-9 2.38	24.0	

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

Table No. 7-H
ALLOWABLE SPAN FOR LOW OR HIGH SLOPE RAFTERS

20 Lbs. Per Sq. Ft. Live Load
(Supporting Plaster Ceiling)

DESIGN CRITERIA:
Strength – 15 lbs. per sq. ft. dead load plus 20 lbs. per sq. ft. live load determines fiber stress.
Deflection – For 20 lbs. per sq. ft. live load. Limited to span in inches divided by 360.

HOW TO USE TABLES: Enter table with span of rafters (upper figure in each square). Determine size and spacing (first column) based on stress grade (top row) and modulus of elasticity (lower figure in each square) of lumber to be used.

RAFTER SIZE	SPACING (IN)	Allowable Extreme Fiber Stress in Bending, "F_b" (psi).									
		300	400	500	600	700	800	900	1000	1100	1200
2x6	12.0	6-7 0.18	7-7 0.28	8-6 0.40	9-4 0.52	10-0 0.66	10-9 0.80	11-5 0.96	12-0 1.12	12-7 1.29	13-2 1.48
	13.7	6-2 0.17	7-1 0.27	7-11 0.37	8-8 0.49	9-5 0.61	10-0 0.75	10-8 0.90	11-3 1.05	11-9 1.21	12-4 1.38
	16.0	5-8 0.16	6-7 0.25	7-4 0.34	8-1 0.45	8-8 0.57	9-4 0.70	9-10 0.83	10-5 0.97	10-11 1.12	11-5 1.28
	19.2	5-2 0.15	6-0 0.22	6-9 0.31	7-4 0.41	7-11 0.52	8-6 0.63	9-0 0.76	9-6 0.89	9-11 1.02	10-5 1.17
	24.0	4-8 0.13	5-4 0.20	6-0 0.28	6-7 0.37	7-1 0.46	7-7 0.57	8-1 0.68	8-6 0.79	8-11 0.92	9-4 1.04
2x8	12.0	8-8 0.18	10-0 0.28	11-2 0.40	12-3 0.52	13-3 0.66	14-2 0.80	15-0 0.96	15-10 1.12	16-7 1.29	17-4 1.48
	13.7	8-1 0.17	9-4 0.27	10-6 0.37	11-6 0.49	12-5 0.61	13-3 0.75	14-0 0.90	14-10 1.05	15-6 1.21	16-3 1.38
	16.0	7-6 0.16	8-8 0.25	9-8 0.34	10-7 0.45	11-6 0.57	12-3 0.70	13-0 0.83	13-8 0.97	14-4 1.12	15-0 1.28
	19.2	6-10 0.15	7-11 0.22	8-10 0.31	9-8 0.41	10-6 0.52	11-2 0.63	11-10 0.76	12-6 0.89	13-1 1.02	13-8 1.17
	24.0	6-2 0.13	7-1 0.20	7-11 0.28	8-8 0.37	9-4 0.46	10-0 0.57	10-7 0.68	11-2 0.79	11-9 0.92	12-3 1.04
2x10	12.0	11-1 0.18	12-9 0.28	14-3 0.40	15-8 0.52	16-11 0.66	18-1 0.80	19-2 0.96	20-2 1.12	21-2 1.29	22-1 1.48
	13.7	10-4 0.17	11-11 0.27	13-4 0.37	14-8 0.49	15-10 0.61	16-11 0.75	17-11 0.90	18-11 1.05	19-10 1.21	20-8 1.38
	16.0	9-7 0.16	11-1 0.25	12-4 0.34	13-6 0.45	14-8 0.57	15-8 0.70	16-7 0.83	17-6 0.97	18-4 1.12	19-2 1.28
	19.2	8-9 0.15	10-1 0.22	11-3 0.31	12-4 0.41	13-4 0.52	14-3 0.63	15-2 0.76	15-11 0.89	16-9 1.02	17-6 1.17
	24.0	7-10 0.13	9-0 0.20	10-1 0.28	11-1 0.37	11-11 0.46	12-9 0.57	13-6 0.68	14-3 0.79	15-0 0.92	15-8 1.04
2x12	12.0	13-5 0.18	15-6 0.28	17-4 0.40	19-0 0.52	20-6 0.66	21-11 0.80	23-3 0.96	24-7 1.12	25-9 1.29	26-11 1.48
	13.7	12-7 0.17	14-6 0.27	16-3 0.37	17-9 0.49	19-3 0.61	20-6 0.75	21-9 0.90	23-0 1.05	24-1 1.21	25-2 1.38
	16.0	11-8 0.16	13-5 0.25	15-0 0.34	16-6 0.45	17-9 0.57	19-0 0.70	20-2 0.83	21-3 0.97	22-4 1.12	23-3 1.28
	19.2	10-8 0.15	12-3 0.22	13-9 0.31	15-0 0.41	16-3 0.52	17-4 0.63	18-5 0.76	19-5 0.89	20-4 1.02	21-3 1.17
	24.0	9-6 0.13	11-0 0.20	12-3 0.28	13-5 0.37	14-6 0.46	15-6 0.57	16-6 0.68	17-4 0.79	18-2 0.92	19-0 1.04

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

Table No. 7-H (cont.)

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

HOW TO USE TABLES: Enter table with span of rafters (upper figure in each square). Determine size and spacing (last column) based on stress grade (top row) and modulus of elasticity (lower figure in each square) of lumber to be used.

Allowable Extreme Fiber Stress in Bending, "F_b" (psi).									RAFTER SPACING (IN)	SIZE (IN)
1300	1400	1500	1600	1700	1800	1900	2000	2100		
13-8 1 66	14-2 1 86	14-8 2 06	15-2 2 27	15-8 2 49					12 0	
12-10 1 56	13-3 1 74	13-9 1 93	14-2 2 12	14 8 2 33	15-1 2 54				13.7	
11 10 1 44	12-4 1 61	12-9 1 79	13 2 1 97	13.7 2 15	13 11 2 35	14 4 2 55			16 0	2x6
10-10 1 32	11-3 1 47	11-7 1 63	12-0 1 80	12 4 1 97	12-9 2 14	13 1 2 32	13-5 2 51		19 2	
9-8 1 18	10-0 1 31	10-5 1 46	10-9 1 61	11 1 1 76	11 5 1 92	11 8 2 08	12 0 2 24	12 4 2 41	24 0	
18-0 1 66	18 9 1 86	19-5 2 06	20-0 2 27	20-8 2 49					12 0	
16-10 1 56	17 6 1 74	18 2 1 93	18 9 2 12	19 4 2 33	19 10 2 54				13 7	
15 7 1 44	16 3 1 61	16 9 1 79	17 4 1 97	17 10 2 15	18 5 2 35	18 11 2 55			16 0	2x8
14 3 1 32	14 10 1 47	15 4 1 63	15 10 1 80	16 4 1 97	16 9 2 14	17 3 2 32	17 8 2 51		19 2	
12 9 1 18	13 3 1 31	13 8 1 46	14 2 1 61	14 7 1 76	15 0 1 92	15 5 2 08	15 10 2 24	16 3 2 41	24 0	
23 0 1 66	23 11 1 86	24 9 2 06	25 6 2 27	26 4 2 49					12 0	
21 6 1 56	22 4 1 74	23 2 1 93	23 11 2 12	24 7 2 33	25 4 2 54				13 7	
19 11 1 44	20 8 1 61	21 5 1 79	22 1 1 97	22 10 2 15	23 5 2 35	24 1 2 55			16 0	2x10
18 2 1 32	18 11 1 47	19 7 1 63	20 2 1 80	20 10 1 97	21 5 2 14	22 0 2 32	22 7 2 51		19 2	
16 3 1 18	16 11 1 31	17 6 1 46	18 1 1 61	18 7 1 76	19 2 1 92	19 8 2 08	20 2 2 24	20 8 2 41	24 0	
28 0 1 66	29 1 1 86	30 1 2 06	31 1 2 27	32 0 2 49					12 0	
26 2 1 56	27 2 1 74	28 2 1 93	29 1 2 12	29 11 2 33	30 10 2 54				13 7	
24 3 1 44	25 2 1 61	26 0 1 79	26 11 1 97	27 9 2 15	28 6 2 35	29 4 2 55			16 0	2x12
22 2 1 32	23 0 1 47	23 9 1 63	24 7 1 80	25 4 1 97	26 0 2 14	26 9 2 32	27 5 2 51		19 2	
19 10 1 18	20 6 1 31	21 3 1 46	21 11 1 61	22 8 1 76	23 3 1 92	23 11 2 08	24 7 2 24	25 2 2 41	24 0	

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

Table No. 7-I
ALLOWABLE SPAN FOR LOW OR HIGH SLOPE RAFTERS

30 Lbs. Per Sq. Ft. Live Load
(Supporting Plaster Ceiling)

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

HOW TO USE TABLES: Enter table with span of rafters (upper figure in each square). Determine size and spacing (first column) based on stress grade (top row) and modulus of elasticity (lower figure in each square) of lumber to be used.

RAFTER SIZE	SPACING (IN)	Allowable Extreme Fiber Stress in Bending, "F_b" (psi).									
		300	400	500	600	700	890	900	1000	1100	1200
2x6	12.0	5-10 0.19	6-8 0.29	7-6 0.41	8-2 0.54	8-10 0.68	9-6 0.83	10-0 0.99	10-7 1.15	11-1 1.33	11-7 1.52
	13.7	5-5 0.18	6-3 0.27	7-0 0.38	7-8 0.50	8-3 0.63	8-10 0.77	9-5 0.92	9-11 1.08	10-5 1.25	10-10 1.42
	16.0	5-0 0.16	5-10 0.25	6-6 0.35	7-1 0.46	7-8 0.59	8-2 0.72	8-8 0.85	9-2 1.00	9-7 1.15	10-0 1.31
	19.2	4-7 0.15	5-4 0.23	5-11 0.32	6-6 0.42	7-0 0.53	7-6 0.65	7-11 0.78	8-4 0.91	8-9 1.05	9-2 1.20
	24.0	4-1 0.13	4-9 0.21	5-4 0.29	5-10 0.38	6-3 0.48	6-8 0.58	7-1 0.70	7-6 0.82	7-10 0.94	8-2 1.07
2x8	12.0	7-8 0.19	8-10 0.29	9-10 0.41	10-10 0.54	11-8 0.68	12-6 0.83	13-3 0.99	13-11 1.15	14-8 1.33	15-3 1.52
	13.7	7-2 0.18	8-3 0.27	9-3 0.38	10-1 0.50	10-11 0.63	11-8 0.77	12-5 0.92	13-1 1.08	13-8 1.25	14-4 1.42
	16.0	6-7 0.16	7-8 0.25	8-7 0.35	9-4 0.46	10-1 0.59	10-10 0.72	11-6 0.85	12-1 1.00	12-8 1.15	13-3 1.31
	19.2	6-1 0.15	7-0 0.23	7-10 0.32	8-7 0.42	9-3 0.53	9-10 0.65	10-6 0.78	11-0 0.91	11-7 1.05	12-1 1.20
	24.0	5-5 0.13	6-3 0.21	7-0 0.29	7-8 0.38	8-3 0.48	8-10 0.58	9-4 0.70	9-10 0.82	10-4 0.94	10-10 1.07
2x10	12.0	9-9 0.19	11-3 0.29	12-7 0.41	13-9 0.54	14-11 0.68	15-11 0.83	16-11 0.99	17-10 1.15	18-8 1.33	19-6 1.52
	13.7	9-1 0.18	10-6 0.27	11-9 0.38	12-11 0.50	13-11 0.63	14-11 0.77	15-10 0.92	16-8 1.08	17-6 1.25	18-3 1.42
	16.0	8-5 0.16	9-9 0.25	10-11 0.35	11-11 0.46	12-11 0.59	13-9 0.72	14-8 0.85	15-5 1.00	16-2 1.15	16-11 1.31
	19.2	7-8 0.15	8-11 0.23	9-11 0.32	10-11 0.42	11-9 0.53	12-7 0.65	13-4 0.78	14-1 0.91	14-9 1.05	15-5 1.20
	24.0	6-11 0.13	8-0 0.21	8-11 0.29	9-9 0.38	10-6 0.48	11-3 0.58	11-11 0.70	12-7 0.82	13-2 0.94	13-9 1.07
2x12	12.0	11-10 0.19	13-8 0.29	15-4 0.41	16-9 0.54	18-1 0.68	19-4 0.83	20-6 0.99	21-8 1.15	22-8 1.33	23-9 1.52
	13.7	11-1 0.18	12-10 0.27	14-4 0.38	15-8 0.50	16-11 0.63	18-1 0.77	19-3 0.92	20-3 1.08	21-3 1.25	22-2 1.42
	16.0	10-3 0.16	11-10 0.25	13-3 0.35	14-6 0.46	15-8 0.59	16-9 0.72	17-9 0.85	18-9 1.00	19-8 1.15	20-6 1.31
	19.2	9-5 0.15	10-10 0.23	12-1 0.32	13-3 0.42	14-4 0.53	15-4 0.65	16-3 0.78	17-1 0.91	17-11 1.05	18-9 1.20
	24.0	8-5 0.13	9-8 0.21	10-10 0.29	11-10 0.38	12-10 0.48	13-8 0.58	14-6 0.70	15-4 0.82	16-1 0.94	16-9 1.07

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

Table No. 7-1 (cont.)

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

HOW TO USE TABLES: Enter table with span of rafters (upper figure in each square). Determine size and spacing (last column) based on stress grade (top row) and modulus of elasticity (lower figure in each square) of lumber to be used.

Allowable Extreme Fiber Stress in Bending, "F_b" (psi).									RAFTER SPACING	SIZE
1300	1400	1500	1600	1700	1800	1900	2000	2100	(IN)	(IN)
12-1 1.71	12-6 1.91	13-0 2.12	13-5 2.34	13-10 2.56					12.0	
11-3 1.60	11-9 1.79	12-2 1.98	12-6 2.19	12-11 2.39					13.7	
10-5 1.48	10-10 1.66	11-3 1.84	11-7 2.02	11-11 2.22	12-4 2.41				16.0	2x6
9-6 1.35	9-11 1.51	10-3 1.68	10-7 1.85	10-11 2.02	11-3 2.20	11-6 2.39	11-10 2.58		19.2	
8-6 1.21	8-10 1.35	9-2 1.50	9-6 1.65	9-9 1.81	10-0 1.97	10-4 2.14	10-7 2.31	10-10 2.48	24.0	
15-11 1.71	16-6 1.91	17-1 2.12	17-8 2.34	18-2 2.56					12.0	
14-11 1.60	15-5 1.79	16-0 1.98	16-6 2.19	17-0 2.39					13.7	
13-9 1.48	14-4 1.66	14-10 1.84	15-3 2.02	15-9 2.22	16-3 2.41				16.0	2x8
12-7 1.35	13-1 1.51	13-6 1.68	13-11 1.85	14-5 2.02	14-10 2.20	15-2 2.39	15-7 2.58		19.2	
11-3 1.21	11-8 1.35	12-1 1.50	12-6 1.65	12-10 1.81	13-3 1.97	13-7 2.14	13-11 2.31	14-4 2.48	24.0	
20-4 1.71	21-1 1.91	21-10 2.12	22-6 2.34	23-3 2.56					12.0	
19-0 1.60	19-8 1.79	20-5 1.98	21-1 2.19	21-9 2.39					13.7	
17-7 1.48	18-3 1.66	18-11 1.84	19-6 2.02	20-1 2.22	20-8 2.41				16.0	2x10
16-1 1.35	16-8 1.51	17-3 1.68	17-10 1.85	18-4 2.02	18-11 2.20	19-5 2.39	19-11 2.58		19.2	
14-4 1.21	14-11 1.35	15-5 1.50	15-11 1.65	16-5 1.81	16-11 1.97	17-4 2.14	17-10 2.31	18-3 2.48	24.0	
24-8 1.71	25-7 1.91	26-6 2.12	27-5 2.34	28-3 2.56					12.0	
23-1 1.60	24-0 1.79	24-10 1.98	25-7 2.19	26-5 2.39					13.7	
21-5 1.48	22-2 1.66	23-0 1.84	23-9 2.02	24-5 2.22	25-2 2.41				16.0	2x12
19-6 1.35	20-3 1.51	21-0 1.68	21-8 1.85	22-4 2.02	23-0 2.20	23-7 2.39	24-2 2.58		19.2	
17-5 1.21	18-1 1.35	18-9 1.50	19-4 1.65	20-0 1.81	20-6 1.97	21-1 2.14	21-8 2.31	22-2 2.48	24.0	

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

Table No. 7-J
ALLOWABLE SPAN FOR LOW OR HIGH SLOPE RAFTERS

40 Lbs. Per Sq. Ft. Live Load
(Supporting Plaster Ceiling)

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

HOW TO USE TABLES: Enter table with span of rafters (upper figure in each square). Determine size and spacing (first column) based on stress grade (top row) and modulus of elasticity (lower figure in each square) of lumber to be used.

RAFTER SIZE (IN)	SPACING (IN)	Allowable Extreme Fiber Stress in Bending, "F_b" (psi). 300	400	500	600	700	800	900	1000	1100	1200
2x6	12.0	5-3 0.19	6-1 0.29	6-9 0.40	7-5 0.53	8-0 0.67	8-7 0.82	9-1 0.97	9-7 1.14	10-0 1.31	10-6 1.50
	13.7	4-11 0.18	5-8 0.27	6-4 0.38	6-11 0.50	7-6 0.62	8-0 0.76	8-6 0.91	8-11 1.07	9-5 1.23	9-10 1.40
	16.0	4-6 0.18	5-3 0.25	5-10 0.35	6-5 0.46	6-11 0.58	7-5 0.71	7-10 0.84	8-3 0.99	8-8 1.14	9-1 1.30
	19.2	4-2 0.15	4-9 0.23	5-4 0.32	5-10 0.42	6-4 0.53	6-9 0.64	7-2 0.77	7-7 0.90	7-11 1.04	8-3 1.18
	24.0	3-8 0.13	4-3 0.20	4-9 0.28	5-3 0.37	5-8 0.47	6-1 0.58	6-5 0.69	6-9 0.81	7-1 0.93	7-5 1.06
2x8	12.0	6-11 0.19	8-0 0.29	8-11 0.40	9-9 0.53	10-7 0.67	11-3 0.82	12-0 0.97	12-7 1.14	13-3 1.31	13-10 1.50
	13.7	6-6 0.18	7-6 0.27	8-4 0.38	9-2 0.50	9-11 0.62	10-7 0.76	11-2 0.91	11-10 1.07	12-5 1.23	12-11 1.40
	16.0	6-0 0.16	6-11 0.25	7-9 0.35	8-6 0.46	9-2 0.58	9-9 0.71	10-4 0.84	10-11 0.99	11-6 1.14	12-0 1.30
	19.2	5-6 0.15	6-4 0.23	7-1 0.32	7-9 0.42	8-4 0.53	8-11 0.64	9-6 0.77	10-0 0.90	10-6 1.04	10-11 1.18
	24.0	4-11 0.13	5-8 0.20	6-4 0.28	6-11 0.37	7-6 0.47	8-0 0.58	8-6 0.69	8-11 0.81	9-4 0.93	9-9 1.06
2x10	12.0	8-10 0.19	10-2 0.29	11-5 0.40	12-6 0.53	13-6 0.67	14-5 0.82	15-3 0.97	16-1 1.14	16-11 1.31	17-8 1.50
	13.7	8-3 0.18	9-6 0.27	10-8 0.38	11-8 0.50	12-7 0.62	13-6 0.76	14-3 0.91	15-1 1.07	15-10 1.23	16-6 1.40
	16.0	7-8 0.16	8-10 0.25	9-10 0.35	10-10 0.46	11-8 0.58	12-6 0.71	13-3 0.84	13-11 0.99	14-8 1.14	15-3 1.30
	19.2	7-0 0.15	8-1 0.23	9-0 0.32	9-10 0.42	10-8 0.53	11-5 0.64	12-1 0.77	12-9 0.90	13-4 1.04	13-11 1.18
	24.0	6-3 0.13	7-2 0.20	8-1 0.28	8-10 0.37	9-6 0.47	10-2 0.58	10-10 0.69	11-5 0.81	11-11 0.93	12-6 1.06
2x12	12.0	10-9 0.19	12-5 0.29	13-10 0.40	15-2 0.53	16-5 0.67	17-6 0.82	18-7 0.97	19-7 1.14	20-6 1.31	21-5 1.50
	13.7	10-0 0.18	11-7 0.27	12-11 0.38	14-2 0.50	15-4 0.62	16-5 0.76	17-5 0.91	18-4 1.07	19-3 1.23	20-1 1.40
	16.0	9-3 0.16	10-9 0.25	12-0 0.35	13-2 0.46	14-2 0.58	15-2 0.71	16-1 0.84	17-0 0.99	17-9 1.14	18-7 1.30
	19.2	8-6 0.15	9-10 0.23	10-11 0.32	12-0 0.42	12-11 0.53	13-10 0.64	14-8 0.77	15-6 0.90	16-3 1.04	17-0 1.18
	24.0	7-7 0.13	8-9 0.20	9-10 0.28	10-9 0.37	11-7 0.47	12-5 0.58	13-2 0.69	13-10 0.81	14-6 0.93	15-2 1.06

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

Table No. 7-J (cont.)

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

HOW TO USE TABLES: Enter table with span of rafters (upper figure in each square). Determine size and spacing (last column) based on stress grade (top row) and modulus of elasticity (lower figure in each square) of lumber to be used.

Allowable Extreme Fiber Stress in Bending, "F_b" (psi).									RAFTER SPACING (IN)	SIZE (IN)
1300	1400	1500	1600	1700	1800	1900	2000	2100		
10-11 1.69	11-4 1.89	11-9 2.09	12-1 2.31	12-6 2.53					12.0	
10-3 1.58	10-7 1.77	11-0 1.96	11-4 2.16	11-8 2.36	12-0 2.57				13.7	
9-5 1.46	9-10 1.63	10-2 1.81	10-6 2.00	10-10 2.19	11-1 2.38	11-5 2.58			16.0	2x6
8-8 1.34	8-11 1.49	9-3 1.65	9-7 1.82	9-10 2.00	10-2 2.18	10-5 2.36	10-8 2.55		19.2	
7-9 1.19	8-0 1.33	8-3 1.48	8-7 1.63	8-10 1.79	9-1 1.95	9-4 2.11	9-7 2.28	9-10 2.45	24.0	
14-5 1.69	14-11 1.89	15-5 2.09	16-0 2.31	16-5 2.53					12.0	
13-6 1.58	14-0 1.77	14-6 1.96	14-11 2.16	15-5 2.36	15-10 2.57				13.7	
12-6 1.46	12-11 1.63	13-5 1.81	13-10 2.00	14-3 2.19	14-8 2.38	15-1 2.58			16.0	2x8
11-5 1.34	11-10 1.49	12-3 1.65	12-7 1.82	13-0 2.00	13-5 2.18	13-9 2.36	14-1 2.55		19.2	
10-2 1.19	10-7 1.33	10-11 1.48	11-3 1.63	11-8 1.79	12-0 1.95	12-4 2.11	12-7 2.28	12-11 2.45	24.0	
18-4 1.69	19-1 1.89	19-9 2.09	20-4 2.31	21-0 2.53					12.0	
17-2 1.58	17-10 1.77	18-5 1.96	19-1 2.16	19-8 2.36	20-2 2.57				13.7	
15-11 1.46	16-6 1.63	17-1 1.81	17-8 2.00	18-2 2.19	18-9 2.38	19-3 2.58			16.0	2x10
14-6 1.34	15-1 1.49	15-7 1.65	16-1 1.82	16-7 2.00	17-1 2.18	17-7 2.36	18-0 2.55		19.2	
13-0 1.19	13-6 1.33	13-11 1.48	14-5 1.63	14-10 1.79	15-3 1.95	15-8 2.11	16-1 2.28	16-6 2.45	24.0	
22-4 1.69	23-2 1.89	24-0 2.09	24-9 2.31	25-6 2.53					12.0	
20-11 1.58	21-8 1.77	22-5 1.96	23-2 2.16	23-11 2.36	24-7 2.57				13.7	
19-4 1.46	20-1 1.63	20-9 1.81	21-5 2.00	22-1 2.19	22-9 2.38	23-5 2.58			16.0	2x12
17-8 1.34	18-4 1.49	19-0 1.65	19-7 1.82	20-2 2.00	20-9 2.18	21-4 2.36	21-11 2.55		19.2	
15-9 1.19	16-5 1.33	17-0 1.48	17-6 1.63	18-1 1.79	18-7 1.95	19-1 2.11	19-7 2.28	20-1 2.45	24.0	

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

Table No. 7-K
ALLOWABLE SPAN FOR LOW SLOPE RAFTERS

Slope 3 in 12 or less – 20 Lbs. Per Sq. Ft. Live Load
(No Finished Ceiling)

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

HOW TO USE TABLES: Enter table with span of rafters (upper figure in each square). Determine size and spacing (first column) based on stress grade (top row) and modulus of elasticity (lower figure in each square) of lumber to be used

RAFTER SIZE	SPACING (IN)	Allowable Extreme Fiber Stress in Bending, "F_b" (psi)										
		300	400	500	600	700	800	900	1000	1100	1200	1300
2x6	12.0	7-1 0.15	8-2 0.24	9-2 0.33	10-0 0.44	10-10 0.55	11-7 0.67	12-4 0.80	13-0 0.94	13-7 1.09	14-2 1.24	14-9 1.40
	13.7	6-8 0.14	7-8 0.22	8-7 0.31	9-5 0.41	10-2 0.52	10-10 0.63	11-6 0.75	12-2 0.88	12-9 1.02	13-3 1.16	13-10 1.31
	16.0	6-2 0.13	7-1 0.21	7-11 0.29	8-8 0.38	9-5 0.48	10-0 0.58	10-8 0.70	11-3 0.82	11-9 0.94	12-4 1.07	12-10 1.21
	19.2	5-7 0.12	6-6 0.19	7-3 0.26	7-11 0.35	8-7 0.44	9-2 0.53	9-9 0.64	10-3 0.75	10-9 0.86	11-3 0.98	11-8 1.10
	24.0	5-0 0.11	5-10 0.17	6-6 0.24	7-1 0.31	7-8 0.39	8-2 0.48	8-8 0.57	9-2 0.67	9-7 0.77	10-0 0.88	10-5 0.99
2x8	12.0	9-4 0.15	10-10 0.24	12-1 0.33	13-3 0.44	14-4 0.55	15-3 0.67	16-3 0.80	17-1 0.94	17-11 1.09	18-9 1.24	19-6 1.40
	13.7	8-9 0.14	10-1 0.22	11-4 0.31	12-5 0.41	13-4 0.52	14-4 0.63	15-2 0.75	16-0 0.88	16-9 1.02	17-6 1.16	18-3 1.31
	16.0	8-1 0.13	9-4 0.21	10-6 0.29	11-6 0.38	12-5 0.48	13-3 0.58	14-0 0.70	14-10 0.82	15-6 0.94	16-3 1.07	16-10 1.21
	19.2	7-5 0.12	8-7 0.19	9-7 0.26	10-6 0.35	11-4 0.44	12-1 0.53	12-10 0.64	13-6 0.75	14-2 0.86	14-10 0.98	15-5 1.10
	24.0	6-7 0.11	7-8 0.17	8-7 0.24	9-4 0.31	10-1 0.39	10-10 0.48	11-6 0.57	12-1 0.67	12-8 0.77	13-3 0.88	13-9 0.99
2x10	12.0	11-11 0.15	13-9 0.24	15-5 0.33	16-11 0.44	18-3 0.55	19-6 0.67	20-8 0.80	21-10 0.94	22-10 1.09	23-11 1.24	24-10 1.40
	13.7	11-2 0.14	12-11 0.22	14-5 0.31	15-10 0.41	17-1 0.52	18-3 0.63	19-4 0.75	20-5 0.88	21-5 1.02	22-4 1.16	23-3 1.31
	16.0	10-4 0.13	11-11 0.21	13-4 0.29	14-8 0.38	15-10 0.48	16-11 0.58	17-11 0.70	18-11 0.82	19-10 0.94	20-8 1.07	21-6 1.21
	19.2	9-5 0.12	10-11 0.19	12-2 0.26	13-4 0.35	14-5 0.44	15-5 0.53	16-4 0.64	17-3 0.75	18-1 0.86	18-11 0.98	19-8 1.10
	24.0	8-5 0.11	9-9 0.17	10-11 0.24	11-11 0.31	12-11 0.39	13-9 0.48	14-8 0.57	15-5 0.67	16-2 0.77	16-11 0.88	17-7 0.99
2x12	12.0	14-6 0.15	16-9 0.24	18-9 0.33	20-6 0.44	22-2 0.55	23-9 0.67	25-2 0.80	26-6 0.94	27-10 1.09	29-1 1.24	30-3 1.40
	13.7	13-7 0.14	15-8 0.22	17-6 0.31	19-3 0.41	20-9 0.52	22-2 0.63	23-6 0.75	24-10 0.88	26-0 1.02	27-2 1.16	28-3 1.31
	16.0	12-7 0.13	14-6 0.21	16-3 0.29	17-9 0.38	19-3 0.48	20-6 0.58	21-9 0.70	23-0 0.82	24-1 0.94	25-2 1.07	26-2 1.21
	19.2	11-6 0.12	13-3 0.19	14-10 0.26	16-3 0.35	17-6 0.44	18-9 0.53	19-11 0.64	21-0 0.75	22-0 0.86	23-0 0.98	23-11 1.10
	24.0	10-3 0.11	11-10 0.17	13-3 0.24	14-6 0.31	15-8 0.39	16-9 0.48	17-9 0.57	18-9 0.67	19-8 0.77	20-6 0.88	21-5 0.99

NOTE The modulus of elasticity, "E", in 1,000,000 pounds per square inch is shown below each span

Table No. 7-K (cont.)

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

HOW TO USE TABLES: Enter table with span of rafters (upper figure in each square). Determine size and spacing (last column) based on stress grade (top row) and modulus of elasticity (lower figure in each square) of lumber to be used.

Allowable Extreme Fiber Stress in Bending, "F_b" (psi).										RAFTER SPACING (IN)	SIZE (IN)
1400	1500	1600	1700	1800	1900	2000	2100	2200	2400		
15-4 1.56	15-11 1.73	16-5 1.91	16-11 2.09	17-5 2.28	17-10 2.47					12.0	
14-4 1.46	14-10 1.62	15-4 1.78	15-10 1.95	16-3 2.13	16-9 2.31	17-2 2.49				13.7	
13-3 1.35	13-9 1.50	14-2 1.65	14-8 1.81	15-1 1.97	15-6 2.14	15-11 2.31	16-3 2.48			16.0	2×6
12-2 1.23	12-7 1.37	13-0 1.51	13-4 1.65	13-9 1.80	14-2 1.95	14-6 2.11	14-10 2.27	15-2 2.43		19.2	
10-10 1.10	11-3 1.22	11-7 1.35	11-11 1.48	12-4 1.61	12-8 1.75	13-0 1.89	13-3 2.03	13-7 2.18	14-2 2.48	24.0	
20-3 1.56	20-11 1.73	21-7 1.91	22-3 2.09	22-11 2.28	23-7 2.47					12.0	
18-11 1.46	19-7 1.62	20-3 1.78	20-10 1.95	21-5 2.13	22-0 2.31	22-7 2.49				13.7	
17-6 1.35	18-2 1.50	18-9 1.65	19-4 1.81	19-10 1.97	20-5 2.14	20-11 2.31	21-5 2.48			16.0	2×8
16-0 1.23	16-7 1.37	17-1 1.51	17-7 1.65	18-2 1.80	18-7 1.95	19-1 2.11	19-7 2.27	20-0 2.43		19.2	
14-4 1.10	14-10 1.22	15-3 1.35	15-9 1.48	16-3 1.61	16-8 1.75	17-1 1.89	17-6 2.03	17-11 2.18	18-9 2.48	24.0	
25-10 1.56	26-8 1.73	27-7 1.91	28-5 2.09	29-3 2.28	30-1 2.47					12.0	
24-2 1.46	25-0 1.62	25-10 1.78	26-7 1.95	27-4 2.13	28-1 2.31	28-10 2.49				13.7	
22-4 1.35	23-2 1.50	23-11 1.65	24-7 1.81	25-4 1.97	26-0 2.14	26-8 2.31	27-4 2.48			16.0	2×10
20-5 1.23	21-1 1.37	21-10 1.51	22-6 1.65	23-2 1.80	23-9 1.95	24-5 2.11	25-0 2.27	25-7 2.43		19.2	
18-3 1.10	18-11 1.22	19-6 1.35	20-1 1.48	20-8 1.61	21-3 1.75	21-10 1.89	22-4 2.03	22-10 2.18	23-11 2.48	24.0	
31-4 1.56	32-6 1.73	33-6 1.91	34-7 2.09	35-7 2.28	36-7 2.47					12.0	
29-4 1.46	30-5 1.62	31-4 1.78	32-4 1.95	33-3 2.13	34-2 2.31	35-1 2.49				13.7	
27-2 1.35	28-2 1.50	29-1 1.65	29-11 1.81	30-10 1.97	31-8 2.14	32-6 2.31	33-3 2.48			16.0	2×12
24-10 1.23	25-8 1.37	26-6 1.51	27-4 1.65	28-2 1.80	28-11 1.95	29-8 2.11	30-5 2.27	31-1 2.43		19.2	
22-2 1.10	23-0 1.22	23-9 1.35	24-5 1.48	25-2 1.61	25-10 1.75	26-6 1.89	27-2 2.03	27-10 2.18	29-1 2.48	24.0	

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

Table No. 7-L
ALLOWABLE SPAN FOR LOW SLOPE RAFTERS

Slope 3 in 12 or less – 30 Lbs. Per Sq. Ft. Live Load
(No Finished Ceiling)

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

HOW TO USE TABLES: Enter table with span of rafters (upper figure in each square). Determine size and spacing (first column) based on stress grade (top row) and modulus of elasticity (lower figure in each square) of lumber to be used.

RAFTER SIZE	SPACING (IN)	Allowable 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 modulus of elasticity, "E", in 1,000,000 pounds per square inch is shown below each span.

Table No. 7-L (cont.)

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

HOW TO USE TABLES:-Enter table with span of rafters (upper figure in each square). Determine size and spacing (last column) based on stress grade (top row) and modulus of elasticity (lower figure in each square) of lumber to be used.

Allowable 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	20-8 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 modulus of elasticity, "E", in 1,000,000 pounds per square inch is shown below each span.

Table No. 7-M
ALLOWABLE SPAN FOR LOW SLOPE RAFTERS

Slope 3 in 12 or less – 40 Lbs Per Sq Ft Live Load
(No Finished Ceiling)

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

HOW TO USE TABLES: Enter table with span of rafters (upper figure in each square). Determine size and spacing (first column) based on stress grade (top row) and modulus of elasticity (lower figure in each square) of lumber to be used

RAFTER SIZE (IN)	SPACING (IN)	Allowable Extreme Fiber Stress in Bending, F_b (psi)										
		300	400	500	600	700	800	900	1000	1100	1200	1300
2×6	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
2×8	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
2×10	12.0	9.3 0.14	10.8 0.22	11.11 0.31	12.1 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
2×12	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 modulus of elasticity, "E", in 1,000,000 pounds per square inch is shown below each span

Table No. 7-M (cont.)

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

HOW TO USE TABLES: Enter table with span of rafters (upper figure in each square). Determine size and spacing (last column) based on stress grade (top row) and modulus of elasticity (lower figure in each square) of lumber to be used.

Allowable Extreme Fiber Stress in Bending, "F_b" (psi).										RAFTER SPACING (IN)	SIZE (IN)
1400	1500	1600	1700	1800	1900	2000	2100	2200	2400		
11-11 1.45	12-4 1.61	12-8 1.77	13-1 1.94	13-6 2.12	13-10 2.30	14-2 2.48				12.0	
11-1 1.36	11-6 1.51	11-11 1.66	12-3 1.82	12-7 1.98	12-11 2.15	13-3 2.32	13-7 2.49			13.7	
10-3 1.26	10-8 1.39	11-0 1.54	11-4 1.68	11-8 1.83	12-0 1.99	12-4 2.15	12-7 2.31	12-11 2.48		16.0	2x6
9-5 1.15	9-9 1.27	10-0 1.40	10-4 1.54	10-8 1.67	10-11 1.81	11-3 1.96	11-6 2.11	11-9 2.26	12-4 2.58	19.2	
8-5 1.03	8-8 1.14	9-0 1.25	9-3 1.37	9-6 1.50	9-9 1.62	10-0 1.75	10-3 1.89	10-6 2.02	11-0 2.30	24.0	
15-8 1.45	16-3 1.61	16-9 1.77	17-3 1.94	17-9 2.12	18-3 2.30	18-9 2.48				12.0	
14-8 1.36	15-2 1.51	15-8 1.66	16-2 1.82	16-7 1.98	17-1 2.15	17-6 2.32	17-11 2.49			13.7	
13-7 1.26	14-0 1.39	14-6 1.54	14-11 1.68	15-5 1.83	15-10 1.99	16-3 2.15	16-7 2.31	17-0 2.48		16.0	2x8
12-5 1.15	12-10 1.27	13-3 1.40	13-8 1.54	14-0 1.67	14-5 1.81	14-10 1.96	15-2 2.11	15-6 2.26	16-3 2.58	19.2	
11-1 1.03	11-6 1.14	11-10 1.25	12-2 1.37	12-7 1.50	12-11 1.62	13-3 1.75	13-7 1.89	13-11 2.02	14-6 2.30	24.0	
20-0 1.45	20-8 1.61	21-4 1.77	22-0 1.94	22-8 2.12	23-3 2.30	23-11 2.48				12.0	
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	23-8 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 modulus of elasticity, "E", in 1,000,000 pounds per square inch is shown below each span.

Table No. 7-N
ALLOWABLE SPAN FOR HIGH SLOPE RAFTERS

Slope over 3 in 12 – 20 Lbs. Per Sq. Ft. Live Load
(Heavy Roof Covering)

DESIGN CRITERIA:
Strength – 15 lbs. per sq. ft. dead load plus 20 lbs. per sq. ft. live load determines fiber stress.
Deflection – For 20 lbs. per sq. ft. live load. Limited to span in inches divided by 180.

HOW TO USE TABLES: Enter table with span of rafters (upper figure in each square). Determine size and spacing (first column) based on stress grade (top row) and modulus of elasticity (lower figure in each square) of lumber to be used.

RAFTER SIZE	SPACING (IN)	Allowable Extreme Fiber Stress in Bending, "F_b" (psi). 200	300	400	500	600	700	800	900	1000	1100	1200	1300
2×4	12.0	3-5 0.05	4-2 0.09	4-10 0.14	5-5 0.20	5-11 0.26	6-5 0.33	6-10 0.40	7-3 0.48	7-8 0.56	8-0 0.65	8-4 0.74	8-8 0.83
	13.7	3-2 0.05	3-11 0.09	4-6 0.13	5-1 0.19	5-6 0.24	6-0 0.31	6-5 0.38	6-9 0.45	7-2 0.52	7-6 0.61	7-10 0.69	8-2 0.78
	16.0	2-11 0.04	3-7 0.08	4-2 0.12	4-8 0.17	5-1 0.23	5-6 0.28	5-11 0.35	6-3 0.41	6-7 0.49	6-11 0.56	7-3 0.64	7-6 0.72
	19.2	2-8 0.04	3-4 0.07	3-10 0.11	4-3 0.16	4-8 0.21	5-1 0.26	5-5 0.32	5-9 0.38	6-0 0.44	6-4 0.51	6-7 0.58	6-11 0.66
	24.0	2-5 0.04	2-11 0.07	3-5 0.10	3-10 0.14	4-2 0.18	4-6 0.23	4-10 0.28	5-1 0.34	5-5 0.40	5-8 0.46	5-11 0.52	6-2 0.59
2×6	12.0	5-4 0.05	6-7 0.09	7-7 0.14	8-6 0.20	9-4 0.26	10-0 0.33	10-9 0.40	11-5 0.48	12-0 0.56	12-7 0.65	13-2 0.74	13-8 0.83
	13.7	5-0 0.05	6-2 0.09	7-1 0.13	7-11 0.19	8-8 0.24	9-5 0.31	10-0 0.38	10-8 0.45	11-3 0.52	11-9 0.61	12-4 0.69	12-10 0.78
	16.0	4-8 0.04	5-8 0.08	6-7 0.12	7-4 0.17	8-1 0.23	8-8 0.28	9-4 0.35	9-10 0.41	10-5 0.49	10-11 0.56	11-5 0.64	11-10 0.72
	19.2	4-3 0.04	5-2 0.07	6-0 0.11	6-9 0.16	7-4 0.21	7-11 0.26	8-6 0.32	9-0 0.38	9-6 0.44	9-11 0.51	10-5 0.58	10-10 0.66
	24.0	3-10 0.04	4-8 0.07	5-4 0.10	6-0 0.14	6-7 0.18	7-1 0.23	7-7 0.28	8-1 0.34	8-6 0.40	8-11 0.46	9-4 0.52	9-8 0.59
2×8	12.0	7-1 0.05	8-8 0.09	10-0 0.14	11-2 0.20	12-3 0.26	13-3 0.33	14-2 0.40	15-0 0.48	15-10 0.56	16-7 0.65	17-4 0.74	18-0 0.83
	13.7	6-7 0.05	8-1 0.09	9-4 0.13	10-6 0.19	11-6 0.24	12-5 0.31	13-3 0.38	14-0 0.45	14-10 0.52	15-6 0.61	16-3 0.69	16-10 0.78
	16.0	6-2 0.04	7-6 0.08	8-8 0.12	9-8 0.17	10-7 0.23	11-6 0.28	12-3 0.35	13-0 0.41	13-8 0.49	14-4 0.56	15-0 0.64	15-7 0.72
	19.2	5-7 0.04	6-10 0.07	7-11 0.11	8-10 0.16	9-8 0.21	10-6 0.26	11-2 0.32	11-10 0.38	12-6 0.44	13-1 0.51	13-8 0.58	14-3 0.66
	24.0	5-0 0.04	6-2 0.07	7-1 0.10	7-11 0.14	8-8 0.18	9-4 0.23	10-0 0.28	10-7 0.34	11-2 0.40	11-9 0.46	12-3 0.52	12-9 0.59
2×10	12.0	9-0 0.05	11-1 0.09	12-9 0.14	14-3 0.20	15-8 0.26	16-11 0.33	18-1 0.40	19-2 0.48	20-2 0.56	21-2 0.65	22-1 0.74	23-0 0.83
	13.7	8-5 0.05	10-4 0.09	11-11 0.13	13-4 0.19	14-8 0.24	15-10 0.31	16-11 0.38	17-11 0.45	18-11 0.52	19-10 0.61	20-8 0.69	21-6 0.78
	16.0	7-10 0.04	9-7 0.08	11-1 0.12	12-4 0.17	13-6 0.23	14-8 0.28	15-8 0.35	16-7 0.41	17-6 0.49	18-4 0.56	19-2 0.64	19-11 0.72
	19.2	7-2 0.04	8-9 0.07	10-1 0.11	11-3 0.16	12-4 0.21	13-4 0.26	14-3 0.32	15-2 0.38	15-11 0.44	16-9 0.51	17-6 0.58	18-2 0.66
	24.0	6-5 0.04	7-10 0.07	9-0 0.10	10-1 0.14	11-1 0.18	11-11 0.23	12-9 0.28	13-6 0.34	14-3 0.40	15-0 0.46	15-8 0.52	16-3 0.59

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

Table No. 7-N (cont.)

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

HOW TO USE TABLES: Enter table with span of rafters (upper figure in each square). Determine size and spacing (last column) based on stress grade (top row) and modulus of elasticity (lower figure in each square) of lumber to be used.

Allowable Extreme Fiber Stress in Bending, "F_b" (psi)												RAFTER SPACING (IN)	RAFTER SIZE (IN)
1400	1500	1600	1700	1800	1900	2000	2100	2200	2400	2700	3000		
9 0 0 93	9 4 1 03	9 8 1 14	9 11 1 24	10 3 1 36	10 6 1 47	10 10 1 59	11 1 1 71	11 4 1 83	11 10 2 09	12 7 2 49		12 0	
8 5 0 87	8 9 0 96	9 0 1 06	9 4 1 16	9 7 1 27	9 10 1 37	10 1 1 48	10 4 1 60	10 7 1 71	11 1 1 95	11 9 2 33		13 7	
7 10 0 80	8 1 0 89	8 4 0 98	8 7 1 08	8 10 1 17	9 1 1 27	9 4 1 37	9 7 1 48	9 10 1 59	10 3 1 81	10 10 2 16	11 5 2 53	16 0	2x4
7 2 0 73	7 5 0 81	7 8 0 90	7 10 0 98	8 1 1 07	8 4 1 16	8 6 1 25	8 9 1 35	8 11 1 45	9 4 1 65	9 11 1 97	10 5 2 31	19 2	
6 5 0 66	6 7 0 73	6 10 0 80	7 0 0 88	7 3 0 96	7 5 1 04	7 8 1 12	7 10 1 21	8 0 1 29	8 4 1 48	8 10 1 76	9 4 2 06	24 0	
14 2 0 93	14 8 1 03	15 2 1 14	15 8 1 24	16 1 1 36	16 7 1 47	17 0 1 59	17 5 1 71	17 10 1 83	18 7 2 09	19 9 2 49		12 0	
13 3 0 87	13 9 0 96	14 2 1 06	14 8 1 16	15 1 1 27	15 6 1 37	15 11 1 48	16 3 1 60	16 8 1 71	17 5 1 95	18 5 2 33		13 7	
12 4 0 80	12 9 0 89	13 2 0 98	13 7 1 08	13 11 1 17	14 4 1 27	14 8 1 37	15 1 1 48	15 5 1 59	16 1 1 81	17 1 2 16	18 0 2 53	16 0	2x6
11 3 0 73	11 7 0 81	12 0 0 90	12 4 0 98	12 9 1 07	13 1 1 16	13 5 1 25	13 9 1 35	14 1 1 45	14 8 1 65	15 7 1 97	16 5 2 31	19 2	
10 0 0 66	10 5 0 73	10 9 0 80	11 1 0 88	11 5 0 96	11 8 1 04	12 0 1 12	12 4 1 21	12 7 1 29	13 2 1 48	13 11 1 76	14 8 2 06	24 0	
18 9 0 93	19 5 1 03	20 0 1 14	20 8 1 24	21 3 1 36	21 10 1 47	22 4 1 59	22 11 1 71	23 6 1 83	24 6 2 09	26 0 2 49		12 0	
17 6 0 87	18 2 0 96	18 9 1 06	19 4 1 16	19 10 1 27	20 5 1 37	20 11 1 48	21 5 1 60	21 11 1 71	22 11 1 95	24 4 2 33		13 7	
16 3 0 80	16 9 0 89	17 4 0 98	17 10 1 08	18 5 1 17	18 11 1 27	19 5 1 37	19 10 1 48	20 4 1 59	21 3 1 81	22 6 2 16	23 9 2 53	16 0	2x8
14 10 0 73	15 4 0 81	15 10 0 90	16 4 0 98	16 9 1 07	17 3 1 16	17 8 1 25	18 2 1 35	18 7 1 45	19 5 1 65	20 7 1 97	21 8 2 31	19 2	
13 3 0 66	13 8 0 73	14 2 0 80	14 7 0 88	15 0 0 96	15 5 1 04	15 10 1 12	16 3 1 21	16 7 1 29	17 4 1 48	18 5 1 76	19 5 2 06	24 0	
23 11 0 93	24 9 1 03	25 6 1 14	26 4 1 24	27 1 1 36	27 10 1 47	28 7 1 59	29 3 1 71	29 11 1 83	31 3 2 09	33 2 2 49		12 0	
22 4 0 87	23 2 0 96	23 11 1 06	24 7 1 16	25 4 1 27	26 0 1 37	26 8 1 48	27 4 1 60	28 0 1 71	29 3 1 95	31 0 2 33		13 7	
20 8 0 80	21 5 0 89	22 1 0 98	22 10 1 08	23 5 1 17	24 1 1 27	24 9 1 37	25 4 1 48	25 11 1 59	27 1 1 81	28 9 2 16	30 3 2 53	16 0	2x10
18 11 0 73	19 7 0 81	20 2 0 90	20 10 0 98	21 5 1 07	22 0 1 16	22 7 1 25	23 2 1 35	23 8 1 45	24 9 1 65	26 3 1 97	27 8 2 31	19 2	
16 11 0 66	17 6 0 73	18 1 0 80	18 7 0 88	19 2 0 96	19 8 1 04	20 2 1 12	20 8 1 21	21 2 1 29	22 1 1 48	23 5 1 76	24 9 2 06	24 0	

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

Table No. 7-0
ALLOWABLE SPAN FOR HIGH SLOPE RAFTERS

Slope over 3 in 12 – 30 Lbs. Per Sq. Ft. Live Load
(Heavy Roof Covering)

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

HOW TO USE TABLES: Enter table with span of rafters (upper figure in each square). Determine size and spacing (first column) based on stress grade (top row) and modulus of elasticity (lower figure in each square) of lumber to be used.

RAFTER SIZE (IN)	SPACING (IN)	Allowable Extreme Fiber Stress in Bending, "F_b" (psi)											
		200	300	400	500	600	700	800	900	1000	1100	1200	1300
2×4	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
2×6	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
2×8	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
2×10	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 modulus of elasticity, "E", in 1,000,000 pounds per square inch is shown below each span.

Table No. 7-0 (cont.)

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

HOW TO USE TABLES: Enter table with span of rafters (upper figure in each square). Determine size and spacing (last column) based on stress grade (top row) and modulus of elasticity (lower figure in each square) of lumber to be used.

Allowable 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	2×4
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	2×6
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	2×8
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	2×10
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 modulus of elasticity, "E", in 1,000,000 pounds per square inch is shown below each span.

Table No. 7-P
ALLOWABLE SPAN FOR HIGH SLOPE RAFTERS

Slope over 3 in 12 – 40 Lbs. Per Sq. Ft. Live Load
(Heavy Roof Covering)

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

HOW TO USE TABLES: Enter table with span of rafters (upper figure in each square). Determine size and spacing (first column) based on stress grade (top row) and modulus of elasticity (lower figure in each square) of lumber to be used.

RAFTER SIZE	SPACING (IN)	Allowable Extreme Fiber Stress in Bending, "F_b" (psi)											
		200	300	400	500	600	700	800	900	1000	1100	1200	1300
2×4	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
2×6	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
2×8	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
2×10	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 modulus of elasticity, "E", in 1,000,000 pounds per square inch is shown below each span.

Table No. 7-P (cont.)

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

HOW TO USE TABLES: Enter table with span of rafters (upper figure in each square). Determine size and spacing (last column) based on stress grade (top row) and modulus of elasticity (lower figure in each square) of lumber to be used

Allowable Extreme Fiber Stress in Bending, "F_b" (psi).												RAFTER SPACING (IN)	RAFTER 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	2×4
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	2×6
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	2×8
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	2×10
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 modulus of elasticity, "E", in 1,000,000 pounds per square inch is shown below each span.

Table No. 7-Q

ALLOWABLE SPAN FOR HIGH SLOPE RAFTERS

Slope over 3 in 12 – 20 Lbs. Per Sq. Ft. Live Load
(Light Roof Covering)

DESIGN CRITERIA:
Strength – 7 lbs. per sq. ft. dead load plus 20 lbs. per sq. ft. live load determines fiber stress.
Deflection – For 20 lbs. per sq. ft. live load. Limited to span in inches divided by 180

HOW TO USE TABLES: Enter table with span of rafters (upper figure in each square). Determine size and spacing (first column) based on stress grade (top row) and modulus of elasticity (lower figure in each square) of lumber to be used.

RAFTER SIZE	SPACING (IN)	Allowable Extreme Fiber Stress in Bending, "F_b" (psi)											
		200	300	400	500	600	700	800	900	1000	1100	1200	1300
2x4	12.0	3 11 0.07	4 9 0.14	5 6 0.21	6 2 0.29	6 9 0.38	7 3 0.49	7 9 0.59	8 3 0.71	8 8 0.83	9 1 0.96	9 6 1.09	9 11 1.23
	13.7	3 8 0.07	4 5 0.13	5 2 0.20	5 9 0.27	6 4 0.36	6 10 0.45	7 3 0.55	7 9 0.66	8 2 0.77	8 6 0.89	8 11 1.02	9 3 1.15
	16.0	3 4 0.06	4 1 0.12	4 9 0.18	5 4 0.25	5 10 0.33	6 4 0.42	6 9 0.51	7 2 0.61	7 6 0.72	7 11 0.83	8 3 0.94	8 7 1.06
	19.2	3 1 0.06	3 9 0.11	4 4 0.17	4 10 0.23	5 4 0.30	5 9 0.38	6 2 0.47	6 6 0.56	6 10 0.65	7 3 0.76	7 6 0.86	7 10 0.97
	24.0	2 9 0.05	3 4 0.10	3 11 0.15	4 4 0.21	4 9 0.27	5 2 0.34	5 6 0.42	5 10 0.50	6 2 0.59	6 5 0.68	6 9 0.77	7 0 0.87
2x6	12.0	6 1 0.07	7 6 0.14	8 8 0.21	9 8 0.29	10 7 0.38	11 5 0.49	12 3 0.59	13 0 0.71	13 8 0.83	14 4 0.96	15 0 1.09	15 7 1.23
	13.7	5 9 0.07	7 0 0.13	8 1 0.20	9 0 0.27	9 11 0.36	10 8 0.45	11 5 0.55	12 2 0.66	12 9 0.77	13 5 0.89	14 0 1.02	14 7 1.15
	16.0	5 4 0.06	6 6 0.12	7 6 0.18	8 4 0.25	9 2 0.33	9 11 0.42	10 7 0.51	11 3 0.61	11 10 0.72	12 5 0.83	13 0 0.94	13 6 1.06
	19.2	4 10 0.06	5 11 0.11	6 10 0.17	7 8 0.23	8 4 0.30	9 0 0.38	9 8 0.47	10 3 0.56	10 10 0.65	11 4 0.76	11 10 0.86	12 4 0.97
	24.0	4 4 0.05	5 4 0.10	6 1 0.15	6 10 0.21	7 6 0.27	8 1 0.34	8 8 0.42	9 2 0.50	9 8 0.59	10 2 0.68	10 7 0.77	11 0 0.87
2x8	12.0	8 1 0.07	9 10 0.14	11 5 0.21	12 9 0.29	13 11 0.38	15 1 0.49	16 1 0.59	17 1 0.71	18 0 0.83	18 11 0.96	19 9 1.09	20 6 1.23
	13.7	7 6 0.07	9 3 0.13	10 8 0.20	11 11 0.27	13 1 0.36	14 1 0.45	15 1 0.55	16 0 0.66	16 10 0.77	17 8 0.89	18 5 1.02	19 3 1.15
	16.0	7 0 0.06	8 7 0.12	9 10 0.18	11 0 0.25	12 1 0.33	13 1 0.42	13 11 0.51	14 10 0.61	15 7 0.72	16 4 0.83	17 1 0.94	17 9 1.06
	19.2	6 4 0.06	7 10 0.11	9 0 0.17	10 1 0.23	11 0 0.30	11 11 0.38	12 9 0.47	13 6 0.56	14 3 0.65	14 11 0.76	15 7 0.86	16 3 0.97
	24.0	5 8 0.05	7 0 0.10	8 1 0.15	9 0 0.21	9 10 0.27	10 8 0.34	11 5 0.42	12 1 0.50	12 9 0.59	13 4 0.68	13 11 0.77	14 6 0.87
2x10	12.0	10 3 0.07	12 7 0.14	14 6 0.21	16 3 0.29	17 10 0.38	19 3 0.49	20 7 0.59	21 10 0.71	23 0 0.83	24 1 0.96	25 2 1.09	26 2 1.23
	13.7	9 7 0.07	11 9 0.13	13 7 0.20	15 2 0.27	16 8 0.36	18 0 0.45	19 1 0.55	20 5 0.66	21 6 0.77	22 5 0.89	23 3 1.02	24 0 1.15
	16.0	8 11 0.06	10 11 0.12	12 7 0.18	14 1 0.25	15 5 0.33	16 8 0.42	17 10 0.51	18 11 0.61	19 11 0.72	20 10 0.83	21 10 0.94	22 8 1.06
	19.2	8 2 0.06	9 11 0.11	11 6 0.17	12 10 0.23	14 1 0.30	15 2 0.38	16 3 0.47	17 3 0.56	18 2 0.65	19 1 0.76	19 11 0.86	20 9 0.97
	24.0	7 3 0.05	8 11 0.10	10 3 0.15	11 6 0.21	12 7 0.27	13 7 0.34	14 6 0.42	15 5 0.50	16 3 0.59	17 1 0.68	17 10 0.77	18 6 0.87

NOTE The modulus of elasticity, "E", in 1,000,000 pounds per square inch is shown below each span

Table No. 7-Q (cont.)

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

HOW TO USE TABLES: Enter table with span of rafters (upper figure in each square). Determine size and spacing (last column) based on stress grade (top row) and modulus of elasticity (lower figure in each square) of lumber to be used.

Allowable Extreme Fiber Stress in Bending, "F_b" (psi).											RAFTER SPACING (IN)	SIZE (IN)
1400	1500	1600	1700	1800	1900	2000	2100	2200	2400	2700		
10·3 1.37	10·8 1.52	11·0 1.68	11·4 1.84	11·8 2.00	12·0 2.17	12·4 2.34	12·7 2.52				12.0	
9·7 1.28	10·0 1.42	10·3 1.57	10·7 1.72	10·11 1.87	11·3 2.03	11·6 2.19	11·9 2.36	12·1 2.53			13.7	
8·11 1.19	9·3 1.32	9·6 1.45	9·10 1.59	10·1 1.73	10·5 1.88	10·8 2.03	10·11 2.18	11·2 2.34			16.0	2x4
8·2 1.08	8·5 1.20	8·8 1.33	9·0 1.45	9·3 1.58	9·6 1.71	9·9 1.85	10·0 1.99	10·2 2.14	10·8 2.43		19.2	
7·3 0.97	7·6 1.08	7·9 1.19	8·0 1.30	8·3 1.41	8·6 1.53	8·8 1.66	8·11 1.78	9·1 1.91	9·6 2.18	10·1 2.60	24.0	
16·2 1.37	16·9 1.52	17·3 1.68	17·10 1.84	18·4 2.00	18·10 2.17	19·4 2.34	19·10 2.52				12.0	
15·1 1.28	15·8 1.42	16·2 1.57	16·8 1.72	17·2 1.87	17·7 2.03	18·1 2.19	18·6 2.36	19·0 2.53			13.7	
14·0 1.19	14·6 1.32	15·0 1.45	15·5 1.59	15·11 1.73	16·4 1.88	16·9 2.03	17·2 2.18	17·7 2.34			16.0	2x6
12·9 1.08	13·3 1.20	13·8 1.33	14·1 1.45	14·6 1.58	14·11 1.71	15·3 1.85	15·8 1.99	16·0 2.14	16·9 2.43		19.2	
11·5 0.97	11·10 1.08	12·3 1.19	12·7 1.30	13·0 1.41	13·4 1.53	13·8 1.66	14·0 1.78	14·4 1.91	15·0 2.18	15·11 2.60	24.0	
21·4 1.37	22·1 1.52	22·9 1.68	23·6 1.84	24·2 2.00	24·10 2.17	25·6 2.34	26·1 2.52				12.0	
19·11 1.28	20·8 1.42	21·4 1.57	22·0 1.72	22·7 1.87	23·3 2.03	23·10 2.19	24·5 2.36	25·0 2.53			13.7	
18·5 1.19	19·1 1.32	19·9 1.45	20·4 1.59	20·11 1.73	21·6 1.88	22·1 2.03	22·7 2.18	23·2 2.34			16.0	2x8
16·10 1.08	17·5 1.20	18·0 1.33	18·7 1.45	19·1 1.58	19·8 1.71	20·2 1.85	20·8 1.99	21·1 2.14	22·1 2.43		19.2	
15·1 0.97	15·7 1.08	16·1 1.19	16·7 1.30	17·1 1.41	17·7 1.53	18·0 1.66	18·5 1.78	18·11 1.91	19·9 2.18	20·11 2.60	24.0	
27·2 1.37	28·2 1.52	29·1 1.68	30·0 1.84	30·10 2.00	31·8 2.17	32·6 2.34	33·4 2.52				12.0	
25·5 1.28	26·4 1.42	27·2 1.57	28·0 1.72	28·10 1.87	29·8 2.03	30·5 2.19	31·2 2.36	31·11 2.53			13.7	
23·7 1.19	24·5 1.32	25·2 1.45	25·11 1.59	26·8 1.73	27·5 1.88	28·2 2.03	28·10 2.18	29·6 2.34			16.0	2x10
21·6 1.08	22·3 1.20	23·0 1.33	23·8 1.45	24·5 1.58	25·1 1.71	25·8 1.85	26·4 1.99	26·11 2.14	28·2 2.43		19.2	
19·3 0.97	19·11 1.08	20·7 1.19	21·2 1.30	21·10 1.41	22·5 1.53	23·0 1.66	23·7 1.78	24·1 1.91	25·2 2.18	26·8 2.60	24.0	

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

Table No. 7-R

ALLOWABLE SPAN FOR HIGH SLOPE RAFTERS

Slope over 3 in 12 – 30 Lbs. Per Sq. Ft. Live Load

(Light Roof Covering)

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

HOW TO USE TABLES: Enter table with span of rafters (upper figure in each square). Determine size and spacing (first column) based on stress grade (top row) and modulus of elasticity (lower figure in each square) of lumber to be used.

RAFTER SIZE	SPACING (IN)	Allowable Extreme Fiber Stress in Bending, "F_b" (psi)											
		200	300	400	500	600	700	800	900	1000	1100	1200	1300
2×4	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
2×6	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
2×8	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
2×10	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 modulus of elasticity, "E", in 1,000,000 pounds per square inch is shown below each span.

Table No. 7-R (cont.)

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

HOW TO USE TABLES: Enter table with span of rafters (upper figure in each square). Determine size and spacing (last column) based on stress grade (top row) and modulus of elasticity (lower figure in each square) of lumber to be used.

Allowable 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	w		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 modulus of elasticity, "E", in 1,000,000 pounds per square inch is shown below each span.

Table No. 7-S

ALLOWABLE SPAN FOR HIGH SLOPE RAFTERS

Slope over 3 in 12 – 40 Lbs. Per Sq. Ft. Live Load
(Light Roof Covering)

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

HOW TO USE TABLES: Enter table with span of rafters (upper figure in each square). Determine size and spacing (first column) based on stress grade (top row) and modulus of elasticity (lower figure in each square) of lumber to be used.

RAFTER SIZE (IN)	SPACING (IN)	Allowable 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 0.08	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 0.06	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 0.08	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 0.06	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	7-8 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 0.06	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 modulus of elasticity, "E", in 1,000,000 pounds per square inch is shown below each span.

Table No. 7-S (cont.)

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

HOW TO USE TABLES: Enter table with span of rafters (upper figure in each square). Determine size and spacing (last column) based on stress grade (top row) and modulus of elasticity (lower figure in each square) of lumber to be used.

Allowable 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	
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	2x4
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	
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	2x6
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 modulus of elasticity, "E", in 1,000,000 pounds per square inch is shown below each span.

Table No. 6/7A—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" Normal Duration	Snow Loading	7-Day Loading	Modulus of Elasticity "E"	Grading Rules
ASPEN (Surfaced dry or surfaced green)						Northeastern Lumber Manufacturers Association Northern Hardwood and Pine Manufacturers Association Western Wood Products Association (See notes 1 and 3)
Select Structural	2x4	1500	1720	1880	1,100,000	
No. 1 & Appearance		1300	1500	1620	1,100,000	
No. 2		1050	1210	1310	1,000,000	
No. 3		575	660	720	900,000	
Stud		575	660	720	900,000	
Construction	2x4	750	860	940	900,000	
Standard		425	490	530	900,000	
Utility		200	230	250	900,000	
Select Structural	2x5 and wider	1300	1500	1620	1,100,000	
No. 1 & Appearance		1100	1260	1380	1,100,000	
No. 2		900	1040	1120	1,000,000	
No. 3		525	600	660	900,000	
Stud		525	600	660	900,000	
BALSAM FIR (Surfaced dry or surfaced green)						Northeastern Lumber Manufacturers Association Northern Hardwood & Pine Manufacturers Association (See notes 1 and 3)
Select Structural	2x4	2000	2300	2500	1,500,000	
No. 1		1700	1950	2120	1,500,000	
No. 2		1400	1610	1750	1,300,000	
No. 3		775	890	970	1,200,000	
Appearance		1700	1950	2120	1,500,000	
Stud		775	890	970	1,200,000	
Construction	2x4	1000	1150	1250	1,200,000	
Standard		575	660	720	1,200,000	
Utility		275	320	340	1,200,000	
Select Structural	2x5 and wider	1700	1950	2120	1,500,000	
No. 1 & Appearance		1450	1670	1810	1,500,000	
No. 2		1200	1380	1500	1,300,000	
No. 3		700	800	875	1,200,000	
Stud		700	800	875	1,200,000	
BLACK COTTONWOOD (Surfaced dry or surfaced green)						National Lumber Grades Authority (A Canadian Agency—See notes 1, 2 and 3)
Select Structural	2x4	1200	1380	1500	1,200,000	
No. 1 & Appearance		1000	1150	1250	1,200,000	
No. 2		825	950	1030	1,100,000	
No. 3		450	520	560	900,000	
Stud		450	520	560	900,000	
Construction	2x4	600	690	750	900,000	
Standard		325	370	410	900,000	
Utility		150	170	190	900,000	
Select Structural	2x5 and wider	1000	1150	1250	1,200,000	
No. 1 & Appearance		875	1010	1090	1,200,000	
No. 2		700	800	880	1,100,000	
No. 3		425	490	530	900,000	
Stud		425	490	530	900,000	

Table No. 6/7A—DESIGN VALUES FOR JOISTS AND RAFTERS—VISUAL GRADING—(Continued)

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" Normal Duration	Snow Loading	7-Day Loading	Modulus of Elasticity "E"	Grading Rules
CALIFORNIA REDWOOD (Surfaced dry or surfaced green)						
Clear Heart Structural	2x4	2650	3050	3310	1,400,000	Redwood Inspection Service (See notes 1 and 3)
Clear Structural	2x4	2650	3050	3310	1,400,000	
Select Structural	2x4	2350	2700	2940	1,400,000	
Select Structural, Open grain	2x4	1850	2130	2310	1,100,000	
No. 1	2x4	1950	2240	2440	1,400,000	
No. 1, Open grain	2x4	1550	1780	1940	1,100,000	
No. 2	2x4	1600	1840	2000	1,250,000	
No. 2, Open grain	2x4	1250	1440	1560	1,000,000	
No. 3	2x4	900	1040	1120	1,100,000	
No. 3, Open grain	2x4	725	830	910	900,000	
Stud	2x4	725	830	910	900,000	
Construction	2x4	950	1090	1190	900,000	
Standard	2x4	525	600	660	900,000	
Utility	2x4	250	290	310	900,000	
Clear Heart Structural	2x5 & wider	2650	3050	3310	1,400,000	
Clear Structural	2x5 & wider	2650	3050	3310	1,400,000	
Select Structural	2x5 and wider	2000	2300	2500	1,400,000	
Select Structural, Open grain	2x5 and wider	1600	1840	2000	1,100,000	
No. 1	2x5 and wider	1700	1960	2120	1,400,000	
No. 1, Open grain	2x5 and wider	1350	1550	1690	1,100,000	
No. 2	2x5 and wider	1400	1610	1750	1,250,000	
No. 2, Open grain	2x5 and wider	1100	1260	1380	1,000,000	
No. 3	2x5 and wider	800	920	1000	1,100,000	
No. 3, Open grain	2x5 and wider	650	750	810	900,000	
Stud	2x5 and wider	650	750	810	900,000	
COAST SITKA SPRUCE (Surfaced dry or surfaced green)						
Select Structural	2x4	1700	1960	2120	1,700,000	Nat'l. Lumber Grades Auth. (A Canadian Agency— See notes 1 and 3)
No. 1 & Appearance	2x4	1450	1670	1810	1,700,000	
No. 2	2x4	1200	1380	1500	1,500,000	
No. 3	2x4	675	780	840	1,300,000	
Stud	2x4	675	780	840	1,300,000	
Construction	2x4	875	1010	1090	1,300,000	
Standard	2x4	500	580	620	1,300,000	
Utility	2x4	225	260	280	1,300,000	
Select Structural	2x5 and wider	1500	1720	1880	1,700,000	
No. 1 & Appearance	2x5 and wider	1250	1440	1560	1,700,000	
No. 2	2x5 and wider	1050	1210	1310	1,500,000	
No. 3	2x5 and wider	600	690	750	1,300,000	
Stud	2x5 and wider	600	690	750	1,300,000	
COAST SPECIES (Surfaced dry or surfaced green)						
Select Structural	2x4	1700	1960	2120	1,500,000	National Lumber Grades Authority (A Canadian Agency See notes 1, 2 and 3)
No. 1 & Appearance	2x4	1450	1670	1810	1,500,000	
No. 2	2x4	1200	1380	1500	1,400,000	
No. 3	2x4	675	780	840	1,200,000	
Stud	2x4	675	780	840	1,200,000	
Construction	2x4	875	1010	1090	1,200,000	
Standard	2x4	500	580	620	1,200,000	
Utility	2x4	225	260	280	1,200,000	
Select Structural	2x5 and wider	1500	1720	1880	1,500,000	
No. 1 & Appearance	2x5 and wider	1250	1440	1560	1,500,000	
No. 2	2x5 and wider	1050	1210	1310	1,400,000	
No. 3	2x5 and wider	600	690	750	1,200,000	
Stud	2x5 and wider	600	690	750	1,200,000	

Table No. 6/7A—DESIGN VALUES FOR JOISTS AND RAFTERS—VISUAL GRADING—(Continued)

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" Normal Duration	Snow Loading	7-Day Loading	Modulus of Elasticity "E"	Grading Rules
COTTONWOOD (Surfaced dry or surfaced green)						Northern Hardwood & Pine Manufacturers Association (See notes 1 and 3)
Stud	2 x 4	600	690	750	1,100,000	
Construction	2 x 4	775	890	970	1,100,000	
Standard		425	490	530	1,100,000	
Utility		200	230	250	1,100,000	
DOUGLAS FIR–LARCH (Surfaced dry or surfaced green)						Western Wood Products Association (See notes 1 and 3) West Coast Lumber Inspection Bureau
Dense Select Structural	2x4	2800	3220	3500	1,900,000	
Select Structural		2400	2760	3000	1,800,000	
Dense No. 1		2400	2760	3000	1,900,000	
No. 1 & Appearance		2050	2360	2560	1,800,000	
Dense No. 2		1950	2240	2440	1,700,000	
No. 2		1650	1900	2060	1,700,000	
No. 3		925	1060	1160	1,500,000	
Stud		925	1060	1160	1,500,000	
Construction	2x4	1200	1380	1500	1,500,000	
Standard		675	780	840	1,500,000	
Utility		325	370	410	1,500,000	
Dense Select Structural	2x5 and wider	2400	2760	3000	1,900,000	
Select Structural		2050	2360	2560	1,800,000	
Dense No. 1		2050	2360	2560	1,900,000	
No. 1 & Appearance		1750	2010	2190	1,800,000	
Dense No. 2		1700	1960	2120	1,700,000	
No. 2		1450	1670	1810	1,700,000	
No. 3		850	980	1060	1,500,000	
Stud		850	980	1060	1,500,000	
DOUGLAS FIR–LARCH (NORTH) (Surfaced dry or surfaced green)						Nat'l Lumber Grades Auth. (A Canadian Agency - See notes 1, 2 and 3)
Select Structural	2x4	2400	2760	3000	1,800,000	
No. 1 & Appearance		2050	2360	2560	1,800,000	
No. 2		1650	1900	2060	1,700,000	
No. 3		925	1060	1160	1,500,000	
Stud		925	1060	1160	1,500,000	
Construction	2x4	1200	1380	1500	1,500,000	
Standard		675	780	840	1,500,000	
Utility		325	370	410	1,500,000	
Select Structural	2x5 and wider	2050	2360	2560	1,800,000	
No. 1 & Appearance		1750	2010	2190	1,800,000	
No. 2		1450	1670	1810	1,700,000	
No. 3		850	980	1060	1,500,000	
Stud		850	980	1060	1,500,000	

Table No. 6/7A—DESIGN VALUES FOR JOISTS AND RAFTERS—VISUAL GRADING—(Continued)

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" Normal Duration	Snow Loading	7-Day Loading	Modulus of Elasticity "E"	Grading Rules
DOUGLAS FIR SOUTH (Surfaced dry or surfaced green)						
Select Structural		2300	2640	2880	1,400,000	
No. 1 & Appearance		1950	2240	2440	1,400,000	
No. 2		1600	1840	2000	1,300,000	Western Wood Products Association (See notes 1 and 3)
No. 3	2x4	875	1010	1090	1,100,000	
Stud		875	1010	1090	1,100,000	
Construction		1150	1320	1440	1,100,000	
Standard	2x4	650	750	810	1,100,000	
Utility		300	340	380	1,100,000	
Select Structural		1950	2240	2440	1,400,000	
No. 1 & Appearance	2x5	1650	1900	2060	1,400,000	
No. 2	and	1350	1550	1690	1,300,000	
No. 3	wider	800	920	1000	1,100,000	
Stud		800	920	1000	1,100,000	
EASTERN HEMLOCK (Surfaced dry or surfaced green)						
Select Structural		2050	2360	2560	1,200,000	
No. 1		1750	2010	2190	1,200,000	
No. 2	2x4	1450	1670	1810	1,100,000	
No. 3		800	920	1000	1,000,000	Northeastern Lumber Manufacturers Association (See notes 1 and 3)
Appearance		1750	2010	2190	1,200,000	
Stud		800	920	1000	1,000,000	
Construction		1050	1210	1310	1,000,000	
Standard	2x4	575	660	720	1,000,000	
Utility		275	320	340	1,000,000	
Select Structural		1750	2010	2190	1,200,000	
No. 1 & Appearance	2x5	1500	1720	1880	1,200,000	
No. 2	and	1250	1440	1560	1,100,000	
No. 3	wider	700	800	875	1,000,000	
Stud		700	800	875	1,000,000	
EASTERN HEMLOCK–TAMARACK (Surfaced dry or surfaced green)						
Select Structural		2050	2360	2560	1,300,000	
No. 1		1750	2010	2190	1,300,000	Northeastern Lumber Manufacturers Association Northern Hardwood & Pine Manufacturers Association (See notes 1 and 3)
No. 2	2x4	1450	1670	1810	1,100,000	
No. 3		800	920	1000	1,000,000	
Appearance		1500	1720	1880	1,300,000	
Stud		800	920	1000	1,000,000	
Construction		1050	1210	1310	1,000,000	
Standard	2x4	575	660	720	1,000,000	
Utility		275	320	340	1,000,000	
Select Structural		1750	2010	2190	1,300,000	
No. 1 & Appearance	2x5	1500	1720	1880	1,300,000	
No. 2	and	1200	1380	1500	1,100,000	
No. 3	wider	725	830	910	1,000,000	
Stud		725	830	910	1,000,000	

Table No. 6/7A – DESIGN VALUES FOR JOISTS AND RAFTERS–VISUAL GRADING—(Continued)

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" Normal Duration	Snow Loading	7-Day Loading	Modules of Elasticity "E"	Grading Rules
EASTERN HEMLOCK-TAMARACK (NORTH) (Surfaced dry or surfaced green)						
Select Structural		2050	2360	2560	1,300,000	
No. 1		1750	2010	2190	1,300,000	
No. 2	2x4	1450	1670	1810	1,100,000	Nat'l Lumber
No. 3		800	920	1000	1,000,000	Grades Auth
Appearance		1750	2010	2190	1,300,000	(A Canadian
Stud		800	920	1000	1,000,000	Agency
						See notes 1, 2
Construction		1050	1210	1310	1,000,000	and 3)
Standard	2x4	575	660	720	1,000,000	
Utility		275	320	340	1,000,000	
Select Structural		1750	2010	2190	1,300,000	
No. 1 & Appearance	2x5	1500	1720	1880	1,300,000	
No. 2	and	1200	1380	1500	1,100,000	
No. 3	wider	725	830	910	1,000,000	
Stud		725	830	910	1,000,000	
EASTERN SOFTWOODS (Surfaced dry or surfaced green)						
Select Structural		1550	1780	1940	1,200,000	Northeastern
No. 1 & Appearance		1350	1550	1690	1,200,000	Lumber
No. 2	2x4	1100	1260	1375	1,100,000	Manufacturers
No. 3		600	690	750	1,000,000	Association
Stud		600	690	750	1,000,000	
Construction		800	920	1000	1,000,000	Northern
Standard	2x4	450	520	560	1,000,000	Hardwood
Utility		200	230	250	1,000,000	& Pine
						Manufacturers
						Association
Select Structural		1350	1550	1690	1,200,000	
No. 1 & Appearance	2x5	1150	1320	1440	1,200,000	(See notes 1
No. 2	and	950	1090	1190	1,100,000	and 3)
No. 3	wider	550	630	690	1,000,000	
Stud		550	630	690	1,000,000	
EASTERN SPRUCE (Surfaced dry or surfaced green)						
Select Structural		1600	1840	2000	1,500,000	Northeastern
No. 1		1350	1550	1690	1,500,000	Lumber
No. 2	2x4	1100	1260	1370	1,400,000	Manufacturers
No. 3		625	720	780	1,200,000	Association
Appearance		1350	1550	1690	1,500,000	
Stud		625	720	780	1,200,000	Northern
						Hardwood
Construction		800	920	1000	1,200,000	& Pine
Standard	2x4	450	520	560	1,200,000	Manufacturers
Utility		225	260	280	1,200,000	Association
Select Structural		1350	1550	1690	1,500,000	
No. 1 & Appearance	2x5	1150	1320	1440	1,500,000	(See notes 1
No. 2	and	950	1090	1190	1,400,000	and 3)
No. 3	wider	550	630	690	1,200,000	
Stud		550	630	690	1,200,000	

Table No. 6/7A—DESIGN VALUES FOR JOISTS AND RAFTERS—VISUAL GRADING—(Continued)

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" Normal Duration	Snow Loading	7-Day Loading	Modulus of Elasticity "E"	Grading Rules
EASTERN WHITE PINE (Surfaced dry or surfaced green)						Northeastern Lumber Manufacturers Association (See note 1)
Select Structural	2x4	1550	1780	1940	1,200,000	
No. 1 & Appearance		1350	1550	1690	1,200,000	
No. 2		1100	1260	1380	1,100,000	
No. 3		600	690	750	1,000,000	
Construction	2x4	800	920	1000	1,000,000	NeLMA and NHPMA (See note 1)
Standard		450	520	560	1,000,000	
Utility		200	230	250	1,000,000	
Stud		600	690	750	1,000,000	
Select Structural	2x5 and wider	1350	1550	1690	1,200,000	Northeastern Lumber Manufacturers Association (See notes 1 and 3)
No. 1 & Appearance		1150	1320	1440	1,200,000	
No. 2		950	1090	1190	1,100,000	
No. 3		550	630	690	1,000,000	
Stud		550	630	690	1,000,000	
EASTERN WHITE PINE (NORTH) (Surfaced dry or surfaced green)						Nat'l. Lumber Grades Auth. (A Canadian Agency—See notes 1, 2 and 3)
Select Structural	2x4	1550	1780	1940	1,200,000	
No. 1 & Appearance		1350	1550	1690	1,200,000	
No. 2		1100	1260	1380	1,100,000	
No. 3		600	690	750	1,000,000	
Stud		600	690	750	1,000,000	
Construction	2x4	800	920	1000	1,000,000	
Standard		450	520	560	1,000,000	
Utility		200	230	250	1,000,000	
Select Structural	2x5 and wider	1350	1550	1690	1,200,000	
No. 1 & Appearance		1150	1320	1440	1,200,000	
No. 2		950	1090	1190	1,100,000	
No. 3		550	630	690	1,000,000	
Stud		550	630	690	1,000,000	
EASTERN WOODS (Surfaced dry or surfaced green)						Northeastern Lumber Manufacturers Association Northern Hardwood & Pine Manufacturers Association (See note 1)
Select Structural	2x4	1500	1720	1880	1,100,000	
No. 1		1300	1500	1620	1,100,000	
No. 2		1050	1210	1310	1,000,000	
No. 3		575	660	720	900,000	
Stud		575	660	720	900,000	
Construction	2x4	750	860	940	900,000	
Standard		425	490	530	900,000	
Utility		200	230	250	900,000	
Appearance	2x4	1300	1500	1620	1,100,000	Northern Hardwood & Pine Manufacturers Association (See notes 1 and 3)
Select Structural	2x5 and wider	1300	1500	1620	1,100,000	
No. 1 & Appearance		1100	1260	1380	1,100,000	
No. 2		900	1040	1120	1,000,000	
No. 3		525	600	660	900,000	
Stud		525	600	660	900,000	

Table No. 6/7A—DESIGN VALUES FOR JOISTS AND RAFTERS—VISUAL GRADING—(Continued)

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" Normal Duration	Snow Loading	7-Day Loading	Modulus of Elasticity "E"	Grading Rules
ENGELMANN SPRUCE–ALPINE FIR (ENGELMANN SPRUCE–LODGEPOLE PINE) (Surfaced dry or surfaced green)						
Select Structural		1550	1780	1940	1,300,000	
No. 1 & Appearance		1350	1550	1690	1,300,000	
No. 2	2x4	1100	1260	1380	1,100,000	Western Wood Products Association (See notes 1 and 3)
No. 3		600	690	750	1,000,000	
Stud		600	690	750	1,000,000	
Construction		800	920	1000	1,000,000	
Standard	2x4	450	520	560	1,000,000	
Utility		200	230	250	1,000,000	
Select Structural		1350	1550	1690	1,300,000	
No. 1 & Appearance	2x5	1150	1320	1440	1,300,000	
No. 2	and	950	1090	1190	1,100,000	
No. 3	wider	550	630	690	1,000,000	
Stud		550	630	690	1,000,000	
HEM–FIR (Surfaced dry or surfaced green)						
Select Structural		1900	2180	2380	1,500,000	
No. 1 & Appearance		1600	1840	2000	1,500,000	
No. 2		1350	1550	1690	1,400,000	Western Wood Products Association (See notes 1 and 3) West Coast Lumber Inspection Bureau
No. 3	2x4	725	830	910	1,200,000	
Stud		725	830	910	1,200,000	
Construction		975	1120	1220	1,200,000	
Standard	2x4	550	630	690	1,200,000	
Utility		250	290	310	1,200,000	
Select Structural		1650	1900	2060	1,500,000	
No. 1 & Appearance	2x5	1400	1610	1750	1,500,000	
No. 2	and	1150	1320	1440	1,400,000	
No. 3	wider	675	780	840	1,200,000	
Stud		675	780	840	1,200,000	
HEM–FIR (NORTH) (Surfaced dry or surfaced green)						
Select Structural		1800	2070	2250	1,500,000	
No. 1 & Appearance		1550	1780	1940	1,500,000	
No. 2		1300	1500	1620	1,400,000	
No. 3	2x4	700	800	875	1,200,000	Nat'l. Lumber Grades Auth. (A Canadian Agency– See notes 1, 2 and 3)
Stud		700	800	875	1,200,000	
Construction		925	1060	1160	1,200,000	
Standard	2x4	525	600	660	1,200,000	
Utility		250	290	310	1,200,000	
Select Structural		1550	1780	1940	1,500,000	
No. 1 & Appearance	2x5	1350	1550	1690	1,500,000	
No. 2	and	1100	1260	1375	1,400,000	
No. 3	wider	650	750	810	1,200,000	
Stud		650	750	810	1,200,000	

Table No. 6/7A – DESIGN VALUES FOR JOISTS AND RAFTERS–VISUAL GRADING —(Continued)

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" Normal Duration	Snow Loading	7-Day Loading	Modules of Elasticity "E"	Grading Rules
IDAHO WHITE PINE (Surfaced dry or surfaced green)						
Select Structural		1550	1780	1940	1,400,000	
No. 1 & Appearance		1300	1500	1620	1,400,000	
No. 2		1050	1210	1310	1,300,000	Western Wood
No. 3	2x4	600	690	750	1,200,000	Products
Stud		600	690	750	1,200,000	Association
						(See notes 1
Construction		775	890	970	1,200,000	and 3)
Standard	2x4	425	490	530	1,200,000	
Utility		200	230	250	1,200,000	
Select Structural		1300	1500	1620	1,400,000	
No. 1 & Appearance	2x5	1100	1260	1380	1,400,000	
No. 2	and	925	1060	1160	1,300,000	
No. 3	wider	550	630	690	1,200,000	
Stud		550	630	690	1,200,000	
LODGEPOLE PINE (Surfaced dry or surfaced green)						
Select Structural		1750	2010	2190	1,300,000	
No. 1 & Appearance		1500	1720	1880	1,300,000	
No. 2	2x4	1200	1380	1500	1,200,000	Western Wood
No. 3		675	780	840	1,000,000	Products
Stud		675	780	840	1,000,000	Association
						(See notes1
Construction		875	1010	1090	1,000,000	and 3)
Standard	2x4	500	580	620	1,000,000	
Utility		225	260	280	1,000,000	
Select Structural		1500	1720	1880	1,300,000	
No. 1 & Appearance	2x5	1300	1500	1620	1,300,000	
No. 2	and	1050	1210	1310	1,200,000	
No. 3	wider	625	720	780	1,000,000	
Stud		625	720	780	1,000,000	
MOUNTAIN HEMLOCK (Surfaced dry or surfaced green)						
Select Structural		2000	2300	2500	1,300,000	
No. 1 & Appearance		1700	1960	2120	1,300,000	
No. 2		1400	1610	1750	1,100,000	Western Wood
No. 3	2x4	775	890	970	1,000,000	Products
Stud		775	890	970	1,000,000	Association
						(See notes 1
Construction		1000	1150	1250	1,000,000	and 3)
Standard	2x4	575	660	720	1,000,000	
Utility		275	320	340	1,000,000	West Coast
						Lumber
Select Structural		1700	1960	2120	1,300,000	Inspection
No. 1 and Appearance	2x5	1450	1670	1810	1,300,000	Bureau
No. 2	and	1200	1380	1500	1,100,000	
No. 3	wider	700	800	880	1,000,000	
Stud		700	800	880	1,000,000	

Table No. 6/7A—DESIGN VALUES FOR JOISTS AND RAFTERS—VISUAL GRADING—(Continued)

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" Normal Duration	Snow Loading	7-Day Loading	Modulus of Elasticity "E"	Grading Rules
MOUNTAIN HEMLOCK – HEM–FIR (Surfaced dry or surfaced green)						
Select Structural		1900	2180	2380	1,300,000	Western Wood Products Association (See notes 1 and 3)
No. 1 & Appearance		1600	1840	2000	1,300,000	
No. 2		1350	1550	1690	1,100,000	
No. 3	2x4	725	830	910	1,000,000	
Stud		725	830	910	1,000,000	
Construction		975	1120	1220	1,000,000	
Standard	2x4	550	630	690	1,000,000	
Utility		250	290	310	1,000,000	
Select Structural		1650	1900	2060	1,300,000	
No. 1 & Appearance	2x5	1400	1610	1750	1,300,000	
No. 2	and	1150	1320	1440	1,100,000	
No. 3	wider	675	780	840	1,000,000	
Stud		675	780	840	1,000,000	
NORTHERN ASPEN (Surfaced dry or surfaced green)						
Select Structural		1500	1720	1880	1,400,000	National Lumber Grades Authority (A Canadian Agency) See notes 1, 2 and 3)
No. 1 & Appearance		1250	1440	1560	1,400,000	
No. 2	2x4	1050	1210	1310	1,200,000	
No. 3		575	660	720	1,100,000	
Stud		575	660	720	1,100,000	
Construction		750	860	940	1,100,000	
Standard	2x4	425	490	530	1,100,000	
Utility		200	230	250	1,100,000	
Select Structural		1250	1440	1560	1,400,000	
No. 1 & Appearance	2x5	1100	1260	1380	1,400,000	
No. 2	and	900	1040	1120	1,200,000	
No. 3	wider	525	600	660	1,100,000	
Stud		525	600	660	1,100,000	
NORTHERN PINE (Surfaced dry or surfaced green)						
Select Structural		1850	2130	2310	1,400,000	Northeastern Lumber Manufacturers Association Northern Hardwood & Pine Manufacturers Association (See notes 1 and 3)
No. 1		1600	1840	2000	1,400,000	
No. 2	2x4	1300	1500	1620	1,300,000	
No. 3		725	830	910	1,100,000	
Appearance		1400	1610	1750	1,400,000	
Stud		725	830	910	1,100,000	
Construction		950	1090	1190	1,100,000	
Standard	2x4	525	600	660	1,100,000	
Utility		250	290	310	1,100,000	
Select Structural		1600	1840	2000	1,400,000	
No. 1 & Appearance	2x5	1400	1610	1750	1,400,000	
No. 2	and	1100	1260	1380	1,300,000	
No. 3	wider	650	750	810	1,100,000	
Stud		650	750	810	1,100,000	

Table No. 6/7A—DESIGN VALUES FOR JOISTS AND RAFTERS—VISUAL GRADING—(Continued)

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" Normal Duration	Snow Loading	7-Day Loading	Modulus of Elasticity "E"	Grading Rules
NORTHERN SPECIES (Surfaced dry or surfaced green)						
Select Structural	2x4	1550	1780	1940	1,100,000	National Lumber Grades Authority (A Canadian Agency See notes 1, 2 and 3)
No. 1 & Appearance		1300	1500	1620	1,100,000	
No. 2		1050	1210	1310	1,000,000	
No. 3		600	690	750	900,000	
Stud		600	690	750	900,000	
Construction	2x4	775	890	970	900,000	
Standard		425	490	530	900,000	
Utility		200	230	250	900,000	
Select Structural	2x5 and wider	1300	1500	1620	1,100,000	
No. 1 & Appearance		1150	1320	1440	1,100,000	
No. 2		925	1060	1160	1,000,000	
No. 3		550	630	690	900,000	
Stud		550	630	690	900,000	
NORTHERN WHITE CEDAR (Surfaced dry or surfaced green)						
Select Structural	2x4	1350	1550	1690	800,000	Northeastern Lumber Manufacturers Association (See notes 1 and 3)
No. 1		1150	1320	1440	800,000	
No. 2		950	1090	1190	700,000	
No. 3		525	600	660	600,000	
Appearance		1000	1150	1250	800,000	
Stud		525	600	660	600,000	
Construction	2x4	675	780	840	600,000	
Standard		375	430	470	600,000	
Utility		175	200	220	600,000	
Select Structural	2x5 and wider	1150	1320	1440	800,000	
No. 1 & Appearance		1000	1150	1250	800,000	
No. 2		825	950	1030	700,000	
No. 3		475	550	590	600,000	
Stud		475	550	590	600,000	
PONDEROSA PINE (Surfaced dry or surfaced green)						
Select Structural	2x4	1650	1900	2060	1,200,000	Nat'l. Lumber Grades Auth. (A Canadian Agency– See notes 1, 2 and 3)
No. 1 & Appearance		1400	1610	1750	1,200,000	
No. 2		1150	1320	1440	1,100,000	
No. 3		625	720	780	1,000,000	
Stud		625	720	780	1,000,000	
Construction	2x4	825	950	1030	1,000,000	
Standard		450	520	560	1,000,000	
Utility		225	260	280	1,000,000	
Select Structural	2x5 and wider	1400	1610	1750	1,200,000	
No. 1 & Appearance		1200	1380	1500	1,200,000	
No. 2		975	1120	1220	1,100,000	
No. 3		575	660	720	1,000,000	
Stud		575	660	720	1,000,000	

Table No. 6/7A—DESIGN VALUES FOR JOISTS AND RAFTERS—VISUAL GRADING—(Continued)

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" Normal Duration	Snow Loading	7-Day Loading	Modulus of Elasticity "E"	Grading Rules
PONDEROSA PINE–SUGAR PINE (PONDEROSA PINE–LODGEPOLE PINE) (Surfaced dry or surfaced green)						
Select Structural	2x4	1650	1900	2060	1,200,000	Western Wood Products Association (See notes 1 and 3)
No. 1 & Appearance		1400	1610	1750	1,200,000	
No. 2		1150	1320	1440	1,100,000	
No. 3		625	720	780	1,000,000	
Stud		625	720	780	1,000,000	
Construction	2x4	825	950	1030	1,000,000	
Standard		450	520	560	1,000,000	
Utility		225	260	280	1,000,000	
Select Structural	2x5 and wider	1400	1610	1750	1,200,000	
No. 1 & Appearance		1200	1380	1500	1,200,000	
No. 2		975	1120	1220	1,100,000	
No. 3		575	660	720	1,000,000	
Stud		575	660	720	1,000,000	
RED PINE (Surfaced dry or surfaced green)						
Select Structural	2x4	1600	1840	2000	1,300,000	Nat'l Lumber Grades Auth. (A Canadian Agency—See notes 1, 2 and 3)
No. 1 & Appearance		1350	1550	1690	1,300,000	
No. 2		1100	1260	1380	1,200,000	
No. 3		625	720	780	1,000,000	
Stud		625	720	780	1,000,000	
Construction	2x4	800	920	1000	1,000,000	
Standard		450	520	560	1,000,000	
Utility		225	260	280	1,000,000	
Select Structural	2x5 and wider	1350	1550	1690	1,300,000	
No. 1 & Appearance		1150	1320	1440	1,300,000	
No. 2		950	1090	1190	1,200,000	
No. 3		550	630	690	1,000,000	
Stud		550	630	690	1,000,000	
SITKA SPRUCE (Surfaced dry or surfaced green)						
Select Structural	2x4	1800	2070	2250	1,500,000	West Coast Lumber Inspection Bureau (See note 3)
No. 1 & Appearance		1550	1780	1940	1,500,000	
No. 2		1250	1440	1560	1,300,000	
No. 3		700	800	880	1,200,000	
Stud		700	800	880	1,200,000	
Construction	2x4	925	1060	1160	1,200,000	
Standard		500	580	620	1,200,000	
Utility		250	290	310	1,200,000	
Select Structural	2x5 and wider	1550	1780	1940	1,500,000	
No. 1 & Appearance		1300	1500	1620	1,500,000	
No. 2		1050	1210	1310	1,300,000	
No. 3		600	690	750	1,200,000	
Stud		600	690	750	1,200,000	

Table No. 6/7A — DESIGN VALUES FOR JOISTS AND RAFTERS — VISUAL GRADING — (Continued)

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" Normal Duration	Snow Loading	7-Day Loading	Modulus of Elasticity "E"	Grading Rules
SOUTHERN PINE (Surfaced dry)						
Select Structural		2300	2640	2880	1,700,000	
Dense Select Structural		2700	3100	3380	1,800,000	
No. 1		1950	2240	2440	1,700,000	
No. 1 Dense		2300	2640	2880	1,800,000	
No. 2	2x4	1650	1900	2060	1,600,000	
No. 2 Dense		1900	2180	2380	1,600,000	
No. 3		900	1040	1120	1,400,000	
No. 3 Dense		1050	1210	1310	1,500,000	Southern Pine Inspection Bureau
Stud		900	1040	1120	1,400,000	
Construction		1150	1320	1440	1,400,000	
Standard	2x4	675	780	840	1,400,000	
Utility		300	340	380	1,400,000	(See note 3)
Select Structural		2000	2300	2500	1,700,000	
Dense Select Structural		2350	2700	2940	1,800,000	
No. 1		1700	1960	2120	1,700,000	
No. 1 Dense		2000	2300	2500	1,800,000	
No. 2	2x5 and wider	1400	1610	1750	1,600,000	
No. 2 Dense		1650	1900	2060	1,600,000	
No. 3		800	920	1000	1,400,000	
No. 3 Dense		925	1060	1160	1,500,000	
Stud		850	980	1060	1,400,000	
SOUTHERN PINE (Surfaced at 15 percent maximum moisture content-KD)						
Select Structural		2500	2880	3120	1,800,000	
Dense Select Structural		2900	3340	3620	1,900,000	
No. 1		2100	2420	2620	1,800,000	
No. 1 Dense		2450	2820	3060	1,900,000	
No. 2	2x4	1750	2010	2190	1,600,000	
No. 2 Dense		2050	2360	2560	1,700,000	Southern Pine Inspection Bureau
No. 3		975	1120	1220	1,500,000	
No. 3 Dense		1150	1320	1440	1,500,000	
Stud		975	1120	1220	1,500,000	
Construction		1250	1440	1560	1,500,000	
Standard	2x4	725	830	910	1,500,000	
Utility		300	340	380	1,500,000	(See note 3)
Select Structural		2150	2470	2690	1,800,000	
Dense Select Structural		2500	2880	3120	1,900,000	
No. 1		1850	2130	2310	1,800,000	
No. 1 Dense	2x5 and wider	2150	2470	2690	1,900,000	
No. 2		1500	1720	1880	1,600,000	
No. 2 Dense		1750	2010	2190	1,700,000	
No. 3		875	1010	1090	1,500,000	
No. 3 Dense		1000	1150	1250	1,500,000	
Stud		900	1040	1120	1,500,000	

Table No. 6/7A — DESIGN VALUES FOR JOISTS AND RAFTERS — VISUAL GRADING — (Continued)

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" Normal Duration	Snow Loading	7-Day Loading	Modulus of Elasticity "E"	Grading Rules
SPRUCE - PINE - FIR (Surfaced dry or surfaced green)						
Select Structural		1650	1900	2060	1,500,000	
No. 1 & Appearance		1400	1610	1750	1,500,000	
No. 2	2x4	1150	1320	1440	1,300,000	
No. 3		650	750	810	1,200,000	Nat'l. Lumber Grades Auth. (A Canadian Agency- See notes 1,2, and 3)
Stud		650	750	810	1,200,000	
Construction		850	980	1060	1,200,000	
Standard	2x4	475	550	590	1,200,000	
Utility		225	260	280	1,200,000	
Select Structural		1450	1670	1810	1,500,000	
No. 1 & Appearance	2x5	1200	1380	1500	1,500,000	
No. 2	and	1000	1150	1250	1,300,000	
No. 3	wider	575	660	720	1,200,000	
Stud		575	660	720	1,200,000	
VIRGINA PINE - POND PINE (Surfaced dry)						
Select Structural		2300	2650	2880	1,500,000	
No 1		1950	2240	2440	1,500,000	
No 2	2x4	1650	1900	2060	1,300,000	
No 3		900	1040	1130	1,200,000	
Stud		900	1040	1130	1,200,000	
Construction		1200	1380	1500	1,200,000	
Standard	2x4	675	775	845	1,200,000	SPIB (See notes 1,2, and 3)
Utility		300	345	375	1,200,000	
Select Structural		2000	2300	2500	1,500,000	
No. 1	2x5	1700	1960	2130	1,500,000	
No. 2	and	1400	1610	1750	1,300,000	
No. 3	wider	800	920	1000	1,200,000	
Stud		850	980	1060	1,200,000	
VIRGINA PINE - POND PINE (Surfaced at 15 percent maximum moisture content-KD)						
Select Structural		2500	2880	3130	1,600,000	
No. 1		2150	2470	2690	1,600,000	
No. 2	2x4	1800	2070	2250	1,400,000	
No. 3		975	1120	1220	1,200,000	
Stud		975	1120	1220	1,200,000	
Construction		1300	1500	1630	1,200,000	SPIB
Standard	2x4	725	835	905	1,200,000	(See notes
Utility		325	375	405	1,200,000	1,2, and 3)
Select Structural		2150	2470	2690	1,600,000	
No. 1		1850	2130	2310	1,600,000	
No. 2	2x5	1500	1730	1880	1,400,000	
No. 3	and	875	1010	1090	1,200,000	
Stud	wider	925	1060	1160	1,200,000	

Table No. 6/7A—DESIGN VALUES FOR JOISTS AND RAFTERS—VISUAL GRADING—(Continued)

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" Normal Duration	Snow Loading	7 Day Loading	Modulus of Elasticity "E"	Grading Rules
WESTERN CEDARS (Surfaced dry or surfaced green)						
Select Structural		1750	2010	2190	1,100,000	
No. 1 & Appearance		1500	1720	1880	1,100,000	
No. 2	2x4	1200	1380	1500	1,000,000	Western Wood Products Association (See notes 1 and 3)
No. 3		675	780	840	900,000	
Stud		675	780	840	900,000	
Construction		875	1010	1090	900,000	
Standard	2x4	500	580	620	900,000	West Coast Lumber Inspection Bureau
Utility		225	260	280	900,000	
Select Structural		1500	1720	1880	1,100,000	
No. 1 & Appearance	2x5	1300	1500	1620	1,100,000	
No. 2	and	1050	1210	1310	1,000,000	
No. 3	wider	625	720	780	900,000	
Stud		625	720	780	900,000	
WESTERN CEDARS (NORTH) (Surfaced dry or surfaced green)						
Select Structural		1700	1960	2120	1,100,000	
No. 1 & Appearance		1450	1670	1810	1,100,000	
No. 2	2x4	1200	1380	1500	1,000,000	
No. 3		650	750	810	900,000	
Stud		650	750	810	900,000	
Construction		850	980	1060	900,000	Nat'l. Lumber Grades Auth. (A Canadian Agency— See notes 1, 2 and 3)
Standard	2x4	475	550	590	900,000	
Utility		225	260	280	900,000	
Select Structural		1450	1670	1810	1,100,000	
No. 1 & Appearance	2x5	1250	1440	1560	1,100,000	
No. 2	and	1000	1150	1250	1,000,000	
No. 3	wider	600	690	750	900,000	
Stud		600	690	750	900,000	
WESTERN HEMLOCK (Surfaced dry or surfaced green)						
Select Structural		2100	2420	2620	1,600,000	
No. 1 & Appearance		1800	2070	2250	1,600,000	
No. 2	2x4	1450	1670	1810	1,400,000	Western Wood Products Association (See notes 1 and 3)
No. 3		800	920	1000	1,300,000	
Stud		800	920	1000	1,300,000	
Construction		1050	1210	1310	1,300,000	
Standard	2x4	600	690	750	1,300,000	West Coast Lumber Inspection Bureau
Utility		275	320	340	1,300,000	
Select Structural		1800	2070	2250	1,600,000	
No. 1 & Appearance	2x5	1550	1780	1940	1,600,000	
No. 2	and	1250	1440	1560	1,400,000	
No. 3	wider	750	860	940	1,300,000	
Stud		750	860	940	1,300,000	

Table No. 6/7A—DESIGN VALUES FOR JOISTS AND RAFTERS—VISUAL GRADING—(Continued)

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" Normal Duration	Snow Loading	7-Day Loading	Modulus of Elasticity "E"	Grading Rules[4]
WESTERN HEMLOCK (NORTH) (Surfaced dry or surfaced green)						
Select Structural		2100	2410	2620	1,600,000	
No. 1 & Appearance		1800	2070	2250	1,600,000	
No. 2	2x4	1450	1670	1810	1,400,000	
No. 3		800	920	1000	1,300,000	
Stud		800	920	1000	1,300,000	Nat'l. Lumber Grades Auth. (A Canadian See notes 1, 2 and 3)
Construction		1050	1210	1310	1,300,000	
Standard	2x4	600	690	750	1,300,000	
Utility		275	320	340	1,300,000	
Select Structural		1800	2070	2250	1,600,000	
No. 1 & Appearance	2x5	1550	1780	1940	1,600,000	
No. 2	and	1250	1440	1560	1,400,000	
No. 3	wider	750	860	940	1,300,000	
Stud		750	860	940	1,300,000	
WESTERN WHITE PINE (Surfaced dry or surfaced green)						
Select Structural		1550	1780	1940	1,400,000	
No. 1 & Appearance		1300	1500	1620	1,400,000	
No. 2	2x4	1050	1210	1310	1,300,000	
No. 3		600	690	750	1,200,000	
Stud		600	690	750	1,200,000	Nat'l. Lumber Grades Auth. (A Canadian Agency— See notes 1, 2 and 3)
Construction		775	890	970	1,200,000	
Standard	2x4	425	490	530	1,200,000	
Utility		200	230	250	1,200,000	
Select Structural		1300	1500	1620	1,400,000	
No. 1 & Appearance	2x5	1150	1320	1440	1,400,000	
No. 2	and	925	1060	1160	1,300,000	
No. 3	wider	550	630	690	1,200,000	
Stud		550	630	690	1,200,000	
WHITE WOODS (WESTERN WOODS) (Surfaced dry or surfaced green)						
Select Structural		1550	1780	1940	1,100,000	
No. 1 & Appearance		1300	1500	1620	1,100,000	
No. 2	2x4	1050	1210	1310	1,000,000	
No. 3		600	690	750	900,000	
Stud		600	690	750	900,000	Western Wood Products Association (See notes 1 and 3)
Construction		775	890	970	900,000	
Standard	2x4	425	490	530	900,000	
Utility		200	230	250	900,000	
Select Structural		1300	1500	1620	1,100,000	
No. 1 & Appearance	2x5	1100	1260	1380	1,100,000	
No. 2	and	925	1060	1160	1,000,000	
No. 3	wider	550	630	690	900,000	
Stud		550	630	690	900,000	

Table No. 6/7A—DESIGN VALUES FOR JOISTS AND RAFTERS—VISUAL GRADING—(Continued)

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
		Normal Duration	Snow Loading	7-Day Loading		
YELLOW-POPLAR (Surfaced dry or surfaced green)						
Select Structural	2x4	1700	1950	2120	1,500,000	Northeastern Lumber Manufacturers Association
No. 1		1450	1670	1810	1,500,000	
No. 2		1200	1380	1500	1,300,000	
No. 3		675	780	840	1,200,000	
Stud		675	780	840	1,200,000	Northern Hardwood & Pine Manufacturers Association
Construction	2x4	875	1010	1090	1,200,000	
Standard		500	575	625	1,200,000	
Utility		225	260	280	1,200,000	
Select Structural	2x5 and wider	1500	1725	1875	1,500,000	(See notes 1 and 3)
No. 1 & Appearance		1250	1440	1560	1,500,000	
No. 2		1050	1210	1310	1,300,000	
No. 3		600	690	750	1,200,000	
Stud		600	690	750	1,200,000	

Table No. 6/7A footnotes applicable visually graded joists and rafters:

[1]When 2-inch lumber is manufactured at a maximum moisture content of 15 percent (grade-marked MC-15) and used in a condition where the moisture content does not exceed 15 percent the design values shown in Table No. 6/7A for "surfaced dry or surfaced green" lumber may be increased 8 percent for design value in bending F_b, and 5 percent 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 2 × 5 and wider size classification apply to 5-inch and 6-inch widths only.

Table No. 6/7B—DESIGN VALUES FOR JOISTS AND RAFTERS—MACHINE STRESS RATED

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 apply at 19 percent maximum moisture content in use.

Grade Designation	Grading Rules Agency (see footnotes 1,2,3,4)	Size Classification	Design Value in Bending "F_b"			Modulus of Elasticity "E"
			Normal Duration	Snow Loading	7-Day Loading	
900f-1.0E	3,4	Machine rated lumber, 2x4 and wider	1050	1210	1310	1,000,000
1200f-1.2E	1,2,3,4		1400	1610	1750	1,200,000
1350f-1.3E	2,4		1550	1780	1940	1,300,000
1450f-1.3E	1,3,4		1650	1900	2060	1,300,000
1500f-1.3E	2		1750	2010	2190	1,300,000
1500f-1.4E	1,2,3,4		1750	2010	2190	1,400,000
1650f-1.4E	2		1900	2190	2370	1,400,000
1650f-1.5E	1,2,3,4		1900	2180	2380	1,500,000
1800f-1.6E	1,2,3,4		2050	2360	2560	1,600,000
1950f-1.5E	2		2250	2590	2810	1,500,000
1950f-1.7E	1,2,4		2250	2590	2810	1,700,000
2100f-1.8E	1,2,3,4		2400	2760	3000	1,800,000
2250f-1.6E	2		2600	2990	3250	1,600,000
2250f-1.9E	1,2,4		2600	2990	3250	1,900,000
2400f-1.7E	2		2750	3160	3440	1,700,000
2400f-2.0E	1,2,3,4		2750	3160	3440	2,000,000
2550f-2.1E	1,2,4		2950	3390	3690	2,100,000
2700f-2.2E	1,2,3,4		3100	3570	3880	2,200,000
2850f-2.3E	2		3300	3800	4130	2,300,000
3000f-2.4E	1,2		3450	3970	4310	2,400,000
3150f-2.5E	2		3600	4140	4500	2,500,000
3300f-2.6E	2		3800	4370	4750	2,600,000
900f-1.0E	1,2,3	See footnotes	1050	1210	1310	1,000,000
900f-1.2E	1,2,3		1050	1210	1310	1,200,000
1200f-1.5E	1,2,3		1400	1610	1750	1,500,000
1350f-1.8E	1,2		1550	1780	1940	1,800,000
1500f-1.8E	3		1750	2010	2190	1,800,000
1800f-2.1E	1,2,3		2050	2360	2560	2,100,000

Table No. 6/7B footnotes applicable to machine stress rated joists and rafters:

[1]National Lumber Grades Authority (see Footnote 2, Table No. 6/7A); Machine Rated Lumber, 2 × 4 and wider.

[2]Southern Pine Inspection Bureau; Machine Rated Lumber, 2 × 4 and wider.

[3]West Coast Lumber Inspection Bureau; Machine Rated Lumber, 2 × 4 and wider; Machine Rated Joists, 2 × 6 and wider.

[4]Western Wood Products Association; Machine Rated Lumber, 2 × 4 and wider.

APPENDIX C

Section C-101—Scope

These provisions shall be applicable only to a manufactured home used as a single-dwelling unit installed on privately owned (nonrental) lots and shall apply to the following:

1. Construction, alteration and repair of any foundation system which is necessary to provide for the installation of a manufactured home unit.

2. Construction, installation, addition, alteration, repair or maintenance of the building service equipment which is necessary for connecting manufactured homes to water, fuel or power supplies and sewage systems.

3. Alterations, additions or repairs to existing manufactured homes. The construction, alteration, moving, demolition, repair and use of accessory buildings and structures and their building service equipment shall comply with the requirements of the codes adopted by this jurisdiction.

These provisions shall not be applicable to the design and construction of manufactured homes nor shall they be deemed to authorize either modifications or additions to manufactured homes where otherwise prohibited.

Section C-102—Application to Existing Manufactured Homes and Building Service Equipment

C-102.1—General. Manufactured homes and their building service equipment to which additions, alterations or repairs are made shall comply with all the requirements of these provisions for new facilities, except as specifically provided in this section.

C-102.2—Additions, Alterations or Repairs. Additions made to a manufactured home shall conform to one of the following:

1. Be certified under the National Manufactured Housing Construction and Safety Standards Act of 1974 (42 U.S.C. Section 5401, et seq.).

2. Be designed and constructed to conform with the applicable provisions of the National Manufactured Housing Construction and Safety Standards Act of 1974 (42 U.S.C. Section 5401, et seq.).

3. Be designed and constructed in conformance with the codes adopted by this jurisdiction.

Additions shall be structurally separated from the manufactured home.

EXCEPTION: A structural separation need not be provided when structural calculations are provided to justify the omission of such separation.

Alterations or repairs may be made to any manufactured home or to its building service equipment without requiring the existing manufactured home or its building service equipment to comply with all the requirements of these provisions, provided the alteration or repair conforms to that required for new construction, and provided further that no hazard to life, health or safety will be created by such additions, alterations or repairs.

Alterations or repairs to an existing manufactured home which are nonstructural and do not adversely affect any structural member or any part of the building or structure having required fire protection may be made with materials equivalent to those of which the manufactured home structure is constructed, subject to approval by the authority having jurisdiction.

EXCEPTION: The installation or replacement of glass shall be as required for new installations.

Minor additions, alterations and repairs to existing building service equipment installations may be made in accordance with the codes in effect at the time the original installation was made, subject to approval of the authority having jurisdiction, and provided such additions, alterations, and repairs will not cause the existing building service equipment to become unsafe, unsanitary or overloaded.

C-102.3—Existing Installations. Building service equipment lawfully in existence at the time of the adoption of the applicable codes may have their use, maintenance or repair continued if the use, maintenance or repair is in accordance with the original design and no hazard to life, health or property has been created by such building service equipment.

C-102.4—Existing Occupancy. Manufactured homes which are in existence at the time of the adoption of these provisions may have their existing use or occupancy continued if such use or occupancy was legal at the time of the adoption of these provisions, provided such continued use is not dangerous to life, health and safety.

The use or occupancy of any existing manufactured home shall not be changed unless evidence satisfactory to the authority having jurisdiction is provided to show compliance with all applicable provisions of the codes adopted by this jurisdiction. Upon any change in use or occupancy, the manufactured home shall cease to be classified as such within the intent of these provisions.

C-102.5—Maintenance. All manufactured homes and their building service equipment, existing and new, and all parts thereof shall be maintained in a safe and sanitary condition. All devices or safeguards which are required by applicable codes or by the Manufactured Home Standards shall be maintained in conformance with the code or standard under which it was installed. The owner or his designated agent shall be responsible for the maintenance of manufactured homes, accessory buildings, structures and their building service equipment. To determine compliance with this subsection, the authority having jurisdiction may cause any manufactured home, accessory building or structure to be reinspected.

C-102.6—Relocation. Manufactured homes which are to be relocated within this jurisdiction shall comply with these provisions.

Section C-201—Definitions

For the purpose of these provisions, certain abbreviations, terms, phrases, words and their derivatives shall be construed as defined or specified herein.

Accessory Building is any building or structure, or portion thereto, located on the same property as a manufactured home which does not qualify as a manufactured home as defined herein.

Building Service Equipment refers to the plumbing, mechanical and electrical equipment including piping, wiring, fixtures and other accessories which provide sanitation, lighting, heating, ventilation, cooling, fire-protection and facilities essential for the habitable occupancy of a manufactured home or accessory building or structure for its designated use and occupancy.

Manufactured Home means a structure transportable in one or more sections, which, in the traveling mode, is 8 body feet or more in width or 40 body feet or more in length or, when erected on site, is 320 or more square feet, and which is built on a permanent chassis and designed to be used as a dwelling with or without a permanent foundation when connected to the required utilities, and includes the plumbing, heating, air-conditioning and electrical systems contained therein; except that such term shall include any structure which meets all the requirements of this paragraph

except the size requirements and with respect to which the manufacturer voluntarily files a certification required by the secretary (HUD) and complies with the standards established under this title. For mobile homes built prior to June 15, 1976, a label certifying compliance to the Standard for Mobile Homes, NFPA 501, ANSI 119.1, in effect at the time of manufacture is required. For the purpose of these provisions, a mobile home shall be considered a manufactured home.

Manufactured Home Installation is a term referring to that construction which is required for the installation of a manufactured home, including the construction of the foundation system, required structural connections thereto and the installation of on-site water, gas, electrical and sewer systems and connections thereto which are necessary for the normal operation of the manufactured home.

Manufactured Home Standards are the Manufactured Home Construction and Safety Standards as promulgated by the United States Department of Housing and Urban Development.

Privately Owned (Nonrental) Lot is a parcel of real estate outside of a manufactured home rental community (park) where the land and the manufactured home to be installed thereon are held in common ownership.

Section C-301—Permits

C-301.1—Initial Installation. A manufactured home shall not be installed on a foundation system reinstalled or altered without first obtaining a permit from the authority having jurisdiction. A separate permit shall be required for each manufactured home installation. When approved by the authority having jurisdiction, such permit may include accessory buildings and structures and their building service equipment when the accessory buildings or structures will be constructed in conjunction with the manufactured home installation.

C-301.2—Additions, Alterations and Repairs to a Manufactured Home. A permit shall be obtained to alter, remodel, repair or add accessory buildings or structures to a manufactured home subsequent to its initial installation. Permit issuance and fees therefor shall be in conformance with the codes applicable to the type of work involved.

An addition made to a manufactured home as defined in these provisions shall comply with these provisions.

C-301.3—Accessory Buildings. Except as provided in C-301.1, permits shall be required for all accessory buildings and structures and their building service equipment. Permit issuance and fees therefore shall be in conformance with the codes applicable to the types of work involved.

C-301.4—Exempted Work. A permit shall not be required for the types of work specifically exempted by applicable codes. Exemption from the permit requirements of any of said codes shall not be deemed to grant authorization for any work to be done in violation of the provisions of said codes or any other laws or ordinances of this jurisdiction.

Section C-302—Application for Permit

C-302.1—Application. To obtain a manufactured home installation permit, the applicant shall first file an application in writing on a form furnished by the authority having jurisdiction for that purpose. At the option of the authority having jurisdiction, every such application shall:

1. Identify and describe the work to be covered by the permit for which application is made.

2. Describe the land on which the proposed work is to be done by legal description, street address or similar description that will readily identify and definitely locate the proposed building or work.

3. Indicate the use or occupancy for which the proposed work is intended.

4. Be accompanied by plans, diagrams, computations and specifications and other data as required in Section C-302.2.

5. Be accompanied by a soil investigation when required by Section C-502.2.

6. State the valuation of any new building or structure or any addition, remodeling or alteration to an existing building.

7. Be signed by permittee, or his authorized agent, who may be required to submit evidence to indicate such authority.

8. Give such other data and information as may be required by the authority having jurisdiction.

C-302.2—Plans and Specifications. Plans, engineering calculations, diagrams and other data as required by the authority having jurisdiction shall be submitted in not less than two sets with each application for a permit. The authority having jurisdiction may require plans, computations and specifications to be prepared and designed by an engineer or architect licensed by the state to practice as such.

Where no unusual site conditions exist, the authority having jurisdiction may accept approved standard foundation plans and details in conjunction with the manufacturer's approved installation instructions without requiring the submittal of engineering calculations.

C-302.3—Information on Plans and Specifications. Plans and specifications shall be drawn to scale upon substantial paper or cloth and shall be of sufficient clarity to indicate the location, nature and extent of the work proposed and shown in detail that it will conform to the provisions of these provisions and all relevant laws, ordinances, rules and regulations. The authority having jurisdiction shall determine what information is required on plans and specifications to ensure compliance.

Section C-303—Permits Issuance

C-303.1—Issuance. The application, plans and specifications and other data filed by an applicant for permit shall be reviewed by the authority having jurisdiction. Such plans may be reviewed by other departments of this jurisdiction to verify compliance with any applicable laws under their jurisdiction. If the authority having jurisdiction finds that the work described in an application for a permit and the plans, specifications and other data filed therewith conform to the requirements of these provisions and other pertinent codes, laws and ordinances, and that the fees specified in C-304 have been paid, he shall issue a permit therefor to the applicant.

When the authority having jurisdiction issues the permit where plans are required, he shall endorse in writing or stamp the plans and specifications "APPROVED." Such approved plans and specifications shall not be changed, modified or altered without authorization from the authority having jurisdiction, and all work shall be done in accordance with the approved plans.

C-303.2—Retention of Plans. One set of approved plans and specifications shall be returned to the applicant and shall be kept on the site of the building or work at all times during which the work authorized thereby is in progress. One set of approved plans, specifications and computations shall be retained by the authority having jurisdiction until final approval of the work.

C-303.3—Validity of Permit. The issuance of a permit or approval of plans and specifications shall not be construed to be a permit for, or an approval of, any violation of any of the provisions of these provisions or other pertinent codes of any other ordinance of the jurisdiction. No permit presuming to give authority to violate or cancel these provisions shall be valid.

The issuance of a permit based upon plans, specifications and other data shall not prevent the authority having jurisdiction from thereafter requiring the correction of errors in said plans, specifications and other data, or from preventing building operations being carried on thereunder when in violation of these provisions or of any other ordinances of this jurisdiction.

C-303.4—Expiration. Every permit issued by the authority having jurisdiction under these provisions shall expire by limitation and become null and void if the work authorized by such permit is not commenced within 180 days from the date of such permit, or if the work authorized by such permit is suspended or abandoned at any time after the work is commenced for a period of 180 days. Before such work can be recommenced, a new permit shall be first obtained so to do, and the fee therefor shall be one-half the amount required for a new permit for such work, provided no changes have been made or will be made in the original plans and specifications for such work, and provided further that such suspension or abandonment has not exceeded one year. In order to renew action on a permit after expiration, the permittee shall pay a new full permit fee.

Any permittee holding an unexpired permit may apply for an extension of the time within which he may commence work under that permit when he is unable to commence work within the time required by this section for good and satisfactory reasons. The authority having jurisdiction may extend the time for action by the permittee for a period not exceeding 180 days upon written request by the permittee showing that circumstances beyond the control of the permittee have prevented action from being taken. No permit shall be extended more than once.

C-303.5—Suspension or Revocation. The authority having jurisdiction may, in writing, suspend or revoke a permit issued under these provisions whenever the permit is issued in error or on the basis of incorrect information supplied, or in violation of any ordinance or regulation or any of these provisions.

Section C-304—Fees

C-304.1—Permit Fees. The fee for each manufactured home installation permit shall be established by the authority having jurisdiction.

When permit fees are to be based on the value or valuation of the work to be performed, the determination of value or valuation under these provisions shall be made by the authority having jurisdiction. The value to be used shall be the total value of all work required for the manufactured home installation plus the total value of all work required for the construction of accessory buildings and structures for which the permit is issued as well as all finish work, painting, roofing, electrical, plumbing, heating, air conditioning, elevators, fire-extinguishing systems and any other permanent equipment which is a part of the accessory building or structure. The value of the manufactured home itself shall not be included.

C-304.2—Plan Review Fees. When a plan or other data are required to be submitted by Section C-302.2, a plan review fee shall be paid at the time of submitting plans and specifications for review. Said plan review fee shall be as established by the authority having jurisdiction. Where plans are incomplete or changed so as to require additional plan review, an additional plan review fee shall be charged at a rate as established by the authority having jurisdiction.

C-304.3—Other Provisions.

C-304.3.1—Expiration of Plan Review. Applications for which no permit is issued within 180 days following the date of application shall expire by limitation, and plans and other data submitted for review may thereafter be returned to the applicant or destroyed by the authority having jurisdiction. The authority having jurisdiction may extend the time for action by the applicant for a period not exceeding 180 days upon request by the applicant showing that circumstances beyond the control of the applicant have prevented action from being taken. No application shall be extended more than once. In order to renew action on an application after expiration, the applicant shall resubmit plans and pay a new plan review fee.

C-304.3.2—Investigation Fees: Work Without a Permit.

C-304.3.2.1—Investigation. Whenever any work for which a permit is required by these provisions has been commenced without first obtaining said permit, a special investigation shall be made before a permit may be issued for such work.

C-304.3.2.2—Fee. An investigation fee, in addition to the permit fee, shall be collected whether or not a permit is then or subsequently issued. The investigation fee shall be equal to the amount of the permit fee required. The minimum investigation fee shall be the same as the minimum fee established by the authority having jurisdiction. The payment of such investigation fee shall not exempt any person from compliance with all other provisions of either these provisions or other pertinent codes nor from any penalty prescribed by law.

C-304.3.3—Fee Refunds.

C-304.3.3.1—Permit Fee Erroneously Paid or Collected. The authority having jurisdiction may authorize the refunding of any fee paid hereunder which was erroneously paid or collected.

C-304.3.3.2—Permit Fee Paid When No Work Done. The authority having jurisdiction may authorize the refunding of not more than 80 percent of the permit fee paid when no work has been done under a permit issued in accordance with these provisions.

C-304.3.3.3—Plan Review Fee. The authority having jurisdiction may authorize the refunding of not more than 80 percent of the plan review fee paid when an application for a permit for which a plan review fee has been paid is withdrawn or canceled before any plan reviewing is done.

The authority having jurisdiction shall not authorize the refunding of any fee paid except upon written application by the original permittee not later than 180 days after the date of the fee payment.

Section C-305—Inspections

C-305.1—General. All construction or work for which a manufactured home installation permit is required shall be subject to inspection by the authority having jurisdiction, and certain types of construction shall have continuous inspection by special inspectors as specified in Section C-306. A survey of the lot may be required by the authority having jurisdiction to verify that the structure is located in accordance with the approved plans.

It shall be the duty of the permit applicant to cause the work to be accessible and exposed for inspection purposes. Neither the authority having jurisdiction nor this jurisdiction shall be liable for expense entailed in the removal or replacement of any material required to allow inspection.

C-305.2—Inspection Requests. It shall be the duty of the person doing the

work authorized by a manufactured home installation permit to notify the authority having jurisdiction that such work is ready for inspection. The authority having jurisdiction may require that every request for inspection be filed at least one working day before such inspection is desired. Such request may be in writing or by telephone at the option of the authority having jurisdiction.

It shall be the duty of the person requesting any inspections required either by these provisions or other applicable codes to provide access to and means for proper inspection of such work.

C-305.3—Inspection Record Card. Work requiring a manufactured home installation permit shall not be commenced until the permit holder or his agent shall have posted an inspection record card in a conspicuous place on the premises and in such position as to allow the authority having jurisdiction conveniently to make the required entries thereon regarding inspection of the work. This card shall be maintained in such position by the permit holder until final approval has been issued by the authority having jurisdiction.

C-305.4—Approval Required. Work shall not be done on any part of the manufactured home installation beyond the point indicated in each successive inspection without first obtaining the approval of the authority having jurisdiction. Such approval shall be given only after an inspection has been made of each successive step in the construction as indicated by each of the inspections required in C-305.5. There shall be a final inspection and approval on the manufactured home installation, including connections to its building service equipment, when completed and ready for occupancy or use.

C-305.5—Required Inspections.

C-305.5.1—Structural Inspections for the Manufactured Home Installation. Reinforcing steel or structural framework of any part of any manufactured home foundation system shall not be covered or concealed without first obtaining the approval of the authority having jurisdiction. The authority having jurisdiction, upon notification from the permit holder or his agent, shall make the following inspections and shall either approve that portion of the construction as completed or shall notify the permit holder or his agent wherein the same fails to comply with these provisions or other applicable codes:

1. Foundation Inspection: To be made after excavations for footings are completed and any required reinforcing steel is in place. For concrete foundations, any required forms shall be in place prior to inspection. All materials for the foundation shall be on the job, except where concrete from a central mixing plant (commonly termed "transit mixed") is to be used, the concrete materials need not be on the job. Where the foundation is to be constructed of approved treated wood, additional framing inspections as required by the authority having jurisdiction may be required.

2. Concrete Slab or Under-floor Inspection: To be made after all in-slab or under-floor building service equipment, conduit, piping accessories and other ancillary equipment items are in place but before any concrete is poured or the manufactured home is installed.

3. Anchorage Inspection: To be made after the manufactured home has been installed and permanently anchored.

C-305.5.2—Structural Inspections for Accessory Buildings and Structures. Inspections for accessory buildings and structures shall be made as set forth in this code.

C-305.5.3—Building Service Equipment Inspections. All building service equipment which is required as a part of a manufactured home installation,

including accessory buildings and structures authorized by the same permit, shall be inspected by the authority having jurisdiction. Building service equipment shall be inspected and tested as required by the applicable codes. Such inspections and testing shall be limited to site construction and shall not include building service equipment which is a part of the manufactured home itself. No portion of any building service equipment intended to be concealed by any permanent portion of the construction shall be concealed until inspected and approved. Building service equipment shall not be connected to the water, fuel or power supply or sewer system until authorized by the authority having jurisdiction.

C-305.5.4—Final Inspection. When finish grading and the manufactured home installation, including the installation of all required building service equipment, is completed and the manufactured home is ready for occupancy, a final inspection shall be made.

C-305.6—Other Inspections. In addition to the called inspections specified above, the authority having jurisdiction may make or require other inspections of any construction work to ascertain compliance with these provisions or other codes and laws which are enforced by the code enforcement agency.

Section C-306—Special Inspections

In addition to the inspections required by Section C-305, the authority having jurisdiction may require the owner to employ a special inspector during construction of specific types of work as described in this code.

Section C-307—Utility Service

Utility service shall not be provided to any building service equipment which is regulated by these provisions or other applicable codes and for which a manufactured home installation permit is required by these provisions until approved by the authority having jurisdiction.

Section C-401—Occupancy Classification

C-401.1—Manufactured Homes. A manufactured home shall be limited in use to use as a single dwelling unit.

C-401.2—Accessory Buildings. Accessory buildings shall be classified as to occupancy by the authority having jurisdiction as set forth in this code.

Section C-402—Location on Property

Manufactured homes and accessory buildings shall be located on the property in accordance with applicable codes and ordinances of this jurisdiction.

Section C-501—Design

C-501.1—General. A manufactured home shall be installed on a foundation system which is designed and constructed to sustain within the stress limitations specified in this code and all loads specified in this code.

> **EXCEPTION:** When specifically authorized by the authority having jurisdiction, foundation and anchorage systems which are constructed in accordance with the methods specified in Section C-600 of these provisions, or in the United States Department of Housing and Urban Development Handbook, "Permanent Foun-

dations for Manufactured Housing," 1984 Edition, Draft, shall be deemed to meet the requirements of this Appendix C.

C-501.2—Manufacturer's Installation Instructions. The installation instructions as provided by the manufacturer of the manufactured home shall be used to determine permissible points of support for vertical loads and points of attachment for anchorage systems used to resist horizontal and uplift forces.

C-501.3—Rationality. Any system or method of construction to be used shall admit to a rational analysis in accordance with well-established principles of mechanics.

Section C-502—Foundation Systems

C-502.1—General. Foundation systems designed and constructed in accordance with this section may be considered as a permanent installation.

C-502.2—Soil Classification. The classification of the soil at each manufactured home site shall be determined when required by the authority having jurisdiction. The authority having jurisdiction may require that the determination be made by an engineer or architect licensed by the state to conduct soil investigations.

The classification shall be based on observation and any necessary tests of the materials disclosed by borings or excavations made in appropriate locations. Additional studies may be necessary to evaluate soil strength, the effect of moisture variation on soil bearing capacity, compressibility and expansiveness.

When required by the authority having jurisdiction, the soil classification design bearing capacity and lateral pressure shall be shown on the plans.

C-502.3—Footings and Foundations. Footings and foundations, unless otherwise specifically provided, shall be constructed of materials specified by this code for the intended use and in all cases shall extend below the frost line. Footings of concrete and masonry shall be of solid material. Foundations supporting untreated wood shall extend at least 8 inches above the adjacent finish grade. Footings shall have a minimum depth below finished grade of 12 inches unless a greater depth is recommended by a foundation investigation.

Piers and bearing walls shall be supported on masonry or concrete foundations or piles or other approved foundation systems which shall be of sufficient capacity to support all loads.

C-502.4—Foundation Design. When a design is provided, the foundation system shall be designed in accordance with the applicable structural provisions of this code and shall be designed to minimize differential settlement. Where a design is not provided, the minimum foundation requirements shall be as set forth in this code.

C-502.5—Drainage. Provisions shall be made for the control and drainage of surface water away from the manufactured home.

C-502.6—Under-floor Clearances—Ventilation and Access. A minimum clearance of 12 inches shall be maintained beneath the lowest member of the floor support framing system. Clearances from the bottom of wood floor joists or perimeter joists shall be as specified in this code.

Under-floor spaces shall be ventilated with openings as specified in this code. If combustion air for one or more heat-producing appliances is taken from within the under-floor spaces, ventilation shall be adequate for proper appliance operation.

Under-floor access openings shall be provided. Such openings shall be not less than 18 inches in any dimension and not less than 3 square feet in area and shall be located so that any water supply and sewer drain connections located under the manufactured home are accessible.

Section C-503—Skirting and Perimeter Enclosures

C-503.1—Skirting and Permanent Perimeter Enclosures. Skirting and permanent perimeter enclosures need be installed only where specifically required by other laws or ordinances. Skirting, when installed, shall be of material suitable for exterior exposure and contact with the ground. Permanent perimeter enclosures shall be constructed of materials as required by this code for regular foundation construction.

Skirting shall be installed in accordance with the skirting manufacturer's installation instructions. Skirting shall be adequately secured to assure stability, to minimize vibration and susceptibility to wind damage, and to compensate for possible frost heave.

C-503.2—Retaining Walls. Where retaining walls are used as a permanent perimeter enclosure, they shall resist the lateral displacements of soil or other materials and shall conform to this code as specified for foundation walls. Retaining walls and foundation walls shall be constructed of approved treated wood, concrete, masonry or other approved materials or combination of materials as for foundations as specified in this code. Siding materials shall extend below the top of the exterior of the retaining or foundation wall or the joint between siding and enclosure wall shall be flashed in accordance with this code.

Section C-504—Structural Additions

Accessory buildings shall not be structurally supported by or attached to a manufactured home unless engineering calculations are submitted to substantiate any proposed structural connection.

> **EXCEPTION:** The authority having jurisdiction may waive the submission of engineering calculations if he finds that the nature of the work applied for is such that engineering calculations are not necessary to show conformance to these provisions.

Section C-505—Building Service Equipment

The installation, alteration, repair, replacement, addition to or maintenance of the building service equipment within the manufactured home shall conform to regulations set forth in the Manufactured Home Standards. Such work which is located outside the manufactured home shall comply with the applicable codes adopted by this jurisdiction.

Section C-506—Exits

C-506.1—Site Development. Exterior stairways and ramps which provide egress to the public way shall comply with applicable provisions of this code.

C-506.2—Accessory Buildings. Every accessory building or portion thereof shall be provided with exits as required by this code.

Section C-507—Occupancy, Fire Safety and Energy Conservation Standards

Alterations made to a manufactured home subsequent to its initial installation shall conform to the occupancy, fire safety and energy conservation requirements set forth in the Manufactured Home Standards.

Section C-600—Special Requirements for Foundation Systems

Section C-600 is applicable only when specifically authorized by the authority having jurisdiction.

Section C-601—Footings and Foundations

The capacity of individual load-bearing piers and their footings shall be sufficient to sustain within the stress limitations specified in this code all loads specified in this code. Footings, unless otherwise approved by the authority having jurisdiction, shall be placed level on firm undisturbed soil or an engineered fill which is free of organic material, such as weeds and grasses. Where used, an engineered fill shall provide a minimum load-bearing capacity of not less than 1000 psf. Continuous footings shall conform to the requirements of this code. Section C-502 of these provisions shall apply to footings and foundations constructed under the provisions of this section.

Section C-602—Pier Construction

Piers shall be designed and constructed to distribute loads evenly. Multiple section homes may have concentrated roof loads which will require special consideration. Load-bearing piers may be constructed utilizing one of the methods listed below. Such piers shall be considered to resist only vertical forces acting in a downward direction. They shall not be considered as providing any resistance to horizontal loads induced by wind or earthquake forces.

1. A prefabricated load-bearing device that is listed and labeled for the intended use.

2. Mortar shall comply with ASTM C 270 Type M, S or N; this may consist of one part portland cement, one-half part hydrated lime and four parts sand by volume. Lime shall not be used with plastic or waterproof cement.

3. A cast-in-place concrete pier with concrete having specified compressive strength at 28 days of 2,500 psi.

Alternate materials and methods of construction may be used for piers which have been designed by an engineer or architect licensed by the state to practice as such.

Caps and leveling spacers may be used for leveling of the manufactured home. Spacing of piers shall be as specified in the manufacturer's installation instructions, if available, or by an approved designer.

Section C-603—Height of Piers

Piers constructed as indicated in Section C-602 may have heights as follows:

1. Except for corner piers, piers 36 inches or less in height may be constructed of masonry units, placed with cores or cells vertically. Piers shall be installed with their long dimension at right angles to the main frame member they support and shall have a minimum cross-sectional area of 128 square inches. Piers shall be capped with minimum 4-inch solid masonry units or equivalent.

2. Piers between 36 and 80 inches in height and all corner piers over 24 inches in height shall be at least 16 inches by 16 inches consisting of interlocking masonry units and shall be fully capped with minimum 4-inch solid masonry units or equivalent.

3. Piers over 80 inches in height may be constructed in accordance with the provisions of Item No. 2 above, provided the piers shall be filled solid with grout and

reinforced with four continuous No. 5 bars. One bar shall be placed in each corner cell of hollow masonry unit piers or in each corner of the grouted space of piers constructed of solid masonry units.

4. Cast-in-place concrete piers meeting the same size and height limitations of Item Nos. 1, 2 and 3 above may be substituted for piers constructed of masonry units.

Section C-604—Anchorage Installations

C-604.1—Ground Anchors. Ground anchors shall be designed and installed to transfer the anchoring loads to the ground. The loading-carrying portion of the ground anchors shall be installed to the full depth called for by the manufacturer's installation directions and shall extend below the established frost line into undisturbed soil.

Manufactured ground anchors shall be listed and installed in accordance with the terms of their listing and the anchor manufacturer's instructions and shall include means of attachment of ties meeting the requirements of Section C-605. Ground anchor manufacturer's installation instructions shall include the amount of preload required and load capacity in various types of soil. These instructions shall include tensioning adjustments which may be needed to prevent damage to the manufactured home, particularly damage that can be caused by frost heave. Each ground anchor shall be marked with the manufacturer's identification and listed model identification number which shall be visible after installation. Instructions shall accompany each listed ground anchor specifying the types of soil for which the anchor is suitable under the requirements of this section.

Each approved ground anchor, when installed, shall be capable of resisting an allowable working load at least equal to 3,150 pounds in the direction of the tie plus a 50 percent overload (4,725 pounds total) without failure. Failure shall be considered to have occurred when the anchor moves more than 2 inches at a load of 4,725 pounds in the direction of the tie installation. Those ground anchors which are designed to be installed so that loads on the anchor are other than direct withdrawal shall be designed and installed to resist an applied design load of 3,150 pounds at 40 to 50 degrees from vertical or within the angle limitations specified by the home manufacturer without displacing the tie end of the anchor more than 4 inches horizontally. Anchors designed for connection of multiple ties shall be capable of resisting the combined working load and overload consistent with the intent expressed herein.

When it is proposed to use ground anchors and the authority having jurisdiction has reason to believe that the soil characteristics at a given site are such as to render the use of ground anchors inadvisable, or when there is doubt regarding the ability of the ground anchors to obtain their listed capacity, the authority having jurisdiction may require that a representative field installation be made at the site in question and tested to demonstrate ground anchor capacity. The authority having jurisdiction shall approve the test procedures.

C-604.2—Anchoring Equipment. Anchoring equipment, when installed as a permanent installation, shall be capable of resisting all loads as specified within these provisions. When the stabilizing system is designed by an engineer or architect licensed by the state to practice as such, alternative designs may be used, providing the anchoring equipment to be used is capable of withstanding a load equal to 1.5 times the calculated load. All anchoring equipment shall be listed and labeled as being capable of meeting the requirements of these provisions. Anchors as specified in this code may be attached to the main frame of the manufactured home by an

approved 3/16-inch-thick slotted steel plate anchoring device. Other anchoring devices or methods meeting the requirements of these provisions may be permitted when approved by the authority having jurisdiction.

Anchoring systems shall be so installed as to be permanent. Anchoring equipment shall be so designed to prevent self-disconnection with no hook ends used.

C-604.3—Resistance to Weather Deterioration. All anchoring equipment, tension devices and ties shall have a resistance to deterioration as required by this code.

C-604.4—Tensioning Devices. Tensioning devices, such as turnbuckles or yoke-type fasteners, shall be ended with clevis or welded eyes.

Section C-605—Ties, Materials and Installation

Steel strapping, cable, chain or other approved materials shall be used for ties. All ties shall be fastened to ground anchors and drawn tight with turnbuckles or other adjustable tensioning devices or devices supplied with the ground anchor. Tie materials shall be capable of resisting an allowable working load of 3,150 pounds with no more than 2 percent elongation and shall withstand a 50 percent overload (4,750 pounds). Ties shall comply with the weathering requirements of Section C-604.3. Ties shall connect the ground anchor and the main structural frame. Ties shall not connect to steel outrigger beams which fasten to and intersect the main structural frame unless specifically stated in the manufacturer's installation instructions. Connection of cable ties to main frame members shall be 5/8-inch closed-eye bolts affixed to the frame member in an approved manner. Cable ends shall be secured with at least two U-bolt cable clamps with the "U" portion of the clamp installed on the short (dead) end of the cable to assure strength equal to that required by this section.

Wood floor support systems shall be fixed to perimeter foundation walls in accordance with provisions of this code. The minimum number of ties required per side shall be sufficient to resist the wind load stated in this code. Ties shall be evenly spaced as practicable along the length of the manufactured home with the distance from each end of the home and the tie nearest that end not exceeding 8 feet. When continuous straps are provided as vertical ties, such ties shall be positioned at rafters and studs. Where a vertical tie and diagonal tie are located at the same place, both ties may be connected to a single anchor, provided the anchor used is capable of carrying both loadings. Multisection manufactured homes require diagonal ties only. Diagonal ties shall be installed on the exterior main frame and slope to the exterior at an angle of 40 to 50 degrees from the vertical or within the angle limitations specified by the home manufacturer. Vertical ties which are not continuous over the top of the manufactured home shall be attached to the main frame.

Appendix D
ENGINEERED PROCEDURE FOR SIZING PLUMBING VENTS

Table Nos. D.1, D.2, and D.3 provide an engineered method for sizing vents. Use of these tables and Figure Nos. D.1 through D.6 shall require a formal plan review prior to installation.

In most residential applications, individual fixtures or small fixture groups may be vented by a ½-, ¾- or 1-inch pipe. Under these conditions, the general rule is to increase a branch vent one size larger than the largest fixture vent served.

A more detailed procedure for sizing branch vents is required where larger fixture vents are required or where more than three fixture vents connect to a branch vent, using the following formula and internal cross-sectional areas listed in Table No. D.2.

$$A_B = \sqrt{A_L} \times \Sigma A_V$$

WHERE:

A_B = Area of branch vent
A_L = Area of largest vent served
A_V = Area of all other vents served

Table No. D.1
MINIMUM SIZE FOR DRY VENTS

Venting Application	Load Served (d.f.u)	Vent Size[1] (In.)
Individual fixture vent (single trap only)	3.9 or less	½
	4.0 or more	¾
Common vent, waste stack vent or wet vent extension	3.9 or less	¾
	4.0 to 6.9	1
	7.0 to 15.9	1¼
Soil stack vent	6.9 or less	1
	7.0 to 15.9	1¼
	16.0 to 30.0	1½
Vent stack	10.9 or less	1¼
	11.0 to 30.0	1½

(Continued)

Table No. D.1 (Continued)
MINIMUM SIZE FOR DRY VENTS

Venting Application	Number of fixture vents served	Pipe sizes larger than largest fixture vent served
Branch vent	Two	One
	Three	One
	(largest = ¼ in.)	
	Three	Usually one[2]
	(largest = 1 in. or more)	
	Four or more	Compute size[3]

[1] Increase one nominal pipe size if:
a. Vent length exceeds 30 feet.
b. If effluent from trap arm falls more than one story before being diverted into a horizontal drain pipe.

[2] Up to two 1-inch, plus ½- or ¾-inch fixture vents require branch vent to be one pipe size larger. Other combinations with fixture vents larger than 1-inch may require branch vent to be two pipe sizes larger. See Table No. D.3, Combinations of Three-Fixture Vents Requiring Two-Pipe-Size Increase in Branch Vent

[3] Compute pipe size using Table No. D.2, Internal Cross-Sectional Areas of Various Nominal Sizes of Pipes, and formula given above Table No. D.1.

Table No. D.2
INTERNAL CROSS-SECTIONAL AREAS OF VARIOUS NOMINAL SIZES OF PIPE

NOMINAL PIPE SIZE, (In.)	INTERNAL CROSS-SECTIONAL AREAS*		
	SCHEDULE 40 PIPE METALLIC OR NONMETALLIC (Sq. In.)	COPPER TUBE	
		Type M (Sq. In.)	Type DWV (Sq. In.)
½	0.304	0.254	———
¾	0.533	0.517	———
1	0.864	0.874	———
1¼	1.495	———	1.317
1½	2.036	———	1.865
2	3.355	———	3.272
3	7.393	———	7.235

*Areas for other piping materials and wall thickness may be obtained or calculated from the respective ASTM standards or the manufacturer's specifications.

Table No. D.3 lists combinations of three-fixture vents that include larger sizes requiring a two-pipe-size increase in a branch vent, based on the above design procedure.

Table No. D.3
COMBINATIONS OF THREE-FIXTURE VENTS REQUIRING TWO-PIPE-SIZE INCREASE IN BRANCH VENT

SIZES OF THE THREE-FIXTURE VENTS SERVED BY BRANCH VENT (Inches)			BRANCH VENT SIZE REQUIRED (Inches)
Largest	Intermediate	Smallest	
1	1	1	1 1/2
1 1/4	1	3/4	2
1 1/4	1	1	2
1 1/4	1 1/4	3/4	2
1 1/4	1 1/4	1	2
1 1/4	1 1/4	1 1/4	2
1 1/2	1 1/2	1 1/4	3
1 1/2	1 1/2	1 1/2	3

Figure No. D.1
TYPICAL SINGLE-BATH WET-VENT ARRANGEMENTS

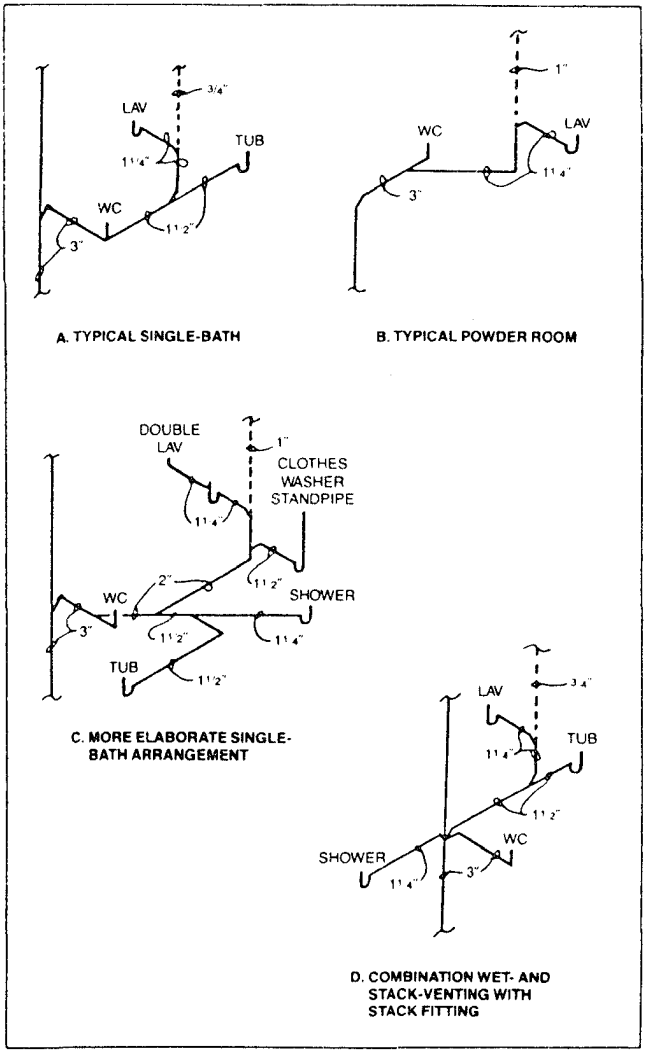


Figure No. D.2
TYPICAL DOUBLE-BATH WET-VENT ARRANGEMENTS

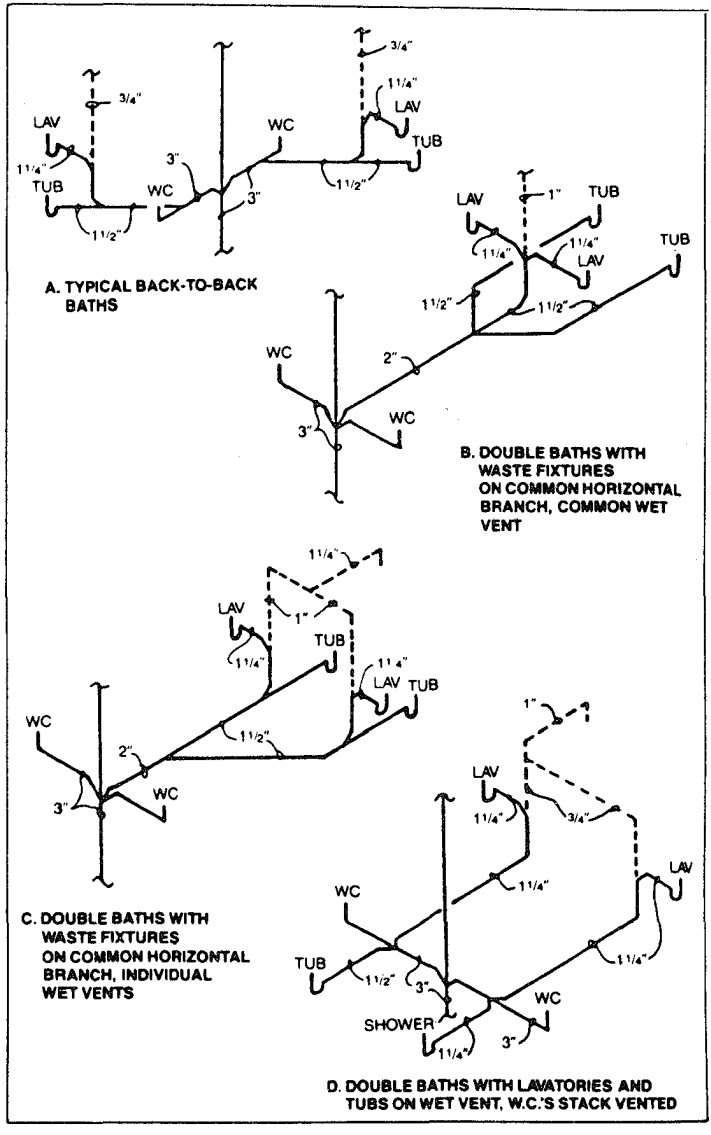


Figure No. D.3
WASTE STACK SERVING AS WET VENT FOR LAUNDRY GROUP

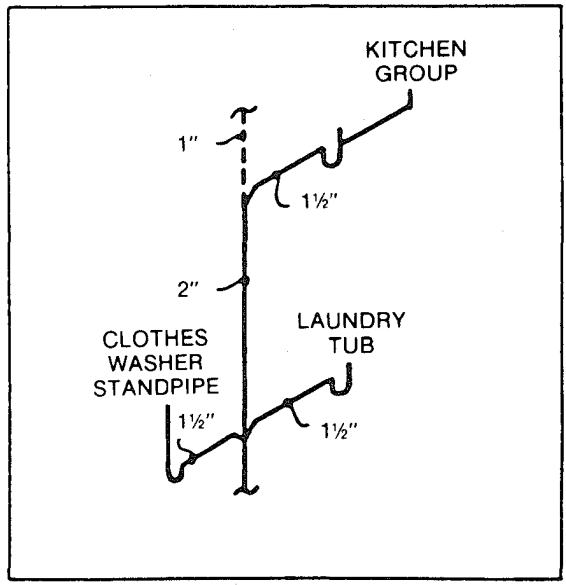
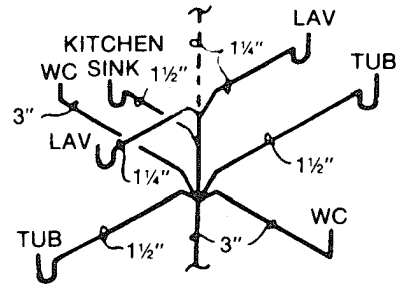
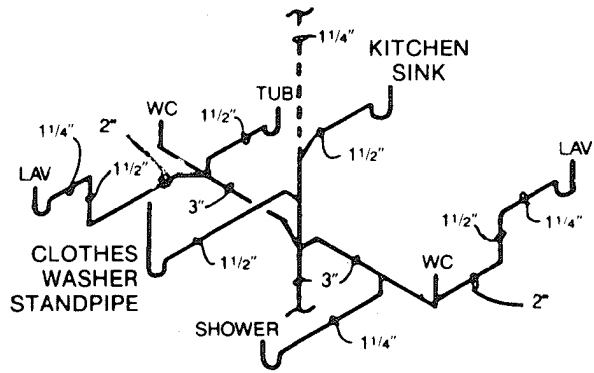


Figure No. D.4
TYPICAL METHODS OF CONNECTING FIXTURE DRAINS TO STACK IN STACK-VENTED SYSTEMS



A. WASTE FIXTURES CONNECTED DIRECTLY TO STACK



B. WASTE FIXTURES CONNECTED TO WATER CLOSET HORIZONTAL BRANCH

Figure No. D.5
TYPICAL UNIFORMLY SIZED HORIZONTAL BRANCH SYSTEM

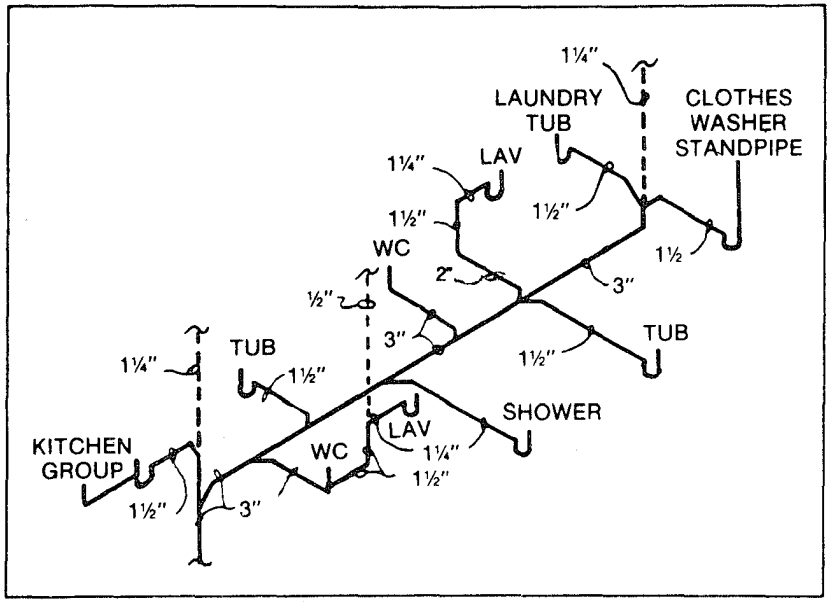
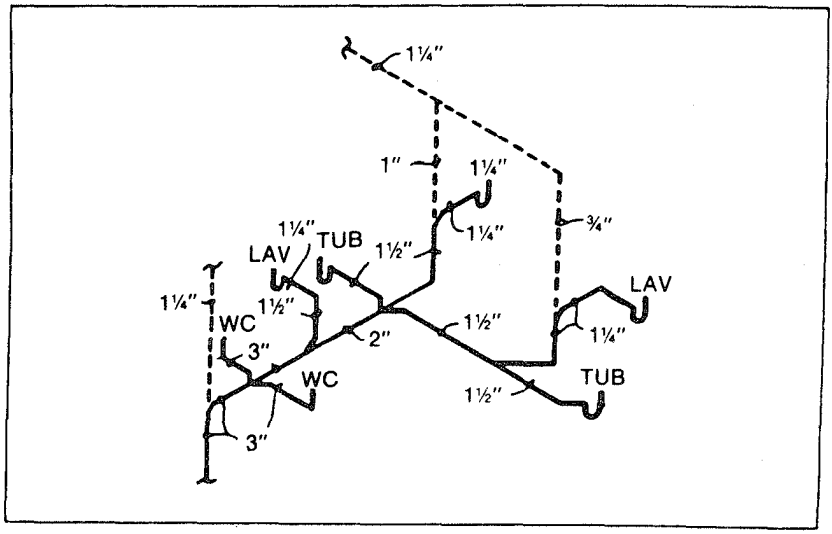


Figure No. D.6
TYPICAL HORIZONTAL BRANCH SYSTEM REDUCING IN SIZE UTILIZING WET VENTING



Appendix E
DETAILED PROCEDURE FOR SIZING THE BUILDING WATER SUPPLY SYSTEM

E.1—Introduction.

This appendix presents a detailed engineering method that may be used for sizing water-service and distribution piping in single-family homes. It complements Chapter 24 of this code, which presents a simplified method based on velocity limitation that may be used where available water-supply pressures are at least 40 psi and the elevation of the highest fixture above the service valve does not exceed 25 feet.

The detailed method presented herein provides greater precision than the simplified method and can be used for determining pipe sizes for any given supply pressure where nonwater-conserving or unusual fixtures will be installed, or in any other case where an engineered design is required.

Preliminary data that should be obtained and recorded are as follows:

1. Piping materials to be used for the water-service pipe and distribution piping, and related standards.

2. Corrosivity and scale-forming tendency of the water supply.

3. Maximum and minimum pressures in the public main or in a private well-water supply system.

4. Developed length of the service pipe from the public main to the building service valve, and the developed length of the longest run of piping from the service valve to the highest and most distant water outlet on the system.

5. Relative elevations of points where the water-service pipe connects to the public main, or building service valve, and of each floor on which plumbing fixtures and appliances are to be installed.

6. Minimum flow pressure required at highest water outlets (deemed to be 8 psi for common plumbing fixtures, and as recommended by manufacturers of plumbing appliances).

E.2—Uniform Friction Drop Method of Pipe Sizing.

This detailed method may be used for buildings of any height and for any available pressure. It may also be used for reference or verification purposes when reviewing a design performed in accordance with the simplified velocity limitation method presented in Chapter 24. In the event a larger size is calculated by the uniform friction drop method than by the velocity limitation method, the larger size should be selected for design. In applying the uniform friction drop method, the following steps are recommended:

a. A detailed and accurate schematic of the water-supply system should be prepared of a sufficiently large size to permit the recording of certain preliminary data, as indicated in E.1, together with the detailed results obtained from the calculations described in this section. The results obtained in each step should be marked on the schematic at the appropriate locations.

b. Calculate the equivalent length of the basic design circuit (BDC*), identify the

*The basic design circuit (BDC) is the longest run of piping from the water source to the highest and most remote fixture or water outlet on the system. In most systems, the BDC may be assumed to consist, first, of the cold-water supply piping extending from the source to the water heater, and then the hot-water supply piping extending from the water heater to the highest and most remote hot-water outlet on the system (terminal fixture).

BDC on the system schematic and determine total equivalent length, including water-service pipe and appropriate distribution piping to the highest and most remote fixture on the BDC. For the purposes of this determination, it may be sufficient to assume that the equivalent length to be added for valves and fittings will be 50 percent of the developed length of the circuit.

For a more accurate allowance of equivalent length for valves and fittings, see Tables Nos. E.1 (a) and E.1 (b). In order to apply such data, it is necessary first to estimate the size appropriate to the pipe element in which the fitting or valve is to be installed. This estimate may also be obtained by means of the velocity limitation sizing procedure, described in Chapter 24.

After obtaining the equivalent length corresponding to all valves and fittings in the BDC as described above, this sum is added to the developed length of the BDC. The result is the total equivalent length of the BDC. This value is essential to an accurate determination of the friction loss design factor (see Item d below).

c. Calculate the pressure available for overcoming friction. The minimum static pressure at the main or other source is reduced by elevation rise up to and within the building and also by pressure losses produced by flow through certain equipment, e.g., a water meter, and by flow through fixture branches. Also, a residual or "flow pressure" must be provided at the terminal fixture while the water is flowing at the predicted demand rate.

Where equipment such as a water meter, water softener, check valve or instantaneous or tankless water heater is provided in the basic design circuit, the friction loss in such equipment corresponding to the demand for the pipe element in which it is to be installed should be determined from the manufacturer or other reliable source. The friction loss in such equipment corresponding to the appropriate demand should be deducted from the minimum static pressure at the source in determining the pressure available for overcoming friction. Figure No. E.1 may be used to obtain estimates of friction losses in water meters. The curves in Figure No. E.1 are based on the assumption that pressure loss is proportional to the square of the flow rate.

In summary, calculate pressure available for overcoming friction by subtracting from the minimum static pressure, in psi, at the main or other source, the sum of Items Nos. 1, 2, 3 and 4 below:

1. Required minimum flow pressure at the terminal fixture of the basic design circuit. In most residential systems using tank-type water closets, a minimum flow pressure of 8 psi may be assumed at the terminal fixture.

2. Friction loss, in psi, due to flow through fixture-supply branches. For this purpose, a value of 5 psi may be assumed.

3. Elevation head loss, in psi, from main or other source up to terminal fixture. This is calculated as the product of the elevation difference, in feet, times the factor 0.433 psi per foot.

4. The sum of friction losses, in psi, caused by certain equipment which is to be installed in the basic design circuit, as described above. The most common source of such losses is the water meter. The appropriate value may be obtained from Figure No. E.1.

d. Calculate the friction loss design factor, Δp, psi/100 feet, for the basic design circuit. This is obtained by dividing the pressure available for friction (see Item c above) by the total equivalent length of the basic design circuit (see Item b above) and multiplying the result by 100:

$$\Delta p = \frac{\text{psi available for friction}}{\text{total equivalent length}} \times 100$$

This factor must be computed as a prerequisite to sizing the hot and cold building mains, as well as the primary branches and risers (see Item g below).

e. Determine the total fixture unit load and equivalent demand flow rate for the service pipe, the hot and cold building mains, and each primary branch and riser. See Table No. E.2 and Figure No. E.2 (or Table No. P-2409.3 in Chapter 24).

f. Size the service pipe by the use of the appropriate table in Table Nos. E.3 (a) through E.3 (f). Enter the appropriate table with the service pipe demand rate obtained in Item e above, the pressure available for friction as obtained in Item c above and the total equivalent legnth of the basic design circuit obtained in Item b above. Values may be interpolated. The size for the service pipe obtained in this way should be the smallest size which will furnish the required flow rate for the given equivalent length and available pressure.

As an alternate approach, Table No. E.4 may be used to size the service pipe.

g. Size each hot and cold building main, as well as each primary branch and riser, by the use of Table No. E.4. Enter the portion of the table for the appropriate piping material with the appropriate demand rate obtained in Item e above and the friction loss design factor, Δp, obtained in Item d above. The size for each pipe element obtained in this way should be the smallest size which will furnish the required flow rate for the given friction loss design factor.

As an alternate approach, the water-distribution system may be sized from Table Nos. E.3 (a) through E.3 (f).

Table No. E.1 (a)
ALLOWANCE IN EQUIVALENT LENGTH
FOR FRICTION LOSS IN VALVES AND FITTINGS*
(Streamline Connections, Soldered, Brazed or Solvent Cemented)

FITTING OR VALVE	EQUIVALENT FEET OF TUBE FOR VARIOUS SIZES (In.)					
	1/4	3/8	1/2	3/4	1	1 1/4
Coupling	0.2	0.2	0.5	0.5	0.5	0.5
45° Elbow	0.2	0.3	0.5	0.5	1.0	1.0
90° Elbow	0.4	0.5	0.5	1.0	1.0	2.0
Tee, run	0.2	0.2	0.5	0.5	0.5	0.5
Tee, branch	0.6	0.8	1.0	2.0	3.0	4.0
Compression stop	5.0	8.0	13.0	—	—	—
Globe valve	4.0	4.0	8.0	10.0	12.0	18.0
Gate valve	0.1	0.1	0.2	0.3	0.4	0.5

*From "Copper Tube Handbook," 404-0 (1980), by Copper Development Association Inc.

In the absence of specific recommendation from the manufacturer, listed values may be applied also to CPVC plasic piping using solvent-cemented fittings, and five times the listed values may be applied to plastic piping systems using insert-type fittings.

Table No. E.1 (b)
ALLOWANCE IN EQUIVALENT LENGTH FOR FRICTION LOSS IN VALVES AND FITTINGS*
(Threaded, Galvanized Steel, Brass or Copper, Standard Wall Schedule 40)

FITTING OR VALVE	EQUIVALENT FEET OF TUBE FOR VARIOUS SIZES (In.)					
	1/4	3/8	1/2	3/4	1	1 1/4
Coupling	0.2	0.4	0.6	0.8	0.9	1.2
45° Elbow	0.5	1.0	1.2	1.5	1.8	2.4
90° Elbow	0.8	1.5	2.0	2.5	3.0	4.0
Tee, run	0.2	0.4	0.6	0.8	0.9	1.2
Tee, branch	1.2	2.0	3.0	4.0	5.0	6.0
Compression stop	5.0	8.0	13.0	—	—	—
Globe valve	6.0	10.0	15.0	20.0	25.0	35.0
Gate valve	0.3	0.3	0.4	0.5	0.6	0.8

*From *National Standard Plumbing Code*, 1983, by National Association of Plumbing-Heating-Cooling Contractors, Inc., for sizes 1/2 through 1 1/4 inch. Values for 1/4 and 3/8 inch are extrapolated.

Table No. E.2
WATER-SUPPLY FIXTURE-UNIT VALUES FOR VARIOUS PLUMBING FIXTURES AND FIXTURE GROUPS

TYPE OF FIXTURE OR GROUP OF FIXTURES	WATER-SUPPLY FIXTURE-UNIT VALUE (w.s.f.u.)		
	Hot	Cold	Combined
Bathtub (with/without overhead shower head)	1.0	1.0	1.4
Clothes washer	1.0	1.0	1.4
Dish washer	1.4	—	1.4
Hose bibb (sill cock)*	—	2.5	2.5
Kitchen sink	1.0	1.0	1.4
Lavatory	0.5	0.5	0.7
Laundry tub	1.0	1.0	1.4
Shower stall	1.0	1.0	1.4
Water closet (tank type)	—	2.2	2.2
Full-bath group with bathtub (with/without shower head) or shower stall	1.5	2.7	3.6
Half-bath group (W.C. and lavatory)	0.5	1.5	2.6
Kitchen group (dishwasher and sink with/without garbage grinder)	1.9	1.0	2.5
Laundry group (clothes washer standpipe and laundry tub)	1.8	1.8	2.5
Multiple-bath groups:			
1 1/2 baths	2.0	3.3	4.4
2 baths	2.6	3.9	5.2
2 1/2 baths	2.8	4.2	5.6
3 baths	3.2	4.7	6.3
3 1/2 baths	3.4	5.1	6.8
Additional 1/2 bath if part of group	.3	.6	.8

*The fixture-unit value 2.5 assumes a flow demand of 2.5 gpm, such as for an individual lawn sprinkler device. If a hose bibb/sill cock will be required to furnish a greater flow rate, the equivalent fixture-unit value may be obtained from Figure No. E.1.

Table No. E.3 (a)
MAXIMUM FLOW RATES, *Q*, WHICH YIELD VELOCITIES NOT EXCEEDING 8 fps AT INDICATED AVAILABLE PRESSURES COPPER WATER TUBE, TYPE K (ASTM B 88) WATER-SERVICE PIPE

NOMINAL PIPE SIZE, IN.	EQUIVALENT LENGTH OF LINE, FT.[1]							
	10	20	40	60	80	100	150	200
	FLOW RATE, GPM[2]							
Pressure Available for Friction[3] - 5 psi								
3/4	←	10.9	8.5	6.8	5.8	5.1	4.1	3.5
1	←	19.4	17.9	14.4	12.3	10.9	8.6	7.5
1 1/4	←		30.3	26.0	22.1	19.8	15.9	13.6
Pressure Available for Friction[3] - 10 psi								
3/4	←		10.9	9.8	8.5	7.5	6.0	5.1
1	←			19.4	17.9	15.9	12.7	10.9
1 1/4	←				30.3	28.8	23.1	19.8
Pressure Available for Friction[3] - 15 psi								
3/4	←			10.9	10.5	9.4	7.5	6.4
1	←					19.4	15.9	13.6
1 1/4	←					30.3	28.8	24.7
Pressure Available for Friction[3] - 20 psi								
3/4	←					10.9	8.7	7.5
1	←					19.4	18.6	15.9
1 1/4	←						30.3	29.0
Pressure Available for Friction[3] - 25 psi								
3/4	←						10.9	8.5
1	←						19.4	17.9
1 1/4	←							30.3
Pressure Available for Friction[3] - 30 psi								
3/4	←						10.9	9.4
1	←							19.4
1 1/4	←							30.3
Pressure Available for Friction[3] - 35 psi								
3/4	←						10.9	10.1
1	←							19.4
1 1/4	←							30.3
Pressure Available for Friction[3] - 40 psi								
3/4	←							10.9
1	←							19.4
1 1/4	←							30.3
Pressure Available for Friction[3] - 45 psi								
3/4	←							10.9
1	←							19.4
1 1/4	←							30.3

(Continued)

Table No. E.3 (a) (Continued)

NOMINAL PIPE SIZE, IN.	EQUIVALENT LENGTH OF LINE, FT.[1]							
	10	20	40	60	80	100	150	200
	FLOW RATE, GPM[2]							
Pressure Available for Friction[3] - 50 psi								
3/4	←							10.9
1	←							19.4
1 1/4	←							30.3
Pressure Available for Friction[3] - 60 psi								
3/4	←							10.9
1	←							19.4
1 1/4	←							30.3
Pressure Available for Friction[3] - 70 psi								
3/4	←							10.9
1	←							19.4
1 1/4	←							30.3

[1]Developed length of primary circuit plus equivalent length of fittings.
[2]Values may be interpolated according to length.
[3]Minimum static pressure at source minus pressure drop due to elevation, minus pressure drop due to water meter and certain other equipment in BDC, minus minimum allowable flow pressure at highest and most remote fixture.
NOTE: Limiting flow rates corresponding to a velocity of 8 fps. See Table No. E.4 for hydraulic formula.

Table No. E.3 (b)
MAXIMUM FLOW RATES, *Q*, WHICH YIELD VELOCITIES NOT EXCEEDING 8 fps AT INDICATED AVAILABLE PRESSURES COPPER WATER TUBE, TYPE L (ASTM B 88) WATER-SERVICE PIPE

NOMINAL PIPE SIZE, IN.	EQUIVALENT LENGTH OF LINE, FT.[1]							
	10	20	40	60	80	100	150	200
	FLOW RATE, GPM[2]							
Pressure Available for Friction[3] - 5 psi								
3/4	←	12.1	9.6	7.7	6.6	5.8	4.6	4.0
1	←	20.6	19.5	15.7	13.3	11.6	9.5	8.1
1 1/4	←		31.3	27.3	23.5	20.2	16.6	14.2
Pressure Available for Friction[3] - 10 psi								
3/4	←		12.1	11.2	9.6	8.4	6.8	5.8
1	←			20.6	19.5	17.1	14.0	11.6
1 1/4	←				31.3	29.1	24.2	20.2
Pressure Available for Friction[3] - 15 psi								
3/4	←				12.1	10.7	8.4	7.3
1	←					20.6	17.1	14.8
1 1/4	←					31.3	29.1	26.0
Pressure Available for Friction[3] - 20 psi								
3/4	←					12.1	10.7	8.4
1	←					20.6	20.1	17.1
1 1/4	←						31.3	29.1
Pressure Available for Friction[3] - 25 psi								
3/4	←					12.1	11.2	9.6
1	←						20.6	19.5
1 1/4	←							31.3
Pressure Available for Friction[3] - 30 psi								
3/4	←						12.1	10.7
1	←							20.6
1 1/4	←							31.3
Pressure Available for Friction[3] - 35 psi								
3/4	←						12.1	11.5
1	←							20.6
1 1/4	←							31.3
Pressure Available for Friction[3] - 40 psi								
3/4	←							12.1
1	←							20.6
1 1/4	←							31.3
Pressure Available for Friction[3] - 45 psi								
3/4	←							12.1
1	←							20.6
1 1/4	←							31.3

(Continued)

Table No. E.3 (b) (Continued)

NOMINAL PIPE SIZE, IN.	EQUIVALENT LENGTH OF LINE, FT.[1]							
	10	20	40	60	80	100	150	200
	FLOW RATE, GPM[2]							
Pressure Available for Friction[3] - 50 psi								
3/4	←							12.1
1	←							20.6
1 1/4	←							31.3
Pressure Available for Friction[3] - 60 psi								
3/4	←							12.1
1	←							20.6
1 1/4	←							31.3
Pressure Available for Friction[3] - 70 psi								
3/4	←							12.1
1	←							20.6
1 1/4	←							31.3

[1]Developed length of primary circuit plus equivalent length of fittings.
[2]Values may be interpolated according to length.
[3]Minimum static pressure at source minus pressure drop due to elevation, minus pressure drop due to water meter and certain other equipment in BDC, minus minimum allowable flow pressure at highest and most remote fixture.
NOTE: Limiting flow rates corresponding to a velocity of 8 fps. See Table No. E.4 for hydraulic formula.

Table No. E.3 (c)
MAXIMUM FLOW RATES, *Q*, WHICH YIELD VELOCITIES NOT EXCEEDING 8 fps AT INDICATED AVAILABLE PRESSURES COPPER WATER TUBE, TYPE M (ASTM B 88) WATER-SERVICE PIPE

NOMINAL PIPE SIZE, IN.	EQUIVALENT LENGTH OF LINE, FT.[1]							
	10	20	40	60	80	100	150	200
	FLOW RATE, GPM[2]							
Pressure Available for Friction[3] - 5 psi								
3/4	←	12.9	10.4	8.2	7.1	6.3	5.0	4.2
1	←	21.8	20.8	16.6	19.1	12.5	10.0	8.5
1 1/4	←		32.6	28.5	24.1	21.3	17.1	14.6
Pressure Available for Friction[3] - 10 psi								
3/4	←		12.9	12.2	10.4	9.2	7.4	6.3
1	←			21.8	20.8	18.4	14.7	12.5
1 1/4	←				32.6	30.7	25.1	21.4
Pressure Available for Friction[3] - 15 psi								
3/4	←				12.9	11.5	9.2	7.8
1	←					21.8	18.4	15.7
1 1/4	←					32.6	31.5	27.0
Pressure Available for Friction[3] - 20 psi								
3/4	←					12.9	10.8	9.2
1	←					21.8	21.6	18.4
1 1/4	←						32.6	30.7
Pressure Available for Friction[3] - 25 psi								
3/4	←					12.9	12.2	10.4
1	←						21.8	20.8
1 1/4	←							32.6
Pressure Available for Friction[3] - 30 psi								
3/4	←						12.9	11.5
1	←							21.8
1 1/4	←							32.6
Pressure Available for Friction[3] - 35 psi								
3/4	←						12.9	12.5
1	←							21.8
1 1/4	←							32.6
Pressure Available for Friction[3] - 40 psi								
3/4	←							12.9
1	←							21.8
1 1/4	←							32.6
Pressure Available for Friction[3] - 45 psi								
3/4	←							12.9
1	←							21.8
1 1/4	←							32.6

(Continued)

Table No. E.3 (c) (Continued)

NOMINAL PIPE SIZE, IN.	EQUIVALENT LENGTH OF LINE, FT.[1]							
	10	20	40	60	80	100	150	200
	FLOW RATE, GPM[2]							
Pressure Available for Friction[3] - 50 psi								
3/4	←							12.9
1	←							21.8
1 1/4	←							32.6
Pressure Available for Friction[3] - 60 psi								
3/4	←							12.9
1	←							21.8
1 1/4	←							32.6
Pressure Available for Friction[3] - 70 psi								
3/4	←							12.9
1	←							21.8
1 1/4	←							32.6

[1]Developed length of primary circuit plus equivalent length of fittings.
[2]Values may be interpolated according to length.
[3]Minimum static pressure at source minus pressure drop due to elevation, minus pressure drop due to water meter and certain other equipment in BDC, minus minimum allowable flow pressure at highest and most remote fixture.
NOTE: Limiting flow rates corresponding to a velocity of 8 fps. See Table No. E.4 for hydraulic formula.

Table No. E.3 (d)
MAXIMUM FLOW RATES, *Q*, WHICH YIELD VELOCITIES NOT EXCEEDING 10 fps AT INDICATED AVAILABLE PRESSURES STEEL PIPE, STANDARD WALL SCHEDULE 40 (ASTM A 120/A 53) WATER-SERVICE PIPE

NOMINAL PIPE SIZE, IN.	EQUIVALENT LENGTH OF LINE, FT.[1]							
	10	20	40	60	80	100	150	200
	FLOW RATE, GPM[2]							
Pressure Available for Friction[3] - 5 psi								
3/4	16.6	16.2	11.1	8.7	7.5	6.7	5.4	4.6
1	←	26.9	21.0	16.7	14.3	12.7	10.1	8.6
1 1/4	←	46.6	42.5	34.0	29.0	25.8	20.8	17.8
Pressure Available for Friction[3] - 10 psi								
3/4	←	16.6	16.2	12.9	11.1	9.8	7.8	6.7
1	←		26.9	24.3	21.0	18.4	15.0	12.7
1 1/4	←			46.6	42.5	37.5	30.2	25.8
Pressure Available for Friction[3] - 15 psi								
3/4	←			16.6	13.7	12.2	9.8	8.3
1	←			26.9	26.0	23.1	18.4	15.8
1 1/4	←					46.6	37.5	32.2
Pressure Available for Friction[3] - 20 psi								
3/4	←			16.6	16.1	14.2	11.3	9.8
1	←					26.9	21.7	18.4
1 1/4	←					46.6	44.0	37.5
Pressure Available for Friction[3] - 25 psi								
3/4	←				16.6	16.1	13.0	11.1
1	←					26.9	24.5	21.0
1 1/4	←						46.6	42.5
Pressure Available for Friction[3] - 30 psi								
3/4	←					16.6	14.2	12.2
1	←						26.9	23.1
1 1/4	←							46.6
Pressure Available for Friction[3] - 35 psi								
3/4	←					16.6	15.6	13.2
1	←						26.9	25.0
1 1/4	←							46.6
Pressure Available for Friction[3] - 40 psi								
3/4	←						16.6	14.3
1	←							26.9
1 1/4	←							46.6
Pressure Available for Friction[3] - 45 psi								
3/4	←						16.6	15.2
1	←							26.9
1 1/4	←							46.6

(Continued)

Table No. E.3 (d) (Continued)

NOMINAL PIPE SIZE, IN.	EQUIVALENT LENGTH OF LINE, FT.[1]							
	10	20	40	60	80	100	150	200
	FLOW RATE, GPM[2]							
Pressure Available for Friction[3] - 50 psi								
3/4	←						16.6	16.2
1	←							26.9
1 1/4	←							46.6
Pressure Available for Friction[3] - 60 psi								
3/4	←							16.6
1	←							26.9
1 1/4	←							46.6
Pressure Available for Friction[3] - 70 psi								
3/4	←							16.6
1	←							26.9
1 1/4	←							46.6

[1]Developed length of primary circuit plus equivalent length of fittings.
[2]Values may be interpolated according to length.
[3]Minimum static pressure at source minus pressure drop due to elevation, minus pressure drop due to water meter and certain other equipment in BDC, minus minimum allowable flow pressure at highest and most remote fixture.
NOTE: Limiting flow rates corresponding to a velocity of 8 fps. See Table No. E.4 for hydraulic formula.

Table No. E.3 (e)
MAXIMUM FLOW RATES, *Q*, WHICH YIELD VELOCITIES NOT EXCEEDING 12 fps AT INDICATED AVAILABLE PRESSURES POLYETHYLENE PE SCHEDULE 40 PIPE (ASTM D 2447) CHLORINATED POLYVINYL CHLORIDE CPVC SCHEDULE 40 PIPE (ASTM F 441) WATER-SERVICE PIPE

NOMINAL PIPE SIZE, IN.	EQUIVALENT LENGTH OF LINE, FT.[1]							
	10	20	40	60	80	100	150	200
	FLOW RATE, GPM[2]							
Pressure Available for Friction[3] - 5 psi								
3/4	←	20.0	11.1	8.7	7.5	6.7	5.4	4.6
1	←	32.2	21.0	16.7	14.3	12.7	10.1	8.6
1 1/4	←	56.0	42.5	34.0	29.0	25.8	20.8	17.8
Pressure Available for Friction[3] - 10 psi								
3/4	←	20.0	16.2	12.9	11.1	9.8	7.8	6.7
1	←	32.2	30.5	24.3	21.0	18.4	15.0	12.7
1 1/4	←	56.0	50.0	42.5	37.5	30.2	25.8	
Pressure Available for Friction[3] - 15 psi								
3/4	←	20.0	16.2	13.7	12.2	9.8	8.3	
1	←	32.2	30.5	26.0	23.1	18.4	15.8	
1 1/4	←	56.0	53.0	47.0	37.5	32.2		
Pressure Available for Friction[3] - 20 psi								
3/4	←	20.0	18.8	16.1	14.2	11.3	9.8	
1	←	32.2	30.6	27.0	21.7	18.4		
1 1/4	←	56.0	55.0	44.0	37.5			
Pressure Available for Friction[3] - 25 psi								
3/4	←	20.0	18.3	16.1	13.0	11.1		
1	←	32.2	30.4	24.5	21.0			
1 1/4	←	56.0	50.0	42.5				
Pressure Available for Friction[3] - 30 psi								
3/4	←	20.0	17.8	14.2	12.2			
1	←	32.2	27.0	23.1				
1 1/4	←	56.0	55.0	47.0				
Pressure Available for Friction[3] - 35 psi								
3/4	←	20.0	19.5	15.6	13.2			
1	←	32.2	29.5	25.0				
1 1/4	←	56.0	51.0					
Pressure Available for Friction[3] - 40 psi								
3/4	←	20.0	16.7	14.3				
1	←	32.2	31.8	27.2				
1 1/4	←	56.0	55.0					
Pressure Available for Friction[3] - 45 psi								
3/4	←	20.0	17.8	15.2				
1	←	32.2	29.0					
1 1/4	←	56.0						

(Continued)

Table No. E.3 (e) (Continued)

NOMINAL PIPE SIZE, IN.	EQUIVALENT LENGTH OF LINE, FT.[1]							
	10	20	40	60	80	100	150	200
	FLOW RATE, GPM[2]							
Pressure Available for Friction[3] - 50 psi								
3/4	←					20.0	18.1	16.1
1	←						32.2	30.5
1 1/4	←							56.0
Pressure Available for Friction[3] - 60 psi								
3/4	←						20.0	18.1
1	←							32.2
1 1/4	←							56.0
Pressure Available for Friction[3] - 70 psi								
3/4	←						20.0	19.5
1	←							32.2
1 1/4	←							56.0

[1]Developed length of primary circuit plus equivalent length of fittings.
[2]Values may be interpolated according to length.
[3]Minimum static pressure at source minus pressure drop due to elevation, minus pressure drop due to water meter and certain other equipment in BDC, minus minimum allowable flow pressure at highest and most remote fixture.
NOTE: Limiting flow rates corresponding to a velocity of 8 fps. See Table No. E.4 for hydraulic formula.

Table No. E.3 (f)
MAXIMUM FLOW RATES, *Q*, WHICH YIELD VELOCITIES NOT EXCEEDING 12 fps AT INDICATED AVAILABLE PRESSURES POLYETHYLENE PB SDR 11 TUBING (ASTM D 3309) CHLORINATED POLYVINYL CHLORIDE CPVC SDR 11 TUBING (ASTM D 2846) WATER-SERVICE PIPE

NOMINAL PIPE SIZE, IN.	EQUIVALENT LENGTH OF LINE, FT.[1]							
	10	20	40	60	80	100	150	200
	FLOW RATE, GPM[2]							
Pressure Available for Friction[3] - 5 psi								
3/4	15.0	11.0	7.6	6.0	5.2	4.6	3.6	3.1
1	24.9	21.3	14.6	11.7	10.0	8.8	7.1	6.1
1 1/4	37.2	36.0	24.8	19.8	17.0	15.0	12.0	10.3
Pressure Available for Friction[3] - 10 psi								
3/4	←	15.0	11.0	8.8	7.6	6.7	5.4	4.6
1	←	24.9	21.3	17.1	14.6	13.0	10.3	8.9
1 1/4	←	37.2	36.0	29.0	24.8	22.0	17.5	15.0
Pressure Available for Friction[3] - 15 psi								
3/4	←	←	15.0	11.0	9.4	8.3	6.7	5.7
1	←	←	24.9	21.3	18.2	16.1	13.0	11.1
1 1/4	←	←	37.2	36.0	31.0	27.5	22.0	18.7
Pressure Available for Friction[3] - 20 psi								
3/4	←	←	15.0	12.9	11.0	9.7	7.7	6.7
1	←	←	←	24.9	21.3	19.0	15.1	13.0
1 1/4	←	←	←	37.2	36.0	32.0	25.7	22.0
Pressure Available for Friction[3] - 25 psi								
3/4	←	←	15.0	14.5	12.3	11.0	8.8	7.6
1	←	←	←	24.9	24.1	21.3	17.1	14.6
1 1/4	←	←	←	←	37.2	36.0	29.0	24.8
Pressure Available for Friction[3] - 30 psi								
3/4	←	←	←	15.0	13.2	12.2	9.7	8.3
1	←	←	←	←	24.9	23.6	19.0	16.1
1 1/4	←	←	←	←	←	37.2	32.0	27.5
Pressure Available for Friction[3] - 35 psi								
3/4	←	←	←	←	15.0	13.2	10.6	9.1
1	←	←	←	←	←	24.9	20.6	17.6
1 1/4	←	←	←	←	←	37.2	35.0	29.6
Pressure Available for Friction[3] - 40 psi								
3/4	←	←	←	←	←	15.0	11.3	9.7
1	←	←	←	←	←	24.9	22.2	19.0
1 1/4	←	←	←	←	←	←	37.2	32.0
Pressure Available for Friction[3] - 45 psi								
3/4	←	←	←	←	←	15.0	12.2	10.4
1	←	←	←	←	←	24.9	23.6	20.2
1 1/4	←	←	←	←	←	←	37.2	34.2

(Continued)

Table No. E.3 (f) (Continued)

NOMINAL PIPE SIZE, IN.	EQUIVALENT LENGTH OF LINE, FT.[1] 10	20	40	60	80	100	150	200
	FLOW RATE, GPM[2]							
Pressure Available for Friction[3] - 50 psi								
3/4	←	←	←	←	←	15.0	12.9	11.0
1	←	←	←	←	←	24.9	21.3	
1 1/4	←	←	←	←	←	37.2	36.0	
Pressure Available for Friction[3] - 60 psi								
3/4	←	←	←	←	←	15.0	14.3	12.2
1	←	←	←	←	←	24.9	23.7	
1 1/4	←	←	←	←	←		37.2	
Pressure Available for Friction[3] - 70 psi								
3/4	←	←	←	←	←	15.0	13.3	
1	←	←	←	←	←		24.9	
1 1/4	←	←	←	←	←		37.2	

[1]Developed length of primary circuit plus equivalent length of fittings.
[2]Values may be interpolated according to length.
[3]Minimum static pressure at source minus pressure drop due to elevation, minus pressure drop due to water meter and certain other equipment in BDC, minus minimum allowable flow pressure at highest and most remote fixture.
NOTE: Limiting flow rates corresponding to a velocity of 8 fps. See Table No. E.4 for hydraulic formula.

Table No. E.4
MAXIMUM FLOW RATES,[1] *Q*, FOR VARIOUS PIPING MATERIALS WHICH YIELD FRICTION LOSSES NOT EXCEEDING INDICATED VALUES AT VELOCITIES NOT EXCEEDING MAXIMUM RECOMMENDED VALUES[2] IN HOT AND COLD BUILDING MAINS, PRIMARY BRANCHES, AND RISERS OF THE WATER-DISTRIBUTION SYSTEM

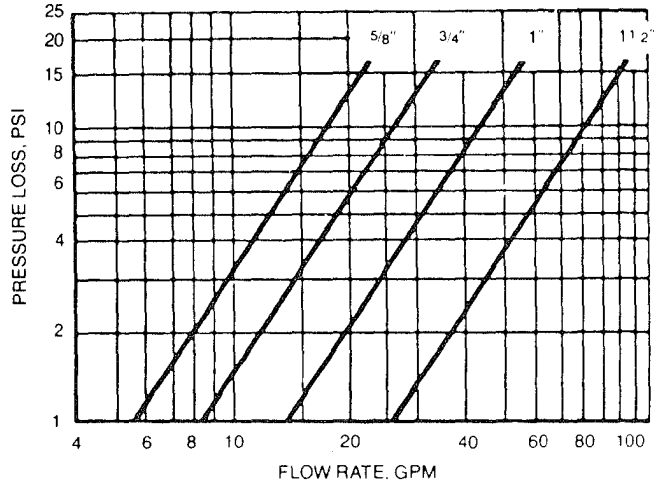
NOMINAL PIPE SIZE, IN.	FRICTION LOSS DESIGN FACTOR, HEAD IN LBS. PER SQ. IN. PER 100 FT. OF LENGTH, Δp													
	2	3	4	5	10	15	20	30	40	50	60	70	80	100
	FLOW RATE, GPM[3]													
Copper Water Tube—Type K, ASTM B 88														
1/2	1.2	1.5	1.8	2.0	3.0	3.7	4.3							5.4
3/4	3.1	3.9	4.5	5.1	7.5	9.4								10.9
1	6.6	8.2	9.7	10.9	15.9									19.4
1 1/4	12.0	15.0	17.4	19.8	20.8									30.3
Copper Water Tube—Type L, ASTM B 88														
1/2	1.4	1.7	2.0	2.3	3.3	4.1	4.8							5.8
3/4	3.6	4.4	4.6	5.8	8.4	10.7								12.1
1	7.2	8.9	10.4	11.6	17.1									20.6
1 1/4	12.6	15.8	18.3	20.2	29.1									31.3
Copper Water Tube—Type M, ASTM B 88														
1/2	1.3	1.9	2.2	2.5	3.7	4.6	5.4							6.3
3/4	3.9	4.8	5.6	6.3	9.2	11.5								12.9
1	7.7	9.7	11.3	12.5	18.4									21.8
1 1/4	13.2	16.3	19.0	21.3	30.7									32.6
Steel Pipe—Standard Wall Schedule 40, ASTM A 120/A53														
1/2	1.9	2.4	2.8	3.2	4.7	5.9	6.8	8.5						9.4
3/4	4.1	5.0	5.9	6.7	9.8	12.2	14.2							16.6
1	7.7	9.5	11.2	12.7	18.4	23.1								26.9
1 1/4	15.6	19.5	22.7	25.8	37.5									46.6

Table No. E.4 (Continued)
MAXIMUM FLOW RATES,[1] *Q*, FOR VARIOUS PIPING MATERIALS WHICH YIELD FRICTION LOSSES NOT EXCEEDING INDICATED VALUES AT VELOCITIES NOT EXCEEDING MAXIMUM RECOMMENDED VALUES[2] IN HOT AND COLD BUILDING MAINS, PRIMARY BRANCHES, AND RISERS OF THE WATER-DISTRIBUTION SYSTEM

NOMINAL PIPE SIZE, IN.	2	3	4	5	10	15	20	30	40	50	60	70	80	100
	FLOW RATE, GPM[3]													
Polybutylene (PB) Tubing—SDR 11, ASTM D3309 Chlorinated Polyvinyl Chloride (CPVC) Tubing—SDR 11, ASTM D2846														
1/2	1.1	1.4	1.6	1.8	2.6	3.2	3.8	4.8	5.6	6.0	6.3	6.7	7.0	7.4
3/4	2.8	3.5	4.0	4.6	6.7	8.3	9.7	12.2						15.0
1	5.4	6.7	7.8	8.8	13.0	16.1	19.0	23.6						24.9
1 1/4	9.1	11.4	13.3	15.0	22.0	27.9	32.0							37.2
Chlorinated Polyvinyl Chloride (CPVC) Pipe—Schedule 40, ASTM F441 Polyethylene (PE) Pipe— Schedule 40, ASTM D2104														
1/2	1.9	2.4	2.8	3.2	4.7	5.9	6.8	8.5	10.0	10.7	11.3			11.4
3/4	4.1	5.0	5.9	6.7	9.8	12.2	14.2	17.6						19.9
1	7.7	9.5	11.2	12.7	18.4	23.1	27.0							32.2
1 1/4	15.6	19.5	22.7	25.8	37.5	47.0	55.0							56.0

[1]Flow rates calculated for "Fairly Smooth Condition."
[2]Limiting rates correspond to 8 fps for copper, 10 fps for steel and 12 fps for plastics. Values may be interpolated between columns.
[3]$Q = 4.57\ \Delta p^{0.0546}\ D^{2.64}$, where:
Q is in gpm.
Δp is in psi 100 feet.
D is in inches, I.D.

Figure No. E.1
PRESSURE LOSS IN COLD-WATER METERS, DISPLACEMENT TYPE (AWWA C700-77)



NOTE: Curves based on the assumption that pressure loss is proportional to the square of the flow rate.

Figure No. E.2
DEMAND FLOW RATE AS A FUNCTION OF FIXTURE-UNIT LOAD

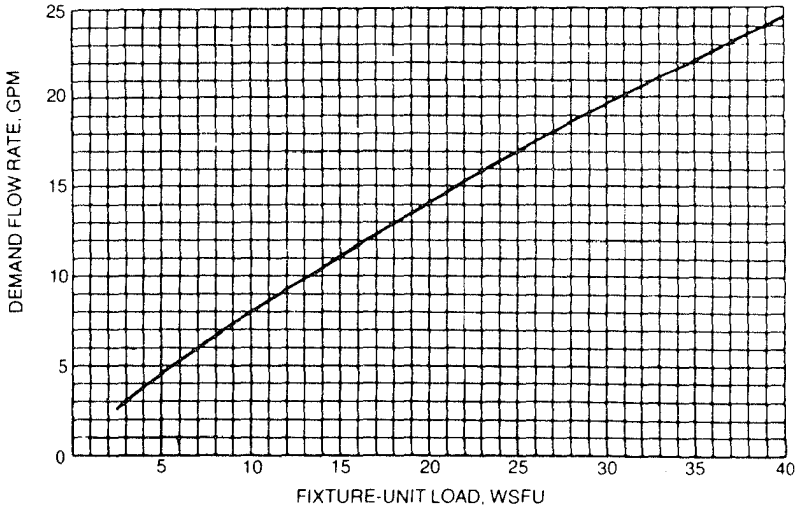


Figure No. E.3 (a)
PRESSURE LOSS (FRICTION) AS A FUNCTION OF FLOW-RATE MATERIAL: COPPER WATER TUBE—TYPE K, ASTM B 88

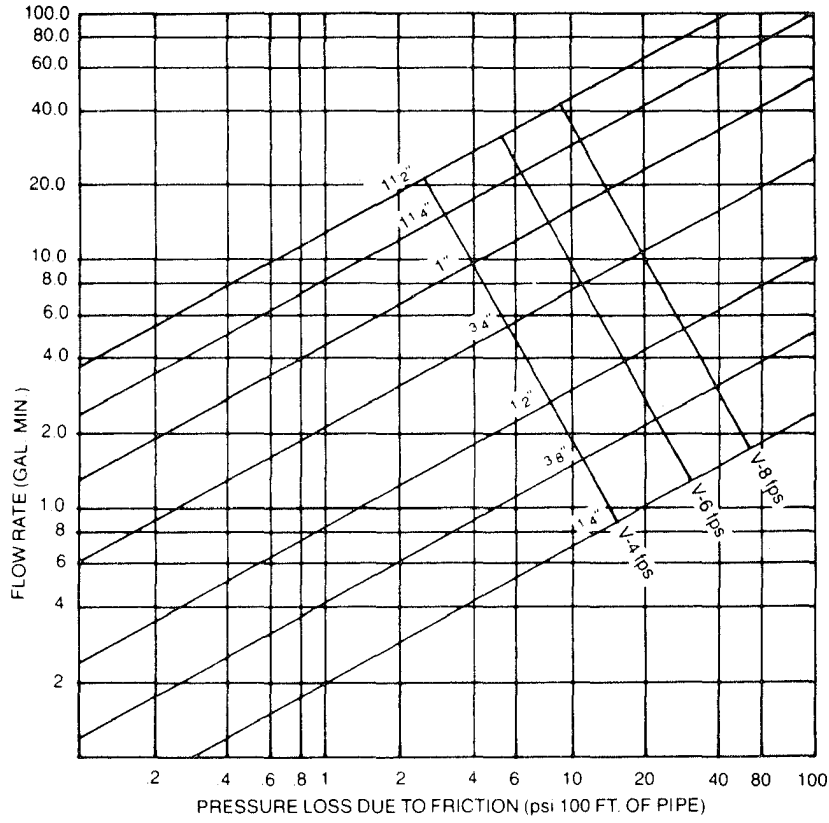


Figure No. E.3. (b)
PRESSURE LOSS (FRICTION) AS A FUNCTION OF FLOW-RATE MATERIAL: COPPER WATER TUBE—TYPE L, ASTM B 88

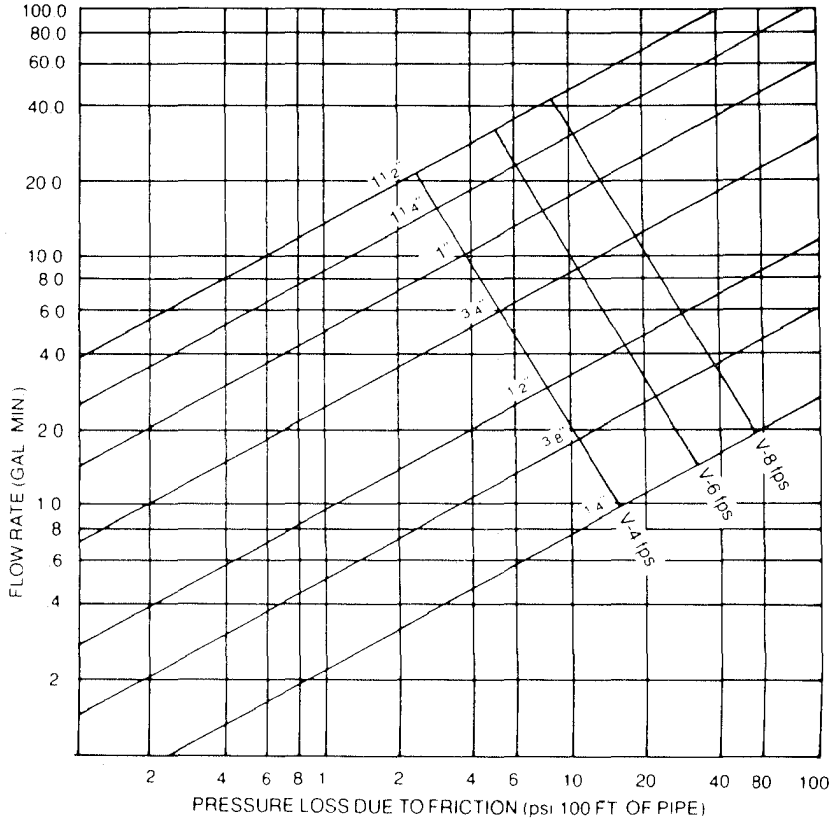


Figure No. E.3. (c)
PRESSURE LOSS (FRICTION) AS A FUNCTION OF FLOW-RATE MATERIAL: COPPER WATER TUBE—TYPE M, ASTM B 88

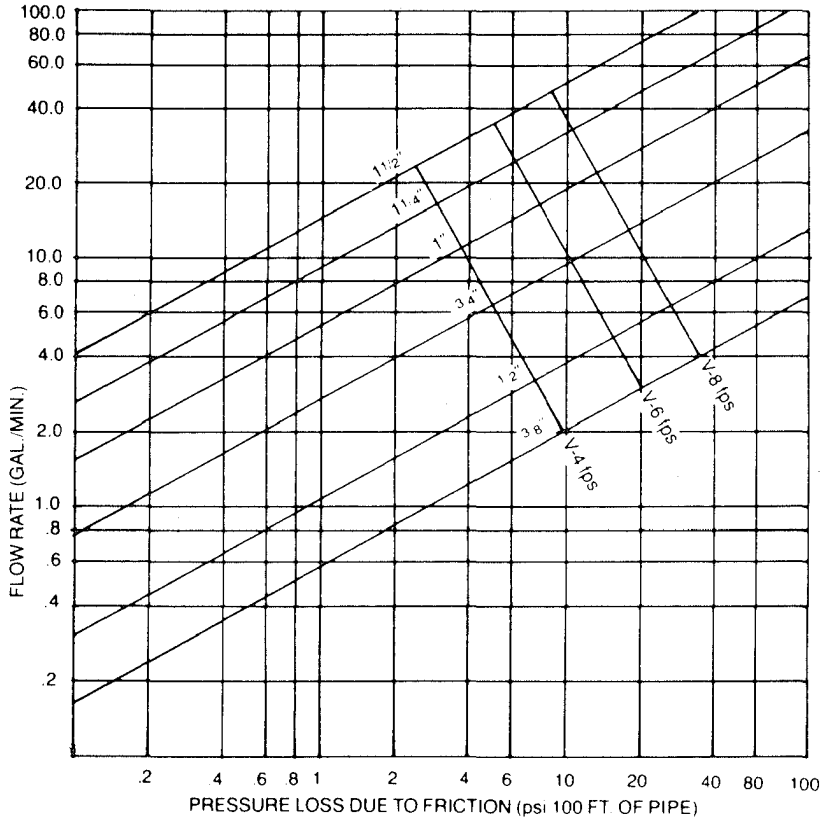


Figure No. E.3. (d)
PRESSURE LOSS (FRICTION) AS A FUNCTION OF FLOW-RATE MATERIAL: STEEL STANDARD WEIGHT PIPE ASTM A 120/A 53

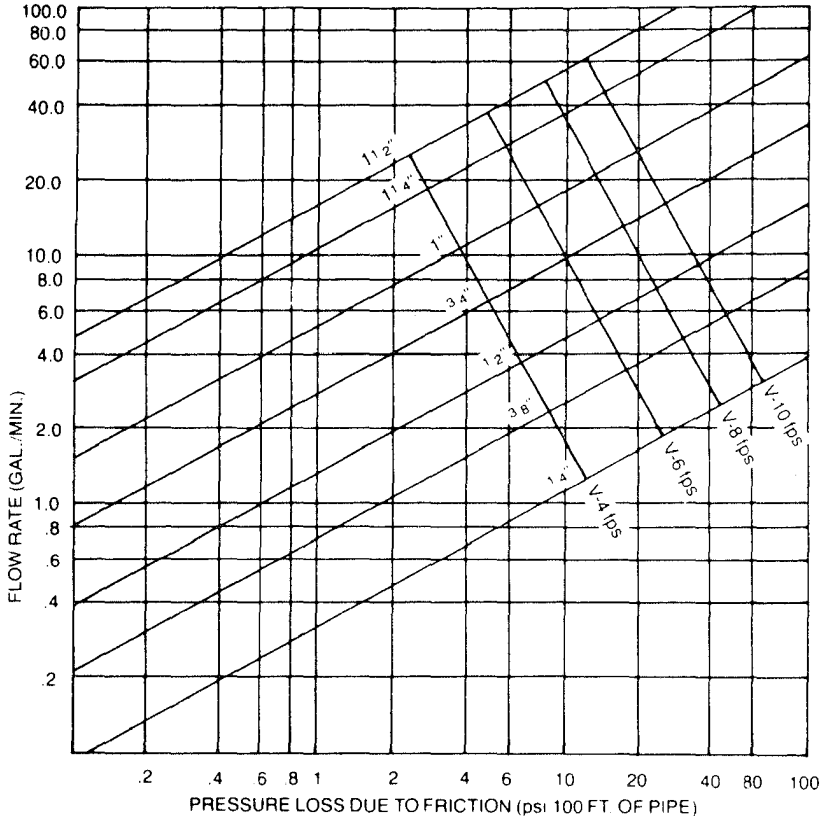


Figure No. E.3. (e)
PRESSURE LOSS (FRICTION) AS A FUNCTION OF FLOW-RATE MATERIAL: CPVC PIPE, SCHEDULE 40, ASTM F 441 OR PE PIPE, SCHEDULE 40, ASTM D 2447

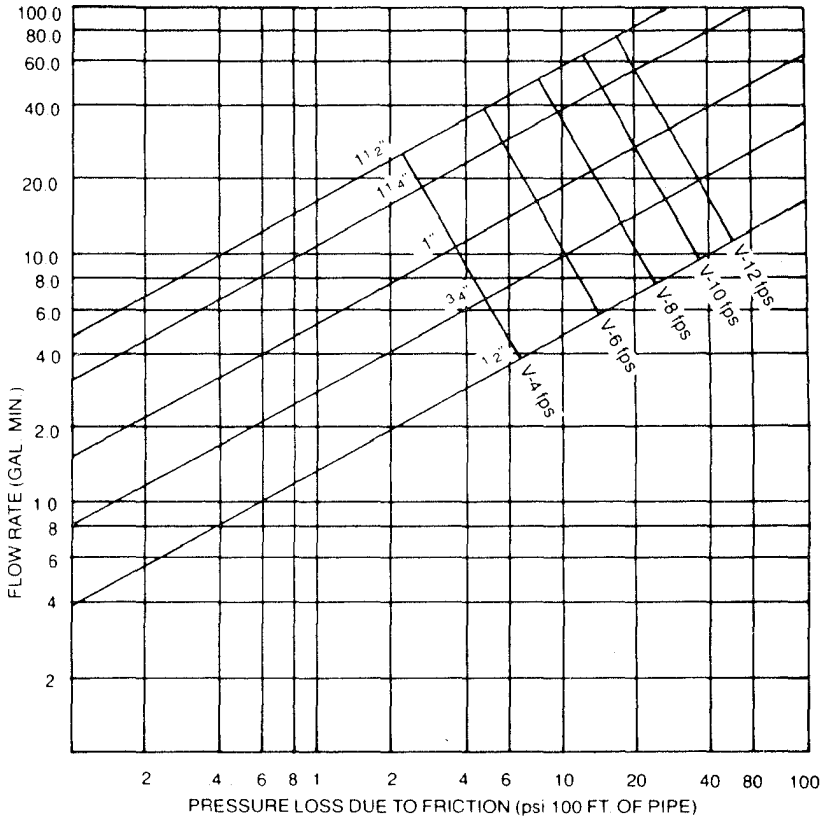
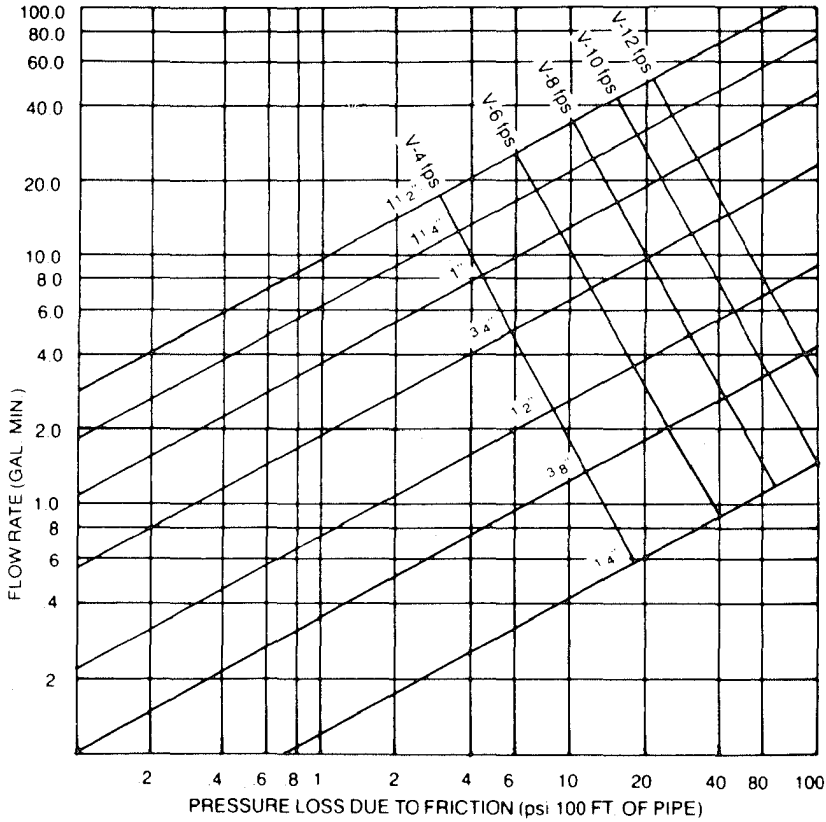


Figure No. E.3. (f)
PRESSURE LOSS (FRICTION) AS A FUNCTION OF FLOW-RATE MATERIAL: POLYBUTYLENE TUBING, SDR-11, ASTM D 3309 OR CPVC TUBING, SDR-11, ASTM D 2846



Appendix F
BARRIERS FOR SWIMMING POOLS, SPAS AND HOT TUBS

Section F-101 Application

The provisions of this chapter shall control the design of barriers for residential swimming pools, spas and hot tubs. These design controls are intended to provide protection against potential drownings and near-drownings by restricting access to swimming pools, spas and hot tubs.

Section F-102 Definitions

For the purposes of these requirements, the terms used shall be defined as follows and as set forth in Section R-118.

Above-ground/on-ground pool: See definition of swimming pool.

Barrier: A fence, a wall, a building wall or a combination thereof which completely surrounds the swimming pool and obstructs access to the swimming pool.

Hot tub: See definition of swimming pool.

In-ground pool: See definition of swimming pool.

Residential: That which is situated on the premises of a detached one-or two-family dwelling or a one-family townhouse not more than three stories in height.

Spa, nonportable: See definition of swimming pool.

Spa, portable: A nonpermanent structure intended for recreational bathing, in which all controls, water-heating and water-circulating equipment are an integral part of the product and which is cord-connected (not permanently electrically wired).

Swimming pool: Any structure intended for swimming or recreational bathing that contains water over 24 inches deep. This includes in-ground, above-ground and on-ground swimming pools, hot tubs and spas.

Swimming pool, indoor: A swimming pool which is totally contained within a structure and surrounded on all four sides by walls of said structure.

Swimming pool, outdoor: Any swimming pool which is not an indoor pool.

Section F-103 Requirements

F-103.1 Outdoor swimming pool: An outdoor swimming pool, including an in-ground, above-ground or on-ground pool, hot tub or spa shall be provided with a barrier which shall comply with the following:

1. The top of the barrier shall be at least 48 inches above grade measured on the side of the barrier which faces away from the swimming pool. The maximum vertical clearance between grade and the bottom of the barrier shall be 2 inches measured on the side of the barrier which faces away from the swimming pool. Where the

top of the pool structure is above grade, such as an above-ground pool, the barrier may be at ground level, such as the pool structure, or mounted on top of the pool structure. Where the barrier is mounted on top of the pool structure, the maximum vertical clearance between the top of the pool structure and the bottom of the barrier shall be 4 inches.

2. Openings in the barrier shall not allow passage of a 4-inch diameter sphere.
3. Solid barriers which do not have openings, such as a masonry or stone wall, shall not contain indentations or protrusions except for normal construction tolerances and tooled masonry joints.
4. Where the barrier is composed of horizontal and vertical members and the distance between the tops of the horizontal members is less than 45 inches, the horizontal members shall be located on the swimming pool side of the fence. Spacing between vertical members shall not exceed 1 3/4 inches in width. Where there are decorative cutouts within vertical members, spacing within the cutouts shall not exceed 1 3/4 inches in width.
5. Where the barrier is composed of horizontal and vertical members and the distance between the tops of the horizontal members is 45 inches or more, spacing between vertical members shall not exceed 4 inches. Where there are decorative cutouts within vertical members, spacing within the cutouts shall not exceed 1 3/4 inches in width.
6. Maximum mesh size for chain link fences shall be a 1 1/4-inch square unless the fence is provided with slats fastened at the top or the bottom which reduce the openings to not more than 1 3/4 inches.
7. Where the barrier is composed of diagonal members, such as a lattice fence, the maximum opening formed by the diagonal members shall not be more than 1 3/4 inches.
8. Access gates shall comply with the requirements of Section F-103.1, Items 1 through 7, and shall be equipped to accommodate a locking device. Pedestrian access gates shall open outward away from the pool and shall be self-closing and have a self-latching device. Gates other than pedestrian access gates shall have a self-latching device. Where the release mechanism of the self-latching device is located less than 54 inches from the bottom of the gate, the release mechanism and openings shall comply with the following:
   a. The release mechanism shall be located on the pool side of the gate at least 3 inches below the top of the gate; and
   b. The gate and barrier shall have no opening greater than 1/2 inch within 18 inches.of the release mechanism.
9. Where a wall of a dwelling serves as part of the barrier one of the following conditions shall be met:
   a. The pool shall be equipped with a powered safety cover in compliance with ASTM ES13-89; or

b. All doors with direct access to the pool through that wall shall be equipped with an alarm which produces an audible warning when the door and its screen, if present, are opened. The alarm shall sound continuously for a minimum of 30 seconds immediately after the door is opened and be capable of being heard throughout the house during normal household activities. The alarm shall automatically reset under all conditions. The alarm system shall be equipped with a manual means, such a touchpad or switch, to temporarily deactivate the alarm for a single opening. Such deactivation shall last for not more than 15 seconds. The deactivation switch(es) shall be located at least 54 inches above the threshold of the door; or

c. Other means of protection, such as self-closing doors with self-latching devices, which are approved by the governing body, shall be acceptable so long as the degree of protection afforded is not less than the protection afforded by (a) or (b) described above.

10. Where an above-ground pool structure is used as a barrier or where the barrier is mounted on top of the pool structure, and the means of access is a ladder or steps, then:

a. The ladder or steps shall be capable of being secured, locked or removed to prevent access; or

b. The ladder or steps shall be surrounded by a barrier which meets the requirements of Section F- 103.1, Items 1 through 9. When the ladder or steps are secured, locked or removed, any opening created shall not allow the passage of a 4-inch diameter sphere.

F-103.2 Indoor swimming pool: All walls surrounding an indoor swimming pool shall comply with Section F-103.1, Item 9.

F-103.3 Prohibited locations: Barriers shall be located so as to prohibit permanent structures, equipment or similar objects from being used to climb the barriers.

Section F-104 Exemptions

A portable spa with a safety cover which complies with ASTM ES13 entitled "Emergency Standard Performance Specification for Safety Covers and Labeling Requirements for All Covers for Swimming Pools, Spas, and Hot Tubs," 1989 edition, shall be exempt from the provisions of this chapter. Swimming pools, hot tubs and nonportable spas with safety covers shall not be exempt from the provisions of this chapter.

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