North Carolina State Building Code

Volume VII – RESIDENTIAL

1995 CABO MODEL
One and Two Family Dwelling Code
with
North Carolina Amendments

1997 EDITION

1998 REVISIONS
1999 REVISIONS

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North Carolina Building Code Council

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UNDER THE
NATIONALLY RECOGNIZED MODEL CODES

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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 Workman Mill Road
Whittier, California 90601-2298

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

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Post Office Box 26387
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NORTH CAROLINA STATE
BUILDING CODE PUBLICATIONS

The Building Code Council shall cause to be printed all amendments to the Codes. Such amendments shall be published and available for distribution by December 1 each year. Please request a new order form each November. Amendments to the code adopted from July 1, 1998 through July 1, 2001 will become effective January 1, 2002 provided, however, that:

(1) The Building Code Council may specify any other effective date that it considers appropriate for amendments deemed necessary.

(2) The provisions of any amendment shall be accepted as an alternate method of construction or alternate materials prior to the effective date if requested by the owner or his agent.

Available from:

North Carolina Department of Insurance
Code Council Section
P. O. Box 26387
Raleigh, North Carolina 27611
(919) 733-3901

OFFICE LOCATED AT:
410 North Boylan Avenue
Raleigh, NC

Volume I–GENERAL CONSTRUCTION CODE

Volume IA–ADMINISTRATION & ENFORCEMENT REQUIREMENTS

Volume IC–ACCESSIBILITY CODE

Volume II–PLUMBING CODE

Volume III–MECHANICAL CODE

Volume IV–ELECTRICAL CODE

Volume V–FIRE PREVENTION CODE

Volume VI–GAS CODE

Volume VII–RESIDENTIAL CODE

Volume VIII–MODULAR CONSTRUCTION REQUIREMENTS

Volume IX–EXISTING BUILDINGS

Volume X–ENERGY

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CHAPTER 1
GENERAL ADMINISTRATION

SECTION 101
TITLE

101.1 One and Two Family Dwelling Code. These provisions shall be known as the One and Two Family Dwelling Code, may be cited as such, and will be referred to herein as "this code."

SECTION 102
PURPOSE

102.1 Minimum standards. The purpose of this code is to provide minimum standards for the protection of life, limb, health, property, environment and for the safety and welfare of the consumer, general public, and the owners and occupants of residential buildings regulated by this code.

SECTION 103
SCOPE

103.1 Application. The provisions of the code apply to the construction, addition prefabrication, alteration, repair, use, occupancy and maintenance of detached one-and two-family dwellings and one-family townhouses not more than three stories in height, and their accessory structures. Accessory buildings with any dimension greater than twelve (12) feet are required to meet the provisions of this code. Accessory buildings may be constructed without a masonry or concrete foundation provided all of the following conditions are met:

1. the building shall not exceed 400 sq. ft. or one story in height;
2. the building is supported on a wood foundation of a minimum 2 x 6 or 3 x 4 mud sill of approved wood in accordance with Section 322; and,
3. the building is anchored to resist overturning and sliding by installing a minimum of one ground anchor at each corner of the building. The total resisting force of all anchors shall be equal to 20 psf times the plan area of the building.

SECTION 104
AUTHORITY

104.1 General. The building official is hereby authorized and directed to administer and enforce all of the provisions of this code. The building official is further authorized to render interpretations of this code, which are consistent with the spirit and intent of this code.

104.2 Referenced standards. The standards referenced in this code and listed in Chapter 43 shall be considered part of the requirements of this code to the prescribed extent of each such reference. Where differences occur between provisions of this code and referenced standards, the provisions of this code shall apply.

SECTION 105
ENTRY

105.1 Authority to enter. Whenever necessary to make an inspection under a permit issued, the building official shall have the right to enter the building or premises. Whenever the building official has reasonable cause to believe that there exists any condition or code violation which makes a building or premises unsafe, dangerous or hazardous, the building official may enter such building or premises. The building official shall present proper credentials and request entry provided such building or premises is occupied. If such building or premises is unoccupied, the building official shall make a reasonable effort to locate the owner or other persons having charge or control of such and request entry. If entry is refused, the building official shall have recourse to every remedy provided by law to secure entry. When the building official has obtained a proper inspection warrant, as provided by law, no owner or occupant or any other persons having control of any building or premises shall fail or neglect to promptly permit entry.

SECTION 106
VIOLATIONS AND PENALTIES

106.1 Unlawful action. It shall be unlawful for any person, firm or corporation whether as owner, lessee, sub-lessee or occupant to erect, construct, enlarge, alter, repair, improve, remove, convert, demolish, equip, use, occupy or maintain any one-and two-family dwelling in the jurisdiction or cause or permit the same to be done, contrary to or in violation of any of the provisions of this code.

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 of the provisions of this code.

106.3 Partial invalidity. 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.

106.4 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 107
RIGHT OF APPEAL

107.1 General. Any person may appeal an order, decision, or determination of a building official pertaining to the code or any state building law by filing written notice or telephone call to the North Carolina Department of Insurance, Engineering Division within ten (10) days after the order, decision, or determination. A technical interpretation shall be provided as follows:

Informal interpretations–The Engineering Division shall provide informal technical interpretations on code related matters either by telephone or letter. These informal interpretations may be accepted by the local building official or party requesting such interpretation or either party may request a formal written interpretation of this code.

Formal interpretations–Any person may request in writing a formal interpretation of this code. Such request shall be addressed to the Chief Engineer for the Department of Insurance. The request shall contain the type and size of building in question, the location of the building, and shall reference the code Sections in question. All formal interpretations shall be in writing and shall set forth the facts found and decisions reached. In reaching a formal interpretation, the decision rendered shall be based upon the technical provisions of this code, public health and safety and shall be construed liberally to those ends. A formal written interpretation shall be binding on all parties, unless appealed to the Building Code Council as specified in Section 107.3. Formal interpretations determined to be of a general nature shall be distributed on a regular basis.

107.2 Stop work order appeals. Whenever a stop order has been issued by an inspection department involving alleged violations of this code, the owner or builder may appeal in writing to the Commissioner of Insurance or his designee within five (5) days after the date the order is issued, with a copy of the appeal to the inspection department. No further work may take place in violation of a stop order. The Commissioner or his designee shall promptly conduct an investigation. The inspection department, an owner or the builder shall be permitted to submit relevant evidence for the investigation. The Commissioner of Insurance or his designee shall provide a written statement of the decision setting forth the facts found, the decision reached, and the reasons for the decision. In the event of dissatisfaction with the decision, the person affected shall have the option of appealing as set forth in Section 107.4.

107.3 Building Code Council. The Council shall hear appeals from the decisions of State enforcement agencies relating to any matter related to this code. The appeal process is specified in Volume I-A, Administration and Enforcement.

107.4 Superior Court. Whenever any person desires to make an appeal from a decision of the Building Code Council or from the decision of a State or local enforcement agency, he may take an appeal either to the Wake County Superior Court or to the Superior Court of the county in which the proposed building is to be situated.

SECTION 108
ALTERNATE MATERIALS AND SYSTEMS

108.1 Alternate materials, methods and equipment. 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. Compliance with specific performance-based provisions of the BOCA National Codes, ICBO Uniform Codes or SBCCI Standard Codes, as adopted by the jurisdiction, in lieu of a prescriptive requirement of this code shall also be permitted as an alternate.

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

108.3 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 109
LIABILITY

109.1 Relief from personal responsibility. The building official or the building official'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 judgment 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 110
PERMIT

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.

110.2 Work authorized. Work shall not deviate substantially from that described on the permit documents.

110.3 Information required. An application for a permit shall be filed with the inspection department on a form furnished for that purpose and include the following:

1. a general description of the proposed work;
2. location of proposed work;
3. the signature of the owner, or his authorized agent;
4. the proposed occupancy classification of all parts of the building; and
5. inspection departments shall make available a list of other information which must be submitted with the building permit application.

110.4 Contractors license required. When the General Statutes require that general construction, plumbing, mechanical, electrical, fire protection, or gas work be performed by an appropriately licensed individual, no permit for such type work shall be issued to an unlicensed person or firm. A local governmental entity may require that the person doing the actual work be licensed or hold a journeyman's certification issued by a local board. Such journeyman's certification shall be evidence that the possessor has passed an examination prepared by the local authority indicating that the individual is competent to perform the intended work.

110.5 Action on permits. The inspection department shall act upon an application for a permit without unreasonable or unnecessary delay. If the inspection department is satisfied that the work described in an application conforms to the requirements of this code and other pertinent laws and ordinances, it shall issue a permit to the applicant. If the submittal does not conform to the requirements of this code or other pertinent laws or ordinances, the application shall be returned to the applicant with the reasons for refusal stated.

110.6 Misrepresentation of application. The CEO shall revoke, in writing, a permit or approval, issued under the provisions of this code for:

1. any substantial departure from the approved application, drawings, or specifications;
2. refusal or failure to comply with the requirements of any applicable State or local laws;
3. any false statement or misrepresentation as to the material fact in the application or plans on which the permit or approval was based.

110.7 Prescribed fees. A permit shall not be issued until the fees prescribed by the local governing authority have been paid. Nor shall an amendment to a permit be released until the additional fee, if any, has been paid.

110.8 Work commencing before permit issuance. If any person commences any work on a building or service system before obtaining the necessary permit, he shall be subject to a penalty as established by the local governing body.

110.9 Building permit valuations. If the valuation of a building or service system appears to be underestimated on the application, the permit shall be denied, unless the applicant shows detailed estimates to meet the approval of the inspection department. Permit valuations shall include total cost, such as electrical, gas, mechanical, plumbing equipment, fire protection and other systems, including materials and labor.

110.10 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 for a period of 12 months or more after the work has commenced. Before such work can be commenced or resumed, a permit extension or renewal as required by Section 110.10.1 or 110.10.2 shall be obtained.

110.10.1 Permit extension. A permittee holding an unexpired permit may apply for an extension.

110.10.2 Permit renewal. A permit which has expired for six months or less may be renewed provided no changes have been made in the original plans and specifications for such work.

110.11 Permit validity. The issuances of a permit shall not authorize the violation of any of the provisions of this code.

SECTION 111
PLANS

111.1 Plans required. Building plans shall be drawn to scale and shall be of sufficient clarity to indicate the nature and extent of the work proposed and in conformance with the provisions of this code. A copy of the plans as approved by the building official shall be kept at the building site and available for scheduled inspections. All information, drawings, specifications and accompanying data shall bear the name and address of the person responsible for the design. Plans submitted shall be maintained as public records. Mirror image plans shall be acceptable when submitted with a set printed such that can be read. It shall be within the discretion of the building official to issue permits for minor construction and/or repair work without plans.

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 112
INSPECTION

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. Plans and specifications are to be used as a guide, but the written code text shall prevail.

112.1.1 Footing inspection. To be made after the trenches are excavated, all grade stakes are installed, all reinforcing steel and supports are in place and appropriately tied, all necessary forms are in place and braced and before any concrete is placed.

112.1.2 Under slab inspection (habitable space). To be made after all forms have been placed, all electrical, plumbing and/or heating and air conditioning facilities, all crushed stone, a vapor retarder, all reinforcing steel with supports and tied and/or all welded wire fabric is installed, when required, but before any concrete is placed.

Exception: Inspection is not required for driveway slabs, garage slabs, carport slabs, patio slabs, walks, etc., which are considered as non-habitable spaces.

112.1.3 Foundation inspection. To be made after all foundation supports are installed. This inspection is to check foundation supports, crawl space leveling, ground clearances, and positive drainage, where required.

112.1.4 Rough-in inspection. To be made when all building framing and parts of the electrical, plumbing or heating/ventilation or cooling system that will be hidden from view in the finished building have been placed but before any wall, ceiling finish or building insulation is installed.

112.1.5 Building framing. To be made after the roof, wall, ceiling and floor framing is complete with appropriate blocking, bracing and fire stopping in place. The following items should be in place and visible for inspection:

1. pipes;
2. chimneys and vents;
3. flashing for roofs, chimneys and wall openings;
4. insulation baffles;
5. all lintels required to be bolted to the framing for support shall not be covered by any exterior or interior wall or ceiling finish material before approval. Work may continue without approval for lintels which are bolted and supported on masonry or concrete.

112.1.6 Insulation inspection. To be made after an approved building framing and rough-in inspection, with all insulation and vapor retarders are in place but before any wall or ceiling covering is applied.

112.1.7 Other inspections. In addition to the called inspections above the inspection department may make or require any other inspections to ascertain compliance with this code and other laws enforced by the inspection department.

112.1.8 Certification of compliance certification. To be made for each trade after completion of work authorized under this code. Upon satisfactory completion of a building, plumbing, mechanical, electrical fire protection or gas system, or portion thereof, a Certificate of Compliance shall be issued. This Certificate represents that a structure or system is complete and for certain types of permits is permission granted for connection to a utility system. This Certificate does not grant authority to occupy a building prior to the issuance of a Certificate of Occupancy.

112.1.9 Certificate of compliance/occupancy. To be issued after all the certificate of compliance inspections for each trade are complete, and other local laws are complied with but before occupancy. A new building shall not be occupied or a change made in the occupancy, nature or use of a building or part of a building until after the inspection department has issued a Certificate of Occupancy. Said certificate shall not be issued until all required building and service systems shall have been inspected for compliance with this code and other applicable laws and ordinances and released by the inspection department.

112.1.10 Written release. Work shall not be done on any part of a building or service systems beyond the point indicated in each successive inspection without first obtaining a written release from the inspection department. Such written release shall be given only after an inspection has been made of each successive step in the construction or installation as indicated by each of the foregoing inspections and the construction has been found to comply with all applicable requirements. In the event that a written release cannot be provided due to code violations or incomplete work, the building official shall specifically identify the provisions of the technical code found to be inconsistent with the inspection. Sign-off on the posted permit shall constitute a written release of the successive step indicated.

112.2 Service utilities.

112.2.1 Connection of service utilities. No person shall make connections from a utility, source of energy, fuel or power to any building or system which is regulated by this code until approved by the inspection department and a Certificate of Compliance is issued.

112.2.2 Temporary connection. The inspection department may authorize the temporary connection of the building or system to the utility source of energy or fuel for the purpose of testing building service systems. Temporary electrical power shall be allowed as required by North Carolina State Building Code, Volume IA-Administration and Enforcement.

112.2.3 Authority to disconnect service utilities. The inspection department shall have the authority to require disconnecting a utility service to the building, structure or system regulated by this code in case of emergency or where necessary to eliminate an imminent hazard to life or property. The inspection department shall have the authority to disconnect a utility service when a building has been illegally occupied, entry into the building for purposes of making inspections cannot be readily granted. The inspection department shall notify the serving utility, and whenever possible the owner and/or occupancy of the building, structure or service system of the decision to disconnect prior to taking such action. If not notified prior to disconnecting, the owner or occupant shall be notified in writing within eight (8) working hours.

SECTION 113
PREFABRICATED CONSTRUCTION

113.1 General. 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 112.1.8.

Note: Provisions for foundation systems and building service equipment connections necessary to provide for the installation of new manufactured homes and existing manufactured homes to which additions, alterations or repairs are made are contained in the *"State of North Carolina Regulations for Manufactured/Mobile Homes."*

SECTION 114
SWIMMING POOLS, SPAS AND HOT TUBS

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

SECTION 115
INSPECTION CARD

115.1 Record required. The permit holder or his agent shall post the inspection record on the job site 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 116
EXISTING STRUCTURES

16.1 Continuations of existing use. 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 adoption of this code, provided such continued used is not dangerous to life.

116.2 Additions, alterations or repairs. Additions, alterations or repairs to any structure shall conform to that required of a new structure without requiring the existing structure to comply with all of the requirements of this code, unless otherwise stated. Additions, alterations or repairs shall not cause an existing structure to become unsafe or adversely affect the performance of the building. Any building plus new additions shall not exceed the height in stories specified for new buildings in Section 103.

116.2.1 Structural and fire-resistance rated limits. Alterations or repairs to an existing structure which are structural or adversely affect any structural member or any part of the structure having a required fire-resistance rating shall be made with materials required for a new structure.

SECTION 117
STOP WORK ORDERS

117.1 General. 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. Written notice shall be within eight (8) working hours to stop the work. Appeals to stop work orders are specified in 107.2.

SECTION 118
BUILDING OFFICIAL NOT FULFILLING RESPONSIBILITY

When the local building official does not fulfill their responsibility as specified in this code, the Commissioner of Insurance or his designee may institute any appropriate action or proceedings available.

SECTION 119
CONTRACTORS RESPONSIBILITIES

It shall be the duty of every person who shall contract for the installation or repairs of a building or service system to comply with state or local rules and regulations concerning licensing. It shall further be the contractors' responsibility to conform to this code for all installations or repairs of a building or service system. Violations and penalties of these provisions are listed in Section 106

SECTION 120
EFFECTIVE DATE OF AMENDMENTS

Amendments and revisions adopted by the Building Code Council on or after, July 1, 1998 , but prior to July 1, 2001, shall become effective January 1, 2002. All future revisions and amendments shall be adopted prior to July 1 every three years after July 1, 2001, to become effective the first day of January of the following year.

(1) The Building Code Council may specify and earlier effective date if the amendment is deemed necessary to address an imminent threat to the public's health, safety, or welfare.

(2) The provisions of any amendment shall be accepted by the CEO prior to the effective date if requested by the owner or his agent.

SECTION 121
BUILDING CODE COUNCIL MAILING LIST

An annual subscription fee of $60.00 will be charged for persons interested in being on the mailing list. Annual subscription will provide for the agenda, minutes with code amendments of the Council's meetings, Council Committee meeting notices and formal interpretations made by the Department of Insurance. A check made payable to the N.C. Department of Insurance with mailing information shall be forwarded to the Engineering Division, N.C. Department of Insurance, 410 N. Boylan Avenue, Raleigh, N.C. 27603. In addition to this information, subscribers will also be mailed a new order form when new amendment packages to the codes become available.

SECTION 122
PORTABLE TOILETS

Suitable toilet facilities shall be provided and maintained in a sanitary condition during construction. An adequate number of facilities must be provided for the number of employees at the construction site according to the following:

Number of employees	Minimum Number of Facilities
Less than 20	1 toilet
20 to 200	1 toilet and 1 urinal per 40 workers
More than 200	1 toilet and 1 urinal per 50 workers

There shall be at least one facility for every two contiguous construction sites. Such facilities may be portable, enclosed, chemically treated, tank-tight units. Portable toilets shall be enclosed, screened, and weatherproofed with internal latches. Temporary toilet facilities need not be provided on site for crews on a job site for no more than one working day and having transportation readily available to nearby toilet facilities.

CHAPTER 2
BUILDING DEFINITIONS

SECTION 201
GENERAL

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.

SECTION 202
GENERAL BUILDING DEFINITIONS

ACCESSIBLE. Having access to but which first may require the removal of a panel, door or similar covering of the item described. See Accessible, Readily.

ACCESSIBLE, READILY. Having direct access without the need of removing any panel, door or similar covering of the item described, and without requiring the use of portable ladders, chairs, etc. See Accessible.

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.

ATTIC STORY. Any story situated wholly or partly in the roof, so designated, arranged or built as to be used for storage or habitation. If an attic which is accessible by a fixed stairway has a 7 ft. clear height for greater than 50% of the width of the floor below, then the space shall be considered as a story when determining building height.

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.

DESIGN PROFESSIONAL. An architect or professional engineer legally registered under the laws of this state regulating the practice of architecture or engineering.

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.

FIREPLACE CHIMNEY. A masonry passageway extending from the top of a smoke chamber for the purpose of discharging combustion emission from the firebox to the atmosphere.

FIREPLACE FIREBOX. Consists of a hearth, back and side walls which extend from the hearth to the throat of the smoke chamber.

FIREPLACE SMOKE CHAMBER. That part of a masonry fireplace which extends from the top of the firebox to the start of the chimney flue lining. A smoke chamber shall have a damper and smoke shelf.

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 (1118 mm) above or below the finished grade adjacent to the window.

GRADE PLANE. A reference plane representing the average of the finished ground level adjoining the building at all exterior walls.

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 C 90, C 129 or C 652.

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, when installed in accordance with the manufacturer's installation instructions.

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 (2438 body mm) or more in width or 40 body feet (12 192 body mm) or more in length, or, when erected on site, is 320 or more square feet (30 m2), 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, in effect at the time of manufacture is required. For the purpose of these provisions, a mobile home shall be considered a manufactured home.

MANUFACTURER'S INSTALLATION INSTRUCTIONS. Printed instructions included with equipment as part of the conditions of listing or labeling.

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.

REMOTE EXITS. Remote exits is when doors or stairs are placed a distance apart equal to not less than 1/2 of the length of the maximum overall diagonal dimension of the living area of the building or area served measured in a straight line between the doors or stairs.

SOLID MASONRY. Load-bearing or nonload-bearing construction using masonry units where the net cross-sectional area of cored brick in any plane parallel to the surface containing the cores shall be not less than 75 percent of its gross cross-sectional area. No part of any hole shall be less than 3/4 inch (19.1 mm) from any edge of the brick. Solid masonry units shall conform to ASTM C 55, C 62, C 73, C 145 or C 216.

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 top-most floor and ceiling or roof above.

STORY ABOVE GRADE (see attic story). 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 (1829 mm) above grade plane;
2. More than 6 feet (1829 mm) above the finished ground level for more than 50 percent of the total building perimeter; or
3. More than 12 feet (3658 mm) 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.

WOOD STRUCTURAL PANEL. A structural panel product composed primarily of wood, and meeting the requirements of DOC PS 1 or DOC PS 2. Wood structural panels include all-veneer plywood, composite panels containing a combination of veneer and wood-based material, and mat-formed panels such as oriented strand board and waferboard.

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 3
BUILDING PLANNING

SECTION 301
DESIGN CRITERIA

301.1 Design. Buildings and structures, and all parts thereof, shall be constructed to support safely all loads, including dead loads.

301.2 Climactic and geographic design criteria. Buildings shall be constructed in accordance with the provisions of this code using the design criteria set forth in Table 301.2a. These criteria shall be established by the jurisdiction based solely or in part on the climactic and geographic conditions set forth in Figures 301.2a through 301.2c.

301.3 Dead load. The actual weights of materials and construction shall be used for determining dead load with consideration for the dead load of fixed service equipment.

301.4 Live load. The minimum uniformly distributed live load shall be as provided in Table 301.4. Elevated garage floors shall be capable of supporting a 2,000 pound (8.90 kN) load applied over a 20 square inch (0.0129 $mm^{2)}$ area.

301.5 Roof load. Roof shall be designed for the live load indicated in Table 301.5 or the snow load indicated in Table 301.2a, whichever is greater.

301.6 Deflection. The allowable deflection of any structural member under the live load listed in Sections 301.4 and 301.5 shall not exceed the values in Table 301.6.

SECTION 302
LOCATION ON LOT

302.1 Exterior walls. Exterior walls located less than 3 feet (914 mm) from property lines shall have not less than a one–hour fire–resistive rating. The fire–resistive rating of exterior walls located less than 3 feet (914 mm) from property line shall be rated for exposure from both sides. Projections beyond the exterior wall shall not extend more than 12 inches (305 mm) into areas where openings are prohibited.

302.2 Openings. Openings shall not be permitted in exterior walls of dwellings located less than 3 feet (914 mm) from the property line. This distance shall be measured perpendicular to the vertical plane of the wall.

SECTION 303
LIGHT, VENTILATION AND HEATING

303.1 Habitable rooms. All habitable rooms shall be provided with aggregate glazing area of not less than 8 percent of the total 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 the opening is not required by Section 310 and an approved mechanical ventilation system is provided capable of producing 0.35 air change per hour in the room or a whole–house mechanical ventilation system is installed capable of supplying outdoor ventilation air of 15 cubic feet per minute (cfm) (7.08 L/s) per occupant computed on the basis of two occupants for the first bedroom and one occupant for each additional bedroom.

2. The glazed areas may be omitted in rooms where the opening is not required by Section 310 and an approved mechanical ventilation system is provided capable of producing 0.35 air change per hour in the room or a whole–house mechanical ventilation system is installed capable of supplying outdoor ventilation air of 15 cfm (7.08 L/s) per occupant computed on the basis of two occupants for the first bedroom and one occupant for each additional bedroom, and artificial light is provided capable of producing an average illumination of 6 footcandles (6.46 L/s)) over the area of the room at a height of 30 inches (762 mm) above the floor level.

TABLE 301.2a
CLIMACTIC AND GEOGRAPHIC DESIGN CRITERIA

ROOF LIVE LOAD(pounds per square foot)	WIND PRESSURE[2] (mile per hour)	SEISMIC CONDITION BY ZONE	SUBJECT TO DAMAGE FROM[1]		SUBJECT TO DAMAGE FROM		WINTER DESIGN TEMP. FOR HTG. FACILITIES
			Weathering	Frost Line Depth	Termite	Decay	
20	Fig.301.2b	N/A	Moderate	Local conditions	YES	YES	Local conditions

For **SI:** 1 pound per square foot (psf) = 0.0479 kN/m2.

1. Weathering may require a higher strength concrete or grade of masonry than necessary to satisfy structural requirements of this code. The grade of masonry units shall be determined from ASTM C 34, C 55, C 62, C 73, C 90, C 129, C 145, C 216 or C 652.. The jurisdiction shall fill in the frost line depth column with "yes" or "no" including minimum depth of footing below finish grade.

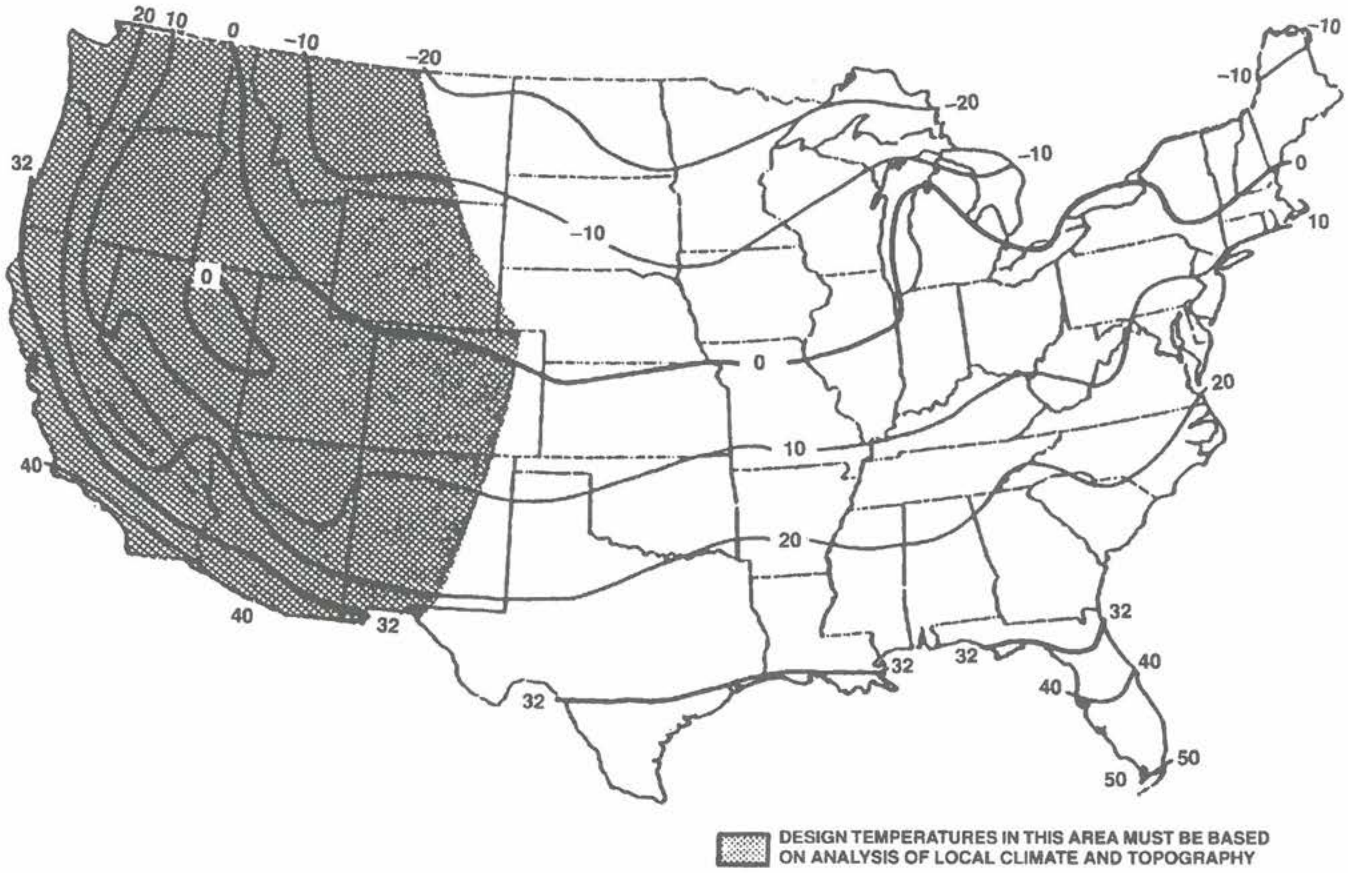
2. The jurisdiction shall fill in this portion of the table with wind design speed determined from the Wind Probability Map (Figure 301.2b)

TABLE 301.4
MINIMUM UNIFORMLY DISTRIBUTED LIVE LOADS
(in pounds per square foot—lb./ft.2)

USE	LIVE LOAD
Balconies (exterior)	40
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
Attics (with fixed stairways)	30
Dwelling units (except sleeping rooms)	40
Sleeping rooms	30
Stairs	40[1]
Guardrails and Handrails (A single concentrated load applied in any direction at any point along the top)	200

For **SI:** 1 psf = 0.0479 kN/m2, 1 square inch = 645 mm2.

1 Individual stair treads shall be designed for the uniformly distributed live load or a 300–pound concentrated load acting over an area of 4 square inches, whichever produces the greater stresses.



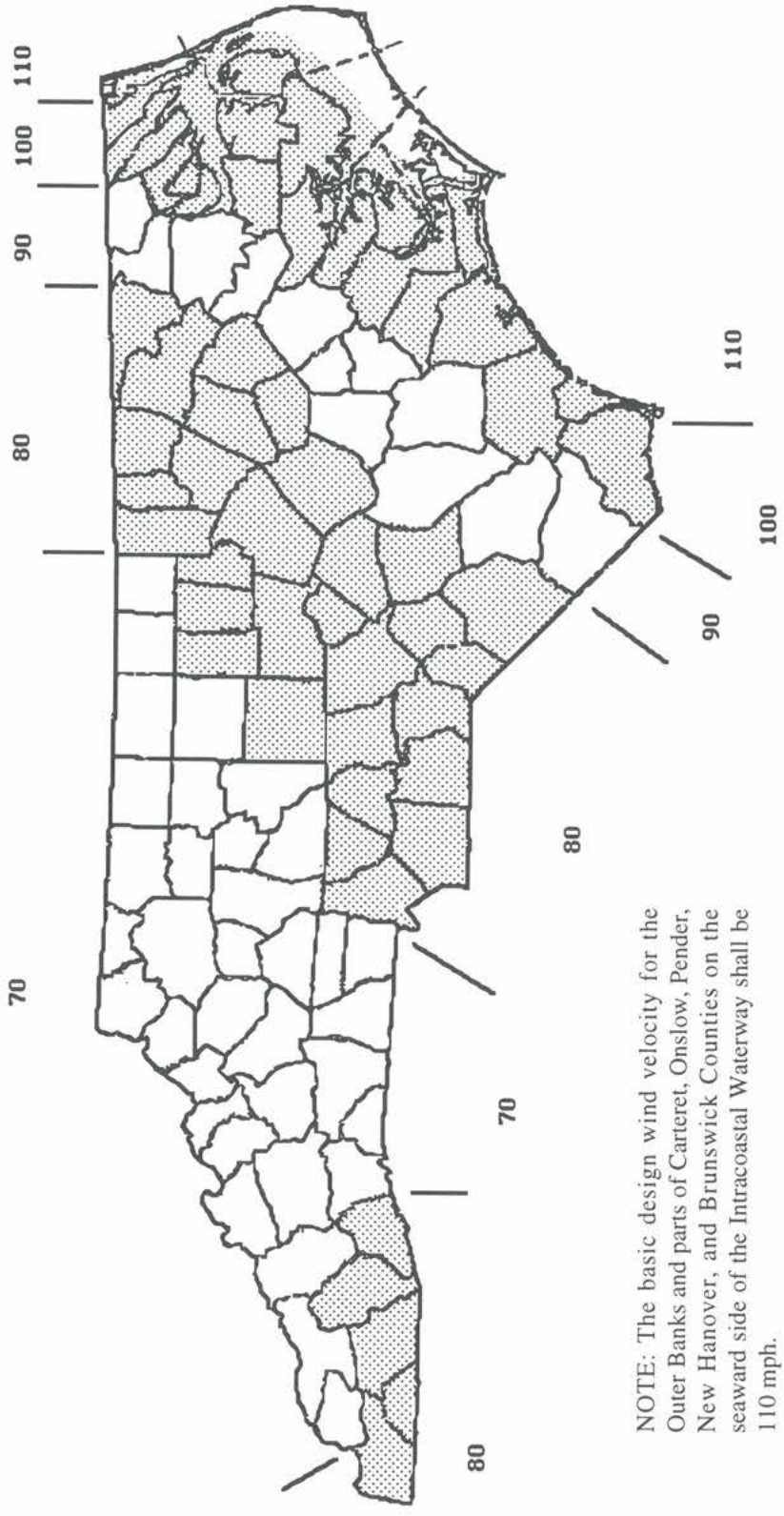
One should be cautioned to use the figure to obtain only a general idea of the 97 1/2 percent winter design temperature for any specific site. Such effects as valley drainage, wind breaks, terrain contours, elevation changes, etc., result in temperature variation over the short distance of 3 to 5°F. 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

DESIGN TEMPERATURES IN THIS AREA MUST BE BASED ON ANALYSIS OF LOCAL CLIMATE AND TOPOGRAPHY

For **SI:** °F. = 1.8°C. + 32.

FIGURE 301.2a
ISOLINES OF THE 971/2 PERCENT WINTER (DEC., JAN. AND FEB.) DESIGN TEMPERATURES (°F.)



NOTE: The basic design wind velocity for the Outer Banks and parts of Carteret, Onslow, Pender, New Hanover, and Brunswick Counties on the seaward side of the Intracoastal Waterway shall be 110 mph.

NORTH CAROLINA

FIGURE 301.2b BASIC WIND SPEED MAP

TABLE 301.2b

BASIC DESIGN WIND VELOCITIES[1]

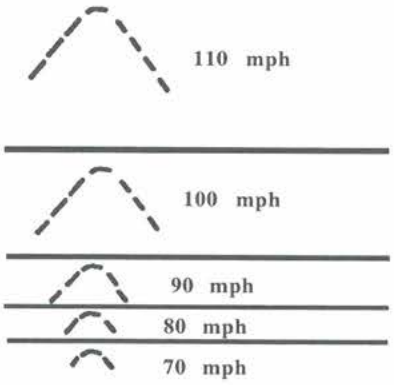
Counties not listed	70
Alamance	80
Anson	80
Beaufort	100
Bertie	90
Bladen	90
Brunswick	100
Cabarrus	80
Camden	100
Carteret	100
Chatham	80
Cherokee	80
Chowan	100
Clay	80
Columbus	90
Craven	100
Cumberland	80
Currituck	100
Dare	100
Duplin	90
Durham	80
Edgcombe	80
Franklin	80
Gates	90
Granville	80
Greene	90
Halifax	80
Harnett	80
Hertford	90
Hoke	80
Hyde	100
Jackson	80
Johnston	80
Jones	100
Lee	80
Lenior	90
Macon	80
Martin	90
Mecklenburg	80
Montgomery	80
Moore	80
Nash	80
New Hanover	100
Northampton	80
Onslow	100
Orange	80
Pamlico	100
Pasquotank	100
Pender	100
Perquimans	100
Pitt	90
Randolph	80
Richmond	80
Robeson	80
Sampson	90
Scotland	80
Stanley	80
Transylvania	80
Tyrrell	100
Union	80
Vance	80
Wake	80
Warren	80
Washington	100
Wayne	90
Wilson	80

1. The basic design wind velocity for the Outer Banks and parts of Carteret, Onslow, Pender, New Hanover, and Brunswick Counties on the seaward side of the Intracoastal Waterway shall be 110 mph.

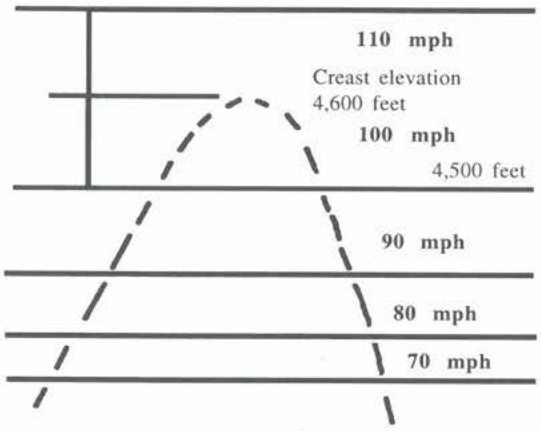
TABLE 301.2c
BASIC DESIGN WIND VELOCITIES FOR MOUNTAIN REGIONS

Controlling Elevation in Feet (1), (2), (3), (4), (5)	Design Wind (MPH)
2,700 or lower	70
2,700 to 3,000 feet	80
3,000 to 3,500 feet	90
3,500 to 4,500 feet	100
4,500 and above	110

1. Wind velocities are to apply to all mountain tops, crests, knobs or peaks as named on the USGS Quadrangle maps.
2. Effect of the 110 mph wind is to extend downward from crest for 200 ft. or to the controlling elevation for a 100 mph wind, whichever is the lesser.
3. Effect of the 100 mph wind is to extend downward from crest for 100 feet or to the controlling elevation for a 90 mph wind, whichever is the lesser.
4. Effect of the 90 mph wind is to extend downward from crest for 70 feet or to the controlling elevation for a 80 mph wind, whichever is the lesser.
5. Effect of the 80 mph wind is to extend downward from crest for 50 feet or to the controlling elevation for the 70 mph wind, whichever is the lesser.



Wind Velocity Diagram



Example
Note # 2 Modification
Note 3, 4, and 5 Similar

Figure 301.2c

TABLE 301.5
MINIMUM ROOF LIVE LOADS IN POUNDS–FORCE PER SQUARE FOOT OF HORIZONTAL PROJECTION

ROOF SLOPE	TRIBUTARY LOADED AREA IN SQUARE FOOT FOR ANY STRUCTURAL MEMBER		
	0 to 200	201 to 600	Over 600
Flat or rise less than 4 inches per foot (1:3)	20	16	12
Rise 4 inches per foot (1:3) to less than 12 inches per foot (1:1)	16	14	12
Rise 12 inches per foot (1:1) and greater	12	12	12

For **SI:** 1 square foot = 0.0929 m2, 1 psf = 0.0479 kN/m2.

TABLE 301.6
ALLOWABLE DEFLECTION OF STRUCTURAL MEMBERS

STRUCTURAL MEMBER	ALLOWABLE DEFLECTION
Rafters having slopes greater than 3/12 with no finished ceiling attached to rafters	L/180
Interior walls and partition	H/180
Floors and plastered ceilings	L/360[1]
All other structural members	L/240

NOTES:
L = span length
H = span height
[1] When floor spans exceed 20 feet, joists, built-up beams and trusses shall not be spaced greater than 24 inches and deflection shall not exceed L/480.

303.2 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 (2.32 m2).

303.3 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 (0.279 m2), 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.

303.4 Stairway illumination. All interior and exterior stairs shall be provided with a means to illuminate the stair in accordance with the North Carolina State Building code, Volume IV-Electrical.

303.5 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.

303.5.1 Roofed porches. 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 (2134 mm).

303.6 Required heating. When required by Table 301.2a, every dwelling unit shall be provided with heating facilities capable of maintaining a room temperature of 68°F. (20°C.) at a point 3 feet (914 mm) above the floor at the design temperature in all habitable rooms.

SECTION 304
ROOM SIZES

304.1 Minimum area. Every dwelling unit shall have at least one habitable room which shall have not less than 150 square feet (13.9 m2) of floor area. Other habitable rooms shall have an area of not less than 70 square feet (6.50 m2). Every kitchen shall not have less than 50 square feet (4.64 m2) of floor area. Habitable rooms, except kitchens, shall not be less than 7 feet (2134 mm) in any horizontal dimension.

SECTION 305
CEILING HEIGHT

305.1 Minimum height. Habitable rooms, except kitchens, shall have a ceiling height of not less than 7 feet 6 inches (2286 mm) 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 (2286 mm) in height with no portion of the required areas less than 5 feet (1524 mm) 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 (2134 mm).

Exceptions:
1. Beams and girders spaced not less than 4 feet (1219 mm) on center may project not more than 6 inches (153 mm) 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 (2134 mm) measured to the lowest projection from the ceiling.
3. Ceiling height in basements without habitable spaces may not be less than 6 feet 8 inches (2032 mm) clear except for under beams, girders, ducts or other obstructions where the clear height shall be 6 feet 4 inches (1931 mm).

305.2 Height effect on room area. Portions of a room with a sloping ceiling measuring less than 5 feet 0 inches (1524 mm) or a furred ceiling measuring less than 7 feet 0 inches (2134 mm) from the finished floor to the finished ceiling shall not be considered as contributing to the minimum required habitable area for that room.

SECTION 306
SANITATION

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

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

306.3 Sewage disposal. All plumbing fixtures shall be connected to a sanitary sewer or to an approved private sewage disposal system.

306.4 Water supply to fixtures. All plumbing fixtures shall be connected to an approved water supply. Kitchen sinks, lavatories, bathtubs, showers, bidets, laundry tubs and washing machine outlets shall be provided with hot and cold water.

SECTION 307
TOILET, BATH AND SHOWER SPACES

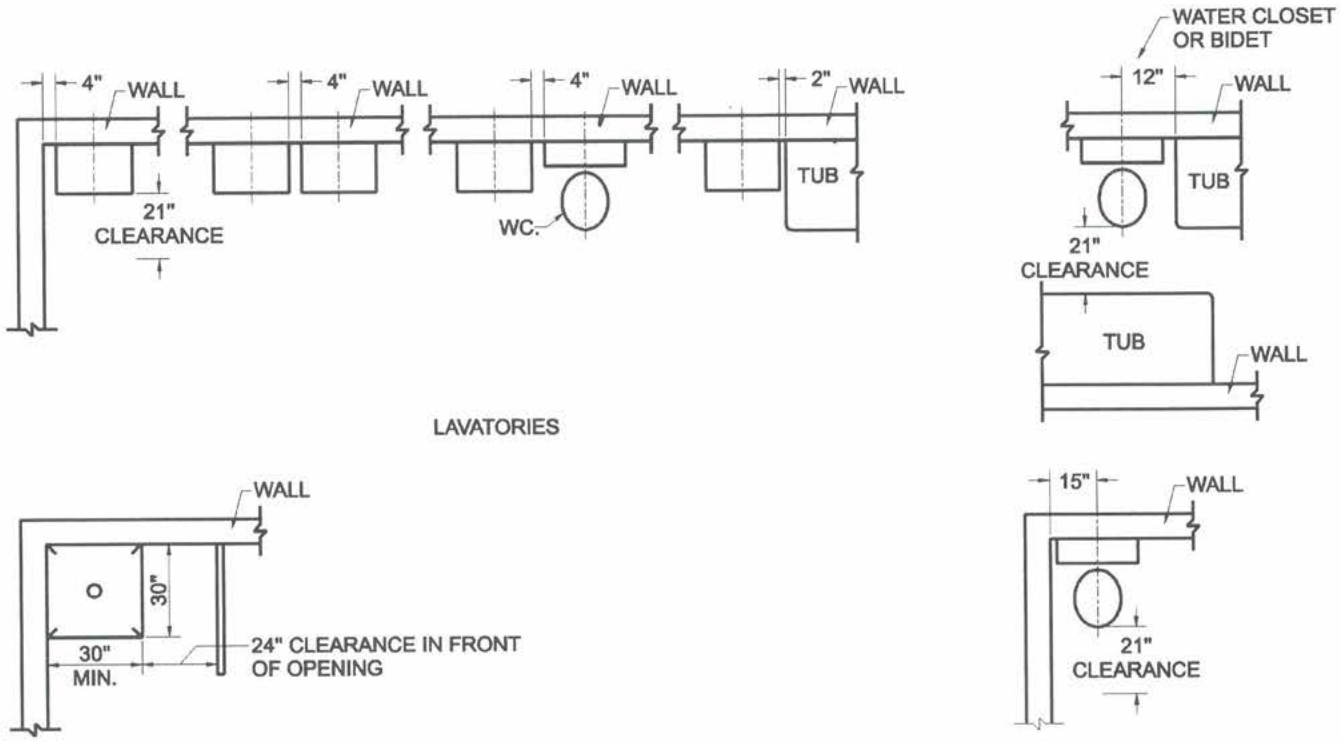
307.1 Privacy required. Every water closet, bathtub or shower required by this code shall be installed in a room which will afford privacy to the occupant.

307.2 Space required. Fixtures shall be spaced as per Figure 307.2.

SECTION 308
GLAZING

308.1 Label required. 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.

308.1.1 Identification. 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



For **SI**: 1 inch = 25.4 mm.

FIGURE 307.2
MINIMUM FIXTURE CLEARANCES

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.

308.2 Louvered windows or jalousies. Regular, float, wire door patterned glass in jalousies and louvered windows shall be no thinner than nominal 3/16 inch (4.76 mm) and no longer than 48 inches (1219 mm). Exposed glass edges shall be smooth.

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

308.3 Human impact loads. Individual glazed areas including glass mirrors in hazardous locations such as those indicated in Section 308.4 shall pass the test requirements of CPSC 16–CFR, Part 1201.

Exceptions:

1. Polished wire glass for use in fire doors, fire windows and view panels in 1–hour fire–resistive walls shall comply with ANSI Z97.1.
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.

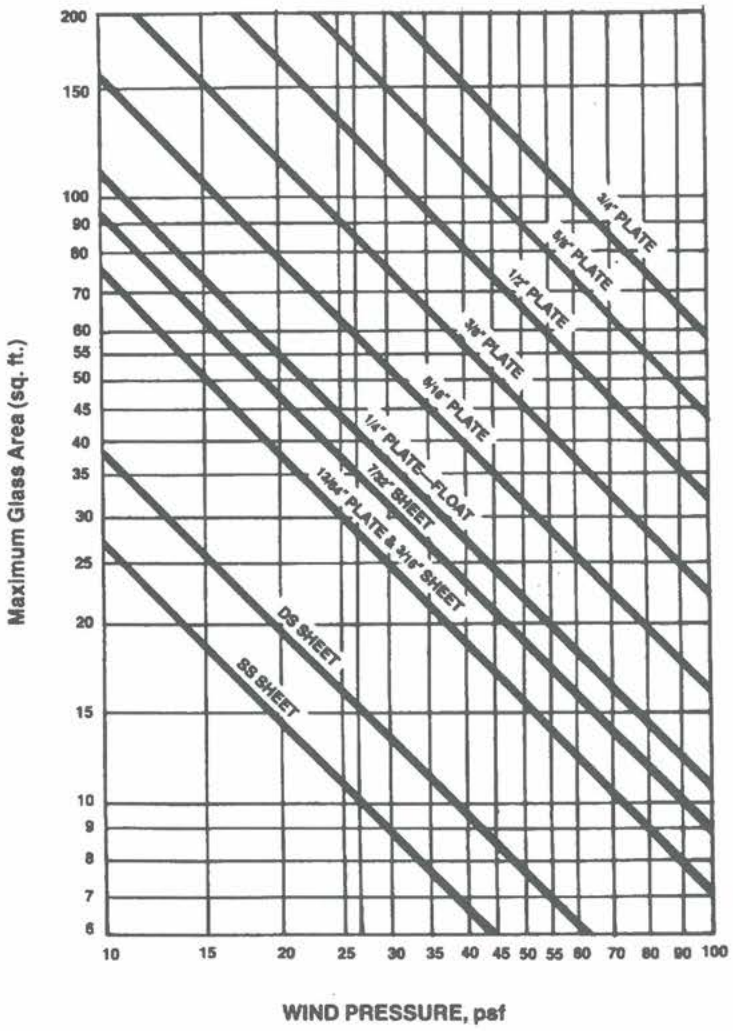
308.4 Hazardous locations. The following shall be considered specific hazardous locations for the purposes of glazing:

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. Glazingin any part of a building wall enclosing these compartments where the bottom edge of the glazing is less than 60 inches (1524 mm) above the drain inlet.
6. Glazing, in an individual fixed or operable panel adjacent to and within the same plane as a door where the nearest vertical edge is within a 24–inch (610 mm) arc of the door in a closed position and whose bottom edge is less than 60 inches (1524 mm) 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:
   - 7.1 Exposed area of an individual pane greater than9 square feet (0.836 m2).
   - 7.2 Bottom edge less than 18 inches (457 mm) above the floor.
   - 7.3 Top edge greater than 36 inches (914 mm) above the floor.
   - 7.4 One or more walking surfaces within 36 inches (914 mm) 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.
9. Glazing in walls and fences enclosing indoor and outdoor swimming pools where the bottom edge of the pool side is (1) less than 60 inches (1524 mm) above a walking surface and (2) within 36 inches (914 mm) horizontally of a walking surface. This shall apply to single glazing and all panes in multiple glazing.

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

   1. Openings in doors through which a 3–inch (76 mm) sphere is unable to pass.
   2. Leaded glass panels.
   3. Faceted and decorative glass.
   4. Glazing in Section 308.4, Item 6, when there is an intervening wall or other permanent barrier between the door and the glazing.
   5. Glazing in Section 308.4, Item 7, when a protective baris installed on the accessible side(s) of the glazing 36 inches – 2 inches (914 mm – 51 mm) above the floor. The bar shall be capable of withstanding a horizontal load of 50 pounds per linear foot (74.5 kg/m) without contacting the glass and be a minimum of 1-1/2 inches(38 mm) in height.
   6. Outboard panes in insulating glass units and other multiple glazed panels in Section 308.4, Item 7, when the bottom edge of the glass is 25 feet (7620 mm) or more above grade, a roof, walking surface, or other horizontal (within 45 degrees of horizontal) surface adjacent to the glass exterior.
   7. Louvered windows and jalousies complying with the requirements of Section 308.2.
   8. Mirrors mounted or hung on a flush door or a panel door without a cut out for the glass.
   9. Mirrors mounted or hung on a solid wall.

308.5 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 301 acting either inward or outward. In the case of regular plate, float or sheet glass supported on four sides, the design shall not be less than 2-1/2. Adjustment factors for other types of glass are given in Table 308.5(a).



For **SI** 1 inch = 2.54 mm, 1 psf = 0.0479 kN/m^2 1 sq ft . = 0.0929m^2

Design wind load from Table 308.6- Pounds per square foot chart applies for ratios of width-length from 2:10 to 10:10.

FIGURE 308.5
WIND LOAD CHART REQUIRED NOMINAL THICKNESS OF REGULAR PLATE, FLOAT OR SHEET GLASS
Based on Minimum Thickness Allowed in Federal Specification
DDG–00451 b Before Weathering
(Design Factor = 2.5)

TABLE 308.5 (a)
RELATIVE RESISTANCE TO WIND LOAD
(Assuming equal thickness)

GLASS TYPE	APPROXIMATE RELATIONSHIP[1]
Laminated	0.6
Wired Glass	0.5
Heat–strengthened	2.0
Tempered	4.0
Sealed Insulated Glass[2]	1.5
Rough–rolled Plate	1.0
Sandblasted	0.4
Regular Plate or Sheet	1.0

NOTES to TABLE 308.5(a)

1. Before using Wind Load Chart (Figure 308.5), divide the design wind load from Section 301 or Table 308.5(b) by the value shown for the glass type involved.
2. Use thickness of the thinner of the two lights, not thickness of unit.

Table 308.5(b)
Design Pressures for Doors and Windows [1,2,3,4]
Positive and Negative in psf

Velocity(mph)	Mean Roof Height (ft) 15	25	35
70	15	17	19
80	20	23	25

1. Alternate design pressures may be determined by using North Carolina State Building Code-General Construction, ASCE-7, or the 1994 Standard Building Code.
2. If window or door is more than 4 ft. from a corner, the pressure from this table shall be permitted to be multiplied by 0.87. This adjustment does not apply to garage doors.
3. For windows and doors in structures with a roof slope of 10 degrees or less (2:12) from the horizontal, the pressures from this table may be multiplied by 0.90.
4. Design pressure ratings based on standards listed in Section 608 or 609 are adequate documentation of capacity to resist pressures from the table.

308.6 Skylights and sloped glazing.

308.6.1 Definition. Any installation of glass or other transparent or translucent glazing material installed at a slope of 15 degrees or more from vertical. Glazing materials in skylights, solariums, sun spaces, roofs and sloped walls are included in this definition.

308.6.2 Permitted materials. The following types of glazing may be used:

1. Laminated glass with a minimum 0.030–inch (0.762 mm) polyvinyl butyral interlayer.
2. Fully tempered glass.
3. Heat–strengthened glass.
4. Wired glass.
5. Approved rigid plastics.

308.6.3 Screens, general. For fully tempered or heat–strengthened glass, a retaining screen meeting the requirements of Section 308.6.6 shall be installed below the glass, except for fully tempered glass that meets either condition listed in Section 308.6.5.

308.6.4 Screens with multiple glazing. When the inboard pane is fully tempered, heat–strengthened, or wired glass, a retaining screen meeting the requirements of Section 308.6.6 shall be installed below the glass, except for either condition listed in Section 308.6.5. All other panes in the multiple glazing may be of any type listed in Section 308.6.2.

308.6.5 Screens not required. Screens shall not be required when fully tempered glass is used as single glazing or the bottom pane in multiple glazing and either of the following conditions are met:

1. Glass area 16 square feet (1.49 m2) or less. Highest point of glass not more than 12 feet (3658 mm) above a walking surface or other accessible area, nominal glass thickness not more than 3/16 inch (4.76 mm), and (for multiple glazing only) the other pane or panes fully tempered, laminated or wired glass.
2. Glass area greater than 16 square feet (1.49 m2). Glass sloped 30 degrees or less from vertical, and highest point of glass not more than 10 feet (3048 mm) above a walking surface or other accessible area.

308.6.6 Glass in greenhouses. Any glazing material is permitted to be installed without screening in the sloped areas of greenhouses, provided the greenhouse height at the ridge does not exceed 20 feet (6096 mm) above grade.

308.6.7 Screen characteristics. The screen and its fastenings shall (1) be capable of supporting twice the weight of the glazing, (2) be firmly and substantially fastened to the framing members, and (3) have a mesh opening of no more than 1 inch by1 inch (25 mm by 25 mm).

308.6.8 Curbs for skylights. All unit skylights installed in a roof with a pitch flatter than three units vertical in 12 units horizontal (25–percent slope) shall be mounted on a curb extending at least 4 inches (102 mm) above the plane of the roof.

SECTION 309
GARAGES

309.1 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 13/8 inch (35 mm) in thickness or 20–minute fire–rated doors.

309.2 Separation required. The garage shall be separated from the residence and its attic area by means of minimum 1/2–inch (12.7 mm) gypsum board applied to the garage side.

309.3 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 to a drain or toward the main vehicle entry doorway.

SECTION 310
EXITS

310.1 Exit required. Not less than one exit conforming to this chapter shall be provided from each dwelling unit.

310.2 Emergency egress required. Every sleeping room shall have at least one openable 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 a key or tool. Where windows are provided as a means of egress or rescue they shall have a sill height of not more than 44 inches (1118 mm) above the floor.

310.2.1 Minimum size. All egress or rescue windows from sleeping rooms must have a net clear opening of 4.0 square feet. The minimum net clear opening height shall be 22 inches. The minimum net clear opening width shall be 20 inches. Each egress window from sleeping rooms must have a minimum total glass area of not less than 5.0 sq. ft. in the case of a ground window and not less than 5.7 sq. ft. in the case of a second story window.

310.2.2 Bars, grills and screens. Bars, grills, screens or other obstructions placed over emergency escape windows shall be releasable or removable from the inside without the use of a key or tool.

310.3 Under stair protection. Enclosed accessible space under stairs shall have walls and soffits protected on the enclosed side with 1/2–inch (12.7 mm) gypsum board.

SECTION 311
DOORS AND HALLWAYS

311.1 General. The required exit door shall be a side–hinged door not less than 3 feet (914 mm) in width and 6 feet 8 inches (2032 mm) 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 (914 mm). All doors from habitable room shall be a nominal 2'-6" in width and 6'-8" in height.

SECTION 312
LANDINGS

312.1 General. A minimum of 3 foot by 3 foot (914 mm by 914 mm) landing shall be required on each side of an egress door. The floor or landing shall not be more than 1-1/2 inches (38 mm) lower than the top of the threshold.

Exceptions:

1. At the top of a flight of stairs, provided the door does not swing over the stairs.
2. The landing at the exterior doorway shall not be more than 8-1/4 inches (210 mm) below the top of the threshold, provided the door does not swing over the landing.
3. Exterior storm and screen doors are exempt from the requirements for landings.
4. At the bottom of an interior flight of stairs, there may be a door between the landing and stair.

SECTION 313
RAMPS

313.1 Maximum slope. All egress ramps shall have a maximum slope of one unit vertical in eight units horizontal (12–percent slope).

313.2 Handrails required. Handrails shall be provided on at least one side of all ramps exceeding a slope of one unit vertical in 12 units horizontal (8–percent slope).

313.3 Landing required. A minimum 3–foot–by–3–foot (914 mm by 914 mm) landing shall be provided at the top and bottom of ramps where doors open onto the ramp and where the ramp changes direction.

SECTION 314
STAIRWAYS

314.1 Width. Stairways shall not be less than 36 inches (914 mm) in clear width at all points above the permitted handrail height and below the required headroom height. The minimum width at and below the handrail height shall not be less than 32 inches (813 mm) where a handrail is installed on one side and 28 inches (711 mm) where handrails are provided on both sides.

Exception: Stairways not required for egress may be as narrow as 26 inches.

314.2 Treads and risers. The maximum riser height shall be 8-1/4 inches (210 mm) and the minimum tread depth shall be 9 inches (228 mm).The riser height shall be measured vertically between leading edges of the adjacent treads. The tread depth shall be measured horizontally between the vertical planes of the foremost projection of adjacent treads and at a right angle to the tread's leading edge. The walking surface of treads and landings of a stairway shall be sloped no steeper than one unit vertical in 48 units horizontal (2–percent slope). The greatest riser height within any flight of stairs shall not exceed the smallest by more than 3/8 inch (9.5 mm). The greatest tread depth within any flight of stairs shall not exceed the smallest by more than 3/8 inch (9.5 mm). The top and bottom riser of interior stairs shall not exceed the smallest riser within that stair run by more than 3/4 inch (19 mm). The height of the top and bottom riser of the interior stairs shall be measured from permanent finished surface to permanent finished surface (carpet excluded). Where the bottom riser of an exterior stair adjoins an exterior walk , porch , driveway, patio, garage floor, or finish grade, the height of the riser may be less than the height of the adjacent risers.

314.2.1 Profile. The radius of curvature at the leading edge of the tread shall be no greater than 9/16 inch (14.3 mm). A nosing not less than 3/4 inch (19 mm) but not more than 1-1/4 inches (32 mm) shall be provided on stairways with solid risers. Beveling of nosing shall not exceed 1/2 inch (12.7 mm). Risers shall be vertical or sloped from the underside of the leading edge of the tread above at an angle not more than 30 degrees from the vertical.

Exception: A nosing is not required where the tread depth is a minimum of 11 inches (279 mm).

314.3 Headroom. The minimum headroom in all parts of the stairway shall not be less than 6 feet 8 inches (2032 mm) measured vertically from the sloped plane adjoining the tread nosing or from the floor surface of the landing or platform.

314.4 Winders. Winders are permitted, provided that the width of the tread at a point not more than 12 inches (305 mm) from the side where the treads are narrower is not less than 9 inches (228 mm) and the minimum width of any tread is not less than 4 inches (153 mm). The continuous handrail required by Section 314.1 shall be located on the side where the tread is narrower.

314.5 Spiral stairs. Spiral stairways are permitted, provided the minimum width shall be 26 inches (660 mm) with each tread having a 7-1/2–inch (190 mm) minimum tread width at 12 inches (305 mm) from the narrow edge. All treads shall be identical, and the rise shall be no more than 9-1/2 inches (241 mm). A minimum headroom of 6 feet 6 inches (1982 mm) shall be provided.

314.6 Circular stairways. Circular stairways shall have a minimum tread depth and a maximum riser height in accordance with Section 314.2 and the smaller radius shall not be less than twice the width of the stairway. The minimum tread depth of 9 inches shall be measured from the narrower end.

314.7 Illumination. All stairs shall be provided with illumination in accordance with Section 303.4

SECTION 315
HANDRAILS AND GUARDRAILS

315.1 Handrails. Handrails having minimum and maximum heights of 30 inches and 38 inches (762 mm and 965 mm), respectively, measured vertically from the nosing of the treads, shall be provided on at least one side of stairways of four or more risers. Spiral stairways 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. Handrails adjacent to a wall shall have a space of not less than 1-1/2 inches (38 mm) between the wall and the handrail.

Exceptions:

1. Handrails shall be permitted to be interrupted by a newel post at a turn.
2. The use of a volute, turnout or starting easing shall be allowed over the lowest tread.

315.2 Handrail grip size. 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.

Exception: Exterior handrails shall not be more than 3-1/2 inches in cross-sectional dimension.

315.3 Guardrail details. Porches, balconies or raised floor surfaces located more than 30 inches (762 mm) above the floor or grade below shall have guardrails not less than 36 inches (914 mm) in height. Open sides of stairs with a total rise of more than 30 inches (762 mm) above the floor or grade below shall have guardrails not less than 30 inches (762 mm) nor more than 38 inches (965 mm) in height measured vertically from the nosing of the treads.

315.4 Guardrail opening limitations. Required guardrails on open sides of stairways, raised floor areas, balconies and porches shall have intermediate rails or ornamental closures which do not allow passage of an object 6 inches (152 mm) or more in diameter. Horizontal spacing between the vertical members in required guardrails shall be a maximum of 4 inches (102 mm) 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 (153 mm) cannot pass through.

SECTION 316
SMOKE DETECTORS

316.1 Smoke detectors required. Smoke detectors shall be installed in in accordance with the Electrical Code.

SECTION 317
FOAM PLASTIC

317.1 General. The provisions of this section shall govern the requirements and uses of foam plastic insulation.

317.1.1 Surface burning characteristics. Except where otherwise noted in Section 317.2, 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 E 84.

317.1.2 Thermal barrier. Foam plastic, except where otherwise noted, shall be separated from the interior of a building by minimum 1/2–inch (12.7 mm) gypsum wallboard. The gypsum board shall be installed using a mechanical fastening system in accordance with Section 702.3.5. Reliance on adhesives to ensure the gypsum wallboard will remain in place when exposed to fire shall be prohibited.

317.2 Specific requirements. The following requirements shall apply to all uses of foam plastic unless specifically approved in accordance with Section 317.3 or by other sections of the code.

17.2.1 Masonry or concrete construction. Foam plastics may be used without the thermal barrier described in Section 317.1 when the foam plastic is protected by a minimum 1–inch (25 mm) thickness of masonry or concrete.

317.2.2 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 or wood structural panel sheathing in accordance with Section 803, not less than 15/32–inch (12 mm) in thickness bonded with exterior glue and identified as Exposure 1, with edge supported by blocking or tongue–and–groove joints. The smoke–developed rating shall not be limited.

317.2.3 Attics. Within an attic accessible by means of a fixed stairway, foam plastics shall be protected against ignition by 1-1/2–inch–thick (38 mm) mineral fiber insulation, 1/4–inch–thick (6.4 mm) wood structural panels, 3/8–inch (9.5 mm) particleboard, 1/4–inch (6.4 mm) hardboard, or 3/8–inch (9.5 mm) gypsum wallboard, corrosion–resistant steel having a base metal thickness of 0.016 inch (0.406 mm).

317.2.4 Foam–filled doors. Foam–filled doors are exempt from the requirements of Section 317.1.

317.2.5 Siding backer board. Foam plastic board of not more than 1/2–inch (12.7 mm) thickness may be used as siding backer board when separated from interior spaces by not less than2 inches (51 mm) of mineral fiber insulation or 1/2–inch (12.7 mm) gypsum wallboard 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 (22 720 kJ/m2) when tested in accordance with NFiPA 259.

317.2.6 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 (3.14 kN/m3),
2. The trim constitutes no more than 10 percent of the area of any wall or ceiling, and
3. The flame–spread rating does not exceed 75 when tested per ASTM E 84. The smoke–developed rating is not limited.

317.3 Specific approval. Plastic foam not meeting the requirements of Sections 317.1 and 317.2 may be specifically approved on the basis of approved tests such as, but not limited to, a tunnel test in accordance with ASTM E 84, FM 4880, UL 1040, ASTM E 152, or UL 1715, 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.

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

SECTION 318
FLAME SPREAD AND SMOKE DENSITY

318.1 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; or to materials which are less than 1/28–inch (0.907 mm) 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.

318.2 Smoke density. The smoke density shall not be greater than 450.

318.3 Testing. Tests shall be made in accordance with ASTM E 84.

SECTION 319
INSULATION

319.1 Insulation. All exposed insulation materials, including facings, such as vapor barriers or breather papers installed within floor–ceiling assemblies, roof–ceiling assemblies, wall assemblies, crawl spaces and attics shall have a flame–spread rating not to exceed 25 with an accompanying smoke developed factor not to exceed 450 when tested in accordance with ASTM E 84.

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.

319.2 Loose–fill insulation. Loose–fill insulation materials which cannot be mounted in the ASTM E 84 apparatus with out a screen or artificial supports shall have a flame–spread rating not to exceed 25 with an accompanying smoke–developed factor not to exceed 450 when tested in accordance with CAN4–S102.2–M83.

319.3 Exposed attic insulation. All exposed insulation materials installed on attic floors shall have a critical radiant flux not less than 0.12 watt per square centimeter.

319.4 Testing. Tests for critical radiant flux shall be made in accordance with ASTM E 970.

SECTION 320
DWELLING UNIT SEPARATION

320.1 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 E 119. 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.

320.2 Townhouses. Each townhouse shall be considered a separate building and separated by separate walls meeting the requirements of Section 302.

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 (10 320 mm2) in surface area. The aggregate surface area of the boxes shall not exceed 100 square inches (0.645 m2) for any 100 square feet (9.29 m2) of wall area. Metallic outlet boxes on opposite sides of walls shall be separated by a minimum distance of 24 inches (610 mm).

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

320.2.1 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.

320.2.2 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 (762 mm) 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 (762 mm) above the lower roof, the parapet shall extend not less than 30 inches (762 mm) above the lower roof surface.

   Exception: A parapet is not required in the two cases above when the roof is covered with a minimum 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 (1219 mm) on each side of the wall, or one layer of 5/8–inch (15.9 mm) Type X gypsum board is installed directly beneath the roof decking or sheathing for a distance of 4 feet (1219 mm) 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 (762 mm) above the lower roof. The wall construction from the lower roof to the underside of the higher roof deck shall not have less than a 1–hour fire–resistive rating. The fire–resistive rating shall be rated for exposure from both sides.

320.2.3 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.

320.3 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.

320.3.1 Airborne noise. Airborne sound insulation for wall and floor–ceiling assemblies shall meet a Sound Transmission Class (STC) of 45 when tested in accordance with ASTM E 90.

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

320.3.2 Structural–borne noise. Impact sound insulation for floor–ceiling assemblies shall meet an Impact Insulation Class (IIC) of 45 when tested in accordance with ASTM E 492. Floor covering may be included in the assembly to obtain the required rating.

SECTION 321
MOISTURE VAPOR RETARDERS

321.1 Retarder required. 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 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. (19°C.) or higher wet–bulb temperature for 3,000 or more hours during the warmest six consecutive months of the year, or 73°F. (23°C.) or higher wet–bulb temperature for 1,500 or more hours during the warmest six consecutive months of the year.

SECTION 322
PROTECTION AGAINST DECAY

322.1 Location required. In areas subject to decay damage as established by Table 301.2a, 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, 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 (457 mm) or wood girders when closer than 12 inches (305 mm) to exposed ground in crawl spaces or unexcavated area located within the periphery of the building foundation.
2. All sills or plates which rest on concrete or masonry exterior walls.
3. Sills and sleepers on a concrete or masonry slab which is in direct contact with the ground unless separated from such slab by an impervious moisture barrier.
4. The ends of wood girders entering exterior masonry or concrete walls having clearances of less than 1/2 inch (12.7 mm) 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 (153 mm) 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 walls or concrete walls below grade except where an approved vapor retarder is applied between the wall and the furring strips or framing members.

322.1.1 Ground contact. 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 groundwater level or continuously submerged in fresh water.

Table No. 322.3
PRESERVATIVE RETENTION REQUIREMENTS

Material & Usage	Creosote and Creosote Coal Tar	CCA[1] ACZA ACA	AWPA Standard
		Lbs./Cubic Foot	
Lumber, Timber & Plywood[2]			
Above Ground	8	0.25[6]	C1/C2/C9
Ground Contact	10	0.40	C1/C2/C9
In Salt Water	25	2.5	C1/C2/C9/C18
Round Piles[3]			
Land or Fresh Water Use	12	0.8	C1/C3
In Salt Water	20	2.5	C1/C3/C18
Square Piles[4]			
Land or Fresh Water Use(SP)	9	0.6	C1/C2C24
Land or Fresh Water Use(Other than SP)	12	0.8	C1/C2/C24
In Salt Water	20	2.5	C1/C2/C18
Poles[5]			
Utility	9	0.6	C1/C4
Structural	9	0.6	C1/C4

[1]CCA – Chromated Copper Arsenate
ACZA – Ammoniacal Copper Zinc Arsenate
ACA – Ammoniacal Copper Arsenate
[2] Marking shall be not closer than two feet from either end.
[3] Marking shall be at points five feet and ten feet from the butt end of the piles
[4] Marking shall be at the approximate midpoint of the pile.
[5] Marking shall be on the face side ten feet from the extreme butt for poles fifty feet and shorter and fourteen feet from the extreme butt for poles over fifty feet long.
[6] Minimum 18" above ground.

322.1.2 Geographical areas. 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.

322.1.3 Post, poles and columns. 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.

322.1.4 Wood columns. Wood columns shall be approved wood of natural decay resistance or approved pressure preservatively treated wood.

Exception: Posts or columns supported by piers projecting 1-1/2 inches (38 mm) above the floor or finish grade and separated therefrom by an approved impervious moisture barrier.

322.2 Quality of mark. All lumber, sawn timber, plywood, piles and poles supporting permanent structures required by this code to be pressure treated shall bear the quality mark of an approved inspection agency which maintains continued supervision, testing, and inspection over the quality of the the product as described in the standards listed in Table No. 322.3. The competency and performance of quality control inspection agencies for pressure treated wood shall be approved by the North Carolina State Building Code Council. The Southern Pine Inspection Bureau and inspection agencies approved by the Board of Review of the American Lumber Standard Committee shall be deemed as approved. All lumber shall be permanently marked so that the approved inspection agency, preservative, retention, treating company and year of treatment can be identified in service. Marking shall be as follows:

1. All rough lumber, 6x6 inch pilings and larger, 6 inch diameter and larger pilings and dressed dimensional lumber thicker than 2 inch shall be marked legibly with indelible ink, branding or non-corrosive metal tags.
2. All dressed dimensional lumber 2 inches and less in thickness and dressed dimensional 4 x 4 inch shall be legibly marked with indelible ink, branding or noncorrosive tags. If tags are used, after construction is completed, the contractor shall insure that 20% to 30% of the lumber used has an identification tag in an accessible location. This may require reattaching tags on the end or bottom of a portion of the lumber used.
3. Treating plants during normal working hours shall permit members of the North Carolina State Building Code Council or their staff access to its plant to monitor the performance of the third party agency by inspecting the operating of the facility and examining all records of the certification program. The expression "pressure treated wood" refers to wood meeting the retention penetration and other requirements applicable to the species, products, treatment and conditions of use in the approved standards of the American Wood Preservers Association (AWPA), as listed in Table No. 322.3.

322.3 Fasteners. Fasteners for pressure preservative and fire retardant treated wood shall be of hot-dipped zinc-coated galvanized stainless steel, silicon bronze, or copper. Fasteners for treated wood foundations shall be as required in NFoPA Technical Report No. 7 listed in Chapter 43.

SECTION 323
PROTECTION AGAINST TERMITES

323.1 Subterranean termite control. Methods of protection shall be by chemical soil treatment or other methods approved by the North Carolina Department of Agriculture.

Exception: The soil beneath a slab-on-grade shall be chemically treated before the concrete is placed. Verification of treatment shall be attached to the permit showing the name of the applicator, chemical name, and areas treated.

323.2 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 the standards of the North Carolina Structural Pest Control Committee of the North Carolina Department of Agriculture.

323.3 Foam plastic, General. This section shall apply to both treated and untreated foam plastic.

323.3.1 Foundation walls. All foam plastic shall be a minimum of 8" above grade. See Appendix E, Figure E-1.

Exception: Foam plastic less than 8" above or in contact with grade shall be installed in accordance with Section 323.3.5 and Figure E-2.

323.3.2 Chemical treatment. When foam plastic is in contact with the ground, the soil area shall be chemically treated in accordance with Section 323.2.

323.3.3 Slab-on-grade (non-structural). Foam plastic shall be installed along the vertical edge and underneath the slab as specified in Chapter 39.

323.3.4 Slab-on-grade (structural). All slabs which distribute the wall loads to the foundation shall be insulated as specified in Section 323.3, Chapter 39, and Figures E-3 or E-4. Foam plastic shall not be positioned so as to receive vertical building loads.

323.3.5 Foam plastic in contact with ground.

323.3.5.1 Inspection and treatment gaps. Foam plastic in contact with the ground shall not be continuous to the bottom of the weather resistant siding. A clear and unobstructed 2 inch minimum inspection gap shall be maintained from the bottom of the weather resistant siding to the top of any foam plastic. A minimum 4" treatment gap shall be provided beginning not more than 6" below grade. The top and bottom edges of the foam plastic installed between the inspection gap and the treatment gap shall be cut at a 45 degree angle. See Figure E-2

323.3.5.2 Protection of exposed foam plastic. Exposed foam plastic shall be protected from physical damage. The required inspection gap, foam plastic, and treatment gap, shall be sealed on the exterior with a cementitious coating that extends at least 2 inches below the foam plastic onto the surface of the foundation wall. See Figure E-2.

323.3.5.3 Waterproofing foam plastic between inspection gap and treatment gap. Waterproofing shall be installed over the required cementitious coating from 6" above grade down to the treatment gap per manufacturers installation instructions.

323.3.5.4 Dampproofing of below grade walls. Any foam plastic applied below the treatment gap shall be installed after required foundation wall dampproofing is in place. See Section 406 and Appendix E, Figure E-2.

CHAPTER 4
FOUNDATIONS

SECTION 401
GENERAL

401.1 Application. The provisions of this chapter shall control the design and construction of the foundation and foundation spaces for all buildings.

Exception: The provisions of this chapter for wood foundations apply only in the following situations:

1. Buildings supported by wood foundations shall be limited to no more than two floors and a roof.
2. No dimension in a basement room or crawl space area shall exceed the smaller of either the building width or length.

401.2 Requirements. The foundation and its structural elements shall be capable of accommodating all superimposed live, dead and other loads according to Section 301 and all lateral loads in accordance with the provisions of this code. 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 Section 403.

401.3 Drainage. Surface drainage shall be diverted to a storm sewer conveyance or other point of collection so as to not create a hazard. Lots 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 (153 mm) within the first 10 feet (3048 mm).

Exception: Where lot lines, walls, slopes or other physical barriers prohibit 6 inches (153 mm) of fall within 10 feet (3048 mm), drains or swales shall be provided to ensure drainage away from the structure.

401.4 Soil tests. In areas likely to have expansive, compressible, shifting or other unknown soil characteristics, the building officials may require a soil test to determine the soil's characteristics at a particular location. This determination, if required, shall be made by an approved agency using an approved method.

401.4.1 The load–bearing values greater than 2000 psf in Table 401.4.1 require an engineering evaluation.

401.5 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 or presaturation.

TABLE 401.4.1
PRESUMPTIVE LOAD–BEARING VALUES OF FOUNDATION MATERIALS

CLASS OF MATERIAL	LOAD–BEARING PRESSURE (pounds per square foot)
Crystalline bedrock	12,000
Sedimentary rock	6,000
Sandy gravel or gravel	5,000
Sand, silty sand, clayey sand, silty gravel and clayey gravel	3,000
Clay, sandy clay, silty clay and clayey silt	2,000

For **SI**: 1 psf = 0.0479 kN/m^2.

SECTION 402
MATERIALS

402.1 Wood foundations. Wood foundation systems shall be designed and installed in accordance with the provisions of this code.

402.1.1 Fasteners. Fasteners used below grade to attach plywood to the exterior side of exterior basement or crawlspace wall studs, or fasteners used in knee wall construction, shall be of Type 304 or 316 stainless steel. Fasteners used above grade to attach plywood, and all lumber–to–lumber fasteners except those used in knee wall construction shall be of Type 304 or 316 stainless steel, silicon bronze, copper, hot–dipped galvanized (zinc coated) steel nails, or hot–tumbled galvanized (zinc coated) steel nails. Electrogalvanized steel nails and galvanized (zinc coated) steel staples shall not be permitted.

402.1.2 Wood treatment. All lumber and plywood shall be treated in accordance with AWPA C22 and shall be identified as in conformance with such standard by an approved inspection agency. Where lumber and plywood is cut or drilled after treatment, the cut surface shall be field treated with Ammoniacal Copper Arsenate (ACA), Chromated Copper Arsenate (CCA), or Copper Napthenate by repeated brushing, dipping or soaking until the wood absorbs no more preservative. Water–borne preservatives ACA and CCA Types A, B and C shall have a minimum concentration of 3 percent in solution. Water–borne preservatives FCAP and ACC shall be permitted for field treatment of material originally treated with CCA and ACA water–borne preservatives, and the concentration of FCAP or ACC shall be a minimum of 5 percent in solution. Copper Napthenate shall be prepared with a solvent conforming to AWPA P5. The preservative concentration shall contain a minimum of 2 percent copper metal.

402.2 Concrete. Concrete shall have a minimum specified compressive strength as shown in Table 402.2. Concrete subject to weathering as indicated in Table 301.2a shall be air entrained as specified in Table 402.2. 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 pounds (236 kg) of cement meeting ASTM C 150 or C 595, per cubic yard (0.765 m3) of concrete.

TABLE 402.2
MINIMUM SPECIFIED COMPRESSIVE STRENGTH OF CONCRETE

TYPE OR LOCATIONS OF CONCRETE CONSTRUCTION	MINIMUM SPECIFIED COMPRESSIVE STRENGTH[1] (f'_c)		
TYPE OR LOCATIONS OF CONCRETE CONSTRUCTION	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, 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]

For SI: 1 psi = 6.895 kPa.

1. At 28 days psi.
2. See Table 301.2a 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 not be less than 5 percent or more than 7 percent.
5. See Section 402.2 for minimum cement content.

SECTION 403
FOOTINGS

403.1 General. All exterior walls 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 on solid rock or otherwise protected from frost, shall extend below the frost line as specified in Table 301.2a. Minimum sizes for concrete or masonry footings shall be as set forth in Table 403.1(a and b) and Figure 403.1a thru 403.1c. Footings for wood foundations shall be in accordance with the details set forth in Section 404.2, Figure 403.1d and 403.1e.

403.1.1 Slope. The top surface of footings shall be level (1/2 inch in 10 feet) or shall be brought level with masonry units with full mortar joints. The bottom surface of footings may have a slope not exceeding one unit vertical in ten units horizontal (10–percent slope). 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 footings will exceed one unit vertical in ten units horizontal (10–percent slope).

403.2 Footings for wood foundations. Footings for wood foundations shall be in accordance with Figure 403.1d and 403.1e. Gravel shall be washed and well graded. The maximum size stone shall not exceed 3/4 inch (19 mm). Gravel shall be free from organic, clayey or silty soils. Sand shall be coarse, not smaller than 1/16–inch (1.6 mm) grains and shall be free from organic, clayey or silty soils. Crushed stone shall have a maximum size of 1/2 inch (12.7 mm).

403.3 Insulated footings. For heated buildings with slab–on–ground foundations, footings are not required to extend below the frost line where protected from frost by insulating in accordance with Figure 403.3a and Table 403.3. Materials used below grade for the purpose of insulating foundations against frost shall be labeled as complying with ASTM C 578.

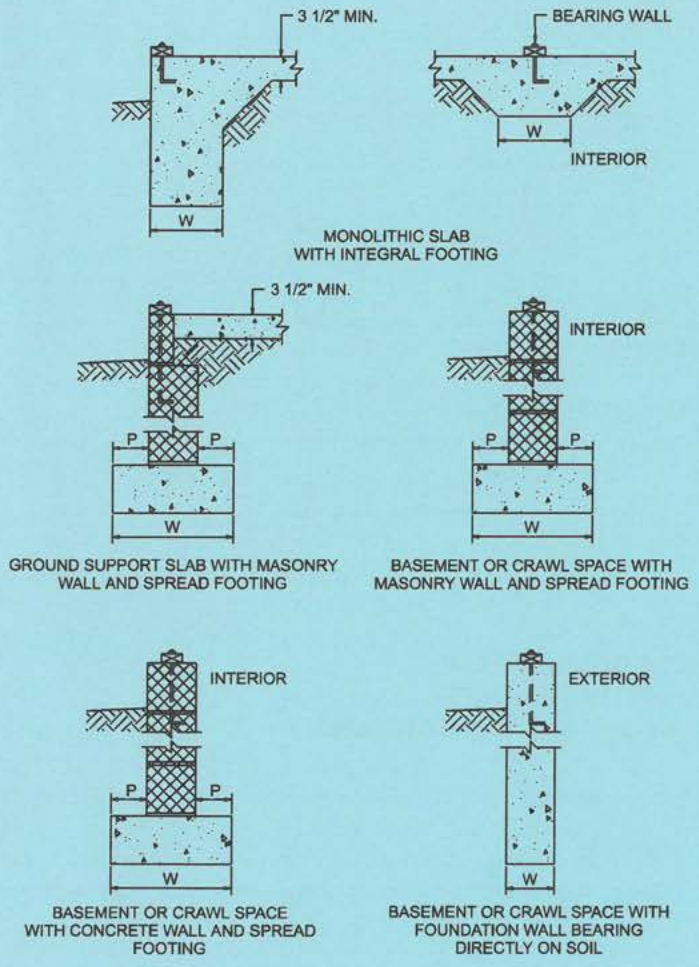


FIGURE 403.1a
CONCRETE AND MASONRY FOUNDATION DETAILS

NOTES:

1. Exterior footings shall extend to below the frost line unless otherwise protected against frost heave. In no case shall exterior footings be less than 12 inches below grade.
2. Footing widths (W) shall be based on the load–bearing value of the soil in accordance with Table 401.4.1 or shall be designed in accordance with accepted engineering practice.
3. Spread footings shall be a minimum of 6 inches thick, and footing projections (P) shall be a minimum 2 inches and shall not exceed the footing thickness.
4. Footings shall be supported on undisturbed natural soil or engineered fill.
5. Exterior walls of houses on foundation systems with more than 30 inches of unbalanced fill, and slab on grade houses shall be anchored to the foundation system or slab with at least 1/2" diameter bolts placed 6 feet on center and not more than 12 inches from corners. Bolts shall extend a minimum of 15 inches into into masonry or 7 inches into concrete.
6. Pier and column footing sizes shall be based on the tributary load and allowable soil pressure in accordance with Table 403.1a.

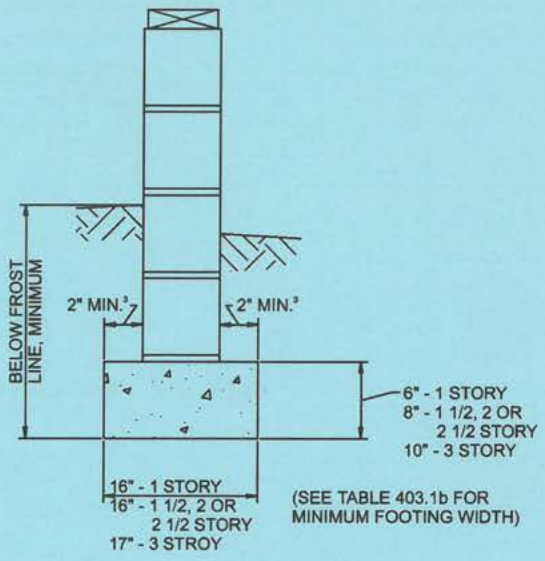


Figure 403.1b
MINIMUM FOUNDATION REQUIREMENTS [1,2]

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 allwable 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.

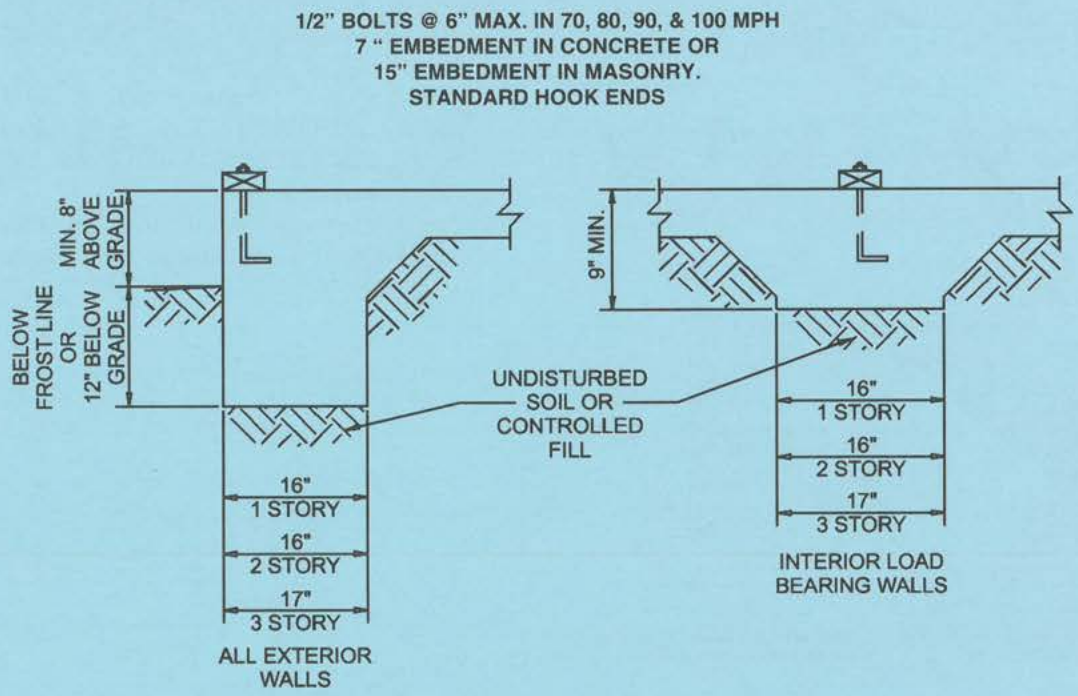


FIGURE 403.1c CONCRETE SLAB FOOTING FOR 70,80, 90 AND 100 MPH WIND ZONES (SEE SECTION 4004 FOR 100E mph and above WIND ZONES)

TABLE 403.1a
PIER[1] AND FOOTING[2] SIZES FOR SUPPORT OF GIRDERS

	1 (One) Story		2 (Two) Story		2-1/2 (Two & One Half) Story	
Area[5]	Pier [3, 4]	Footing	Pier[3, 4]	Footing	Pier[3, 4]	Footing
50	8" x 16"	1' -4" x 2' -0" x 8"	8" x 16"	1' -4" x 2 -6" x 8"	8" x 16"	1' -4" x 2' -6" x 8"
100	8" x 16"	1' -4" x 2' -0" x 8"	8" x 16"	2' -0" x 2' -0" x 10"	16" x 16"	2' -6" x 2' -6" x 10"
150	8" x 16"	2' -0" x 2' -0" x 8"	16" x 16"	2' -8" x 2' -8" x 10"	16" x 16"	3' -0" x 3' -0" x 10"
200	8" x 16"	2' -4" x 2' -4" x 10"	16" x 16"	3' -0" x 3' -0 x 10"	16" x 16"	3' -11" x 3' -8" x 1' -0"
250	–	–	16" x 16"	3' -4" x 3' -4" x 1' -0"	16" x 24"	4' -0" x 4' -0" x 1' -0"
300	–	–	16" x 16"	3' -8" x 3'-8" x 1' -0"	16" x 24"	4' -6" x 4' -6" x 1' -0"

FOOTNOTES:

1. Pier sizes are based on hollow CMU capped with 4" of solid masonry for 1 (one) story and 8" of solid masonry for 2 (two) and 2-1/2 story houses. Mortar shall be Type S.
2. Footing sizes are based on 2000 psf allowable soil bearing and 2500 psi concrete.
3. Centers of piers shall bear in the middle 1/3 of the footings, and girders shall center in the middle 1/3 of the piers, except exterior girders. Footings shall be full thickness over the the entire area of the footing.
4. Pier sizes given are minimum. For height/thickness limitations see Section 604.5. In 100E mph and above wind zones, footings shall be sized to accommodate the anchor connections of Chapter 40.
5. Area at first level supported by pier and footing (sq. ft.).

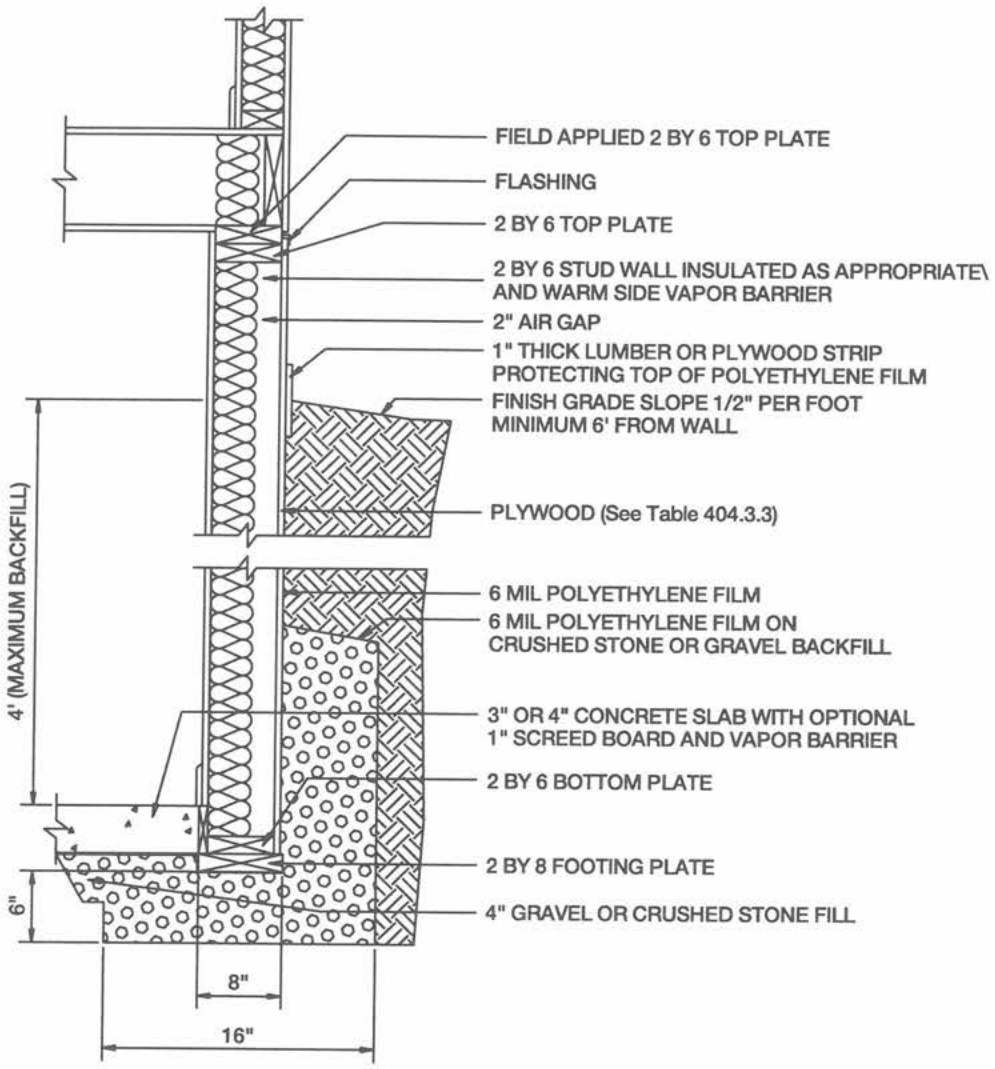


FIGURE 403.1d
TYPICAL DETAILS FOR WOOD FOUNDATION BASEMENT WALLS

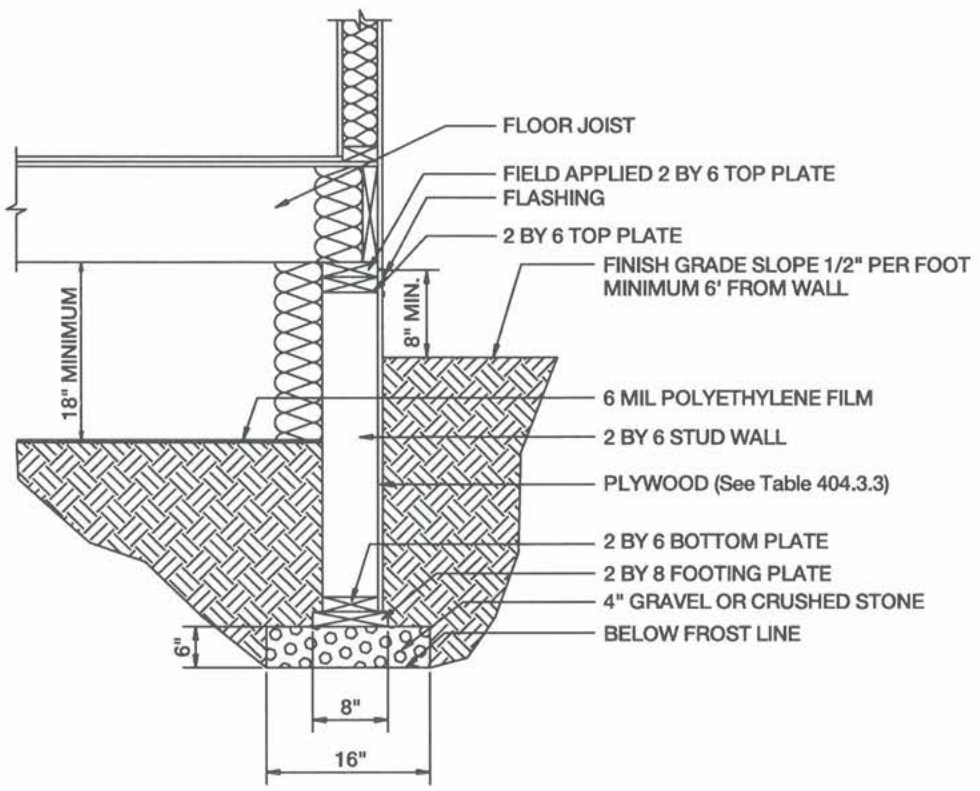


FIGURE 403.1e
TYPICAL DETAILS FOR WOOD FOUNDATION CRAWL SPACE WALLS

TABLE 403.1b
MINIMUM WIDTH OF CONCRETE OR MASONRY FOOTINGS (inches)

	LOAD–BEARING VALUE OF SOIL (psf)					
	1,500	2,000	2,500	3,000	3,500	4,000
Convention Wood Frame Construction						
1–story	16	16	10	8	7	6
2–story	19	16	12	10	8	7
3–story	22	17	14	11	10	9
4–Inch Brick Veneer over Wood Frame or 8–Inch Hollow Concrete Masonry						
1–story	19	16	12	10	8	7
2–story	25	19	15	13	11	10
3–story	31	23	19	16	13	12
8–Inch Solid or Fully Grouted Masonry						
1–story	22	17	13	11	10	9
2–story	31	23	19	16	13	12
3–story	40	30	24	20	17	15

For SI: 1 inch = 25.4 mm, 1 psf = 0.0479 kN/m2.

TABLE 403.3
MINIMUM INSULATION REQUIREMENTS FOR SLAB ON GRADE FROST–PROTECTED FOOTINGS IN HEATED BUILDINGS[1]

AIR FREEZING INDEX (°F.–days)[2]	VERTICAL INSULATION R–VALUE[3,4]	HORIZONTAL INSULATION R–VALUE[3,5]		HORIZONTAL INSULATION DIMENSIONS PER FIGURE 403.3 (inches)		
		along walls	at corners	A	B	C
1,500 or less	4.5	NR	NR	NR	NR	NR
2,000	5.6	NR	NR	NR	NR	NR
2,500	6.7	1.7	4.9	12	24	40
3,000	7.8	6.5	8.6	12	24	40
3,500	9.0	8.0	11.2	24	30	60
4,000	10.1	10.5	13.1	24	36	60

For SI: 1 inch = 25.4 mm, °F. = 1.8°C. + 32.

1. Insulation requirements are for protection against frost damage in heated buildings. Greater values may be required to meet energy conservation standards. Interpolation between values is permissible.
2. See Figure 403.3b for Air Freezing Index values.
3. Insulation materials shall provide the stated minimum R–values under long–term exposure to moist, below–ground conditions in freezing climates. The following R–values shall be used to determine insulation thicknesses required for this application: Type II expanded polystyrene—2.4R per inch; Type IV extruded polystyrene—4.5R per inch; Type VI extruded polystyrene—4.5R per inch; Type IX expanded polystyrene—3.2R per inch; Type X extruded polystyrene—4.5R per inch. NR indicates that insulation is not required.
4. Vertical insulation shall be expanded polystyrene insulation or extruded polystyrene insulation.
5. Horizontal insulation shall be extruded polystyrene insulation.

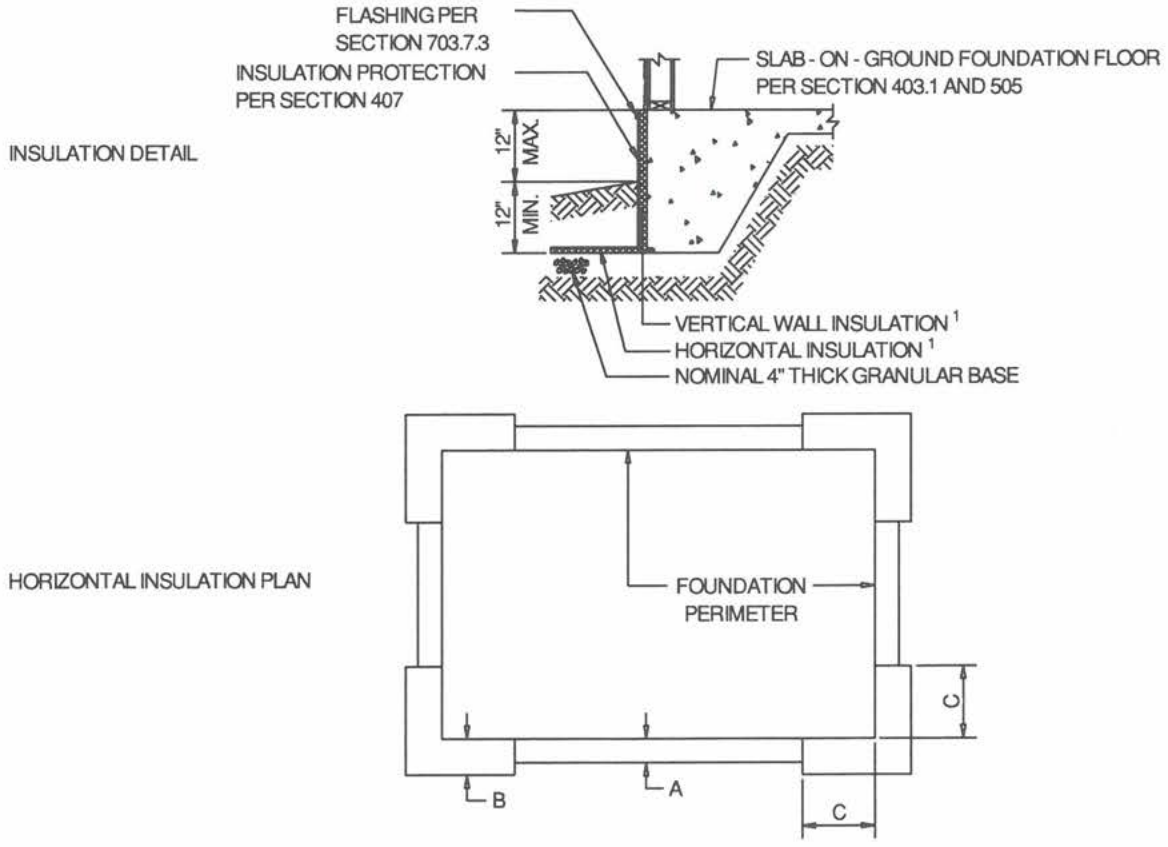
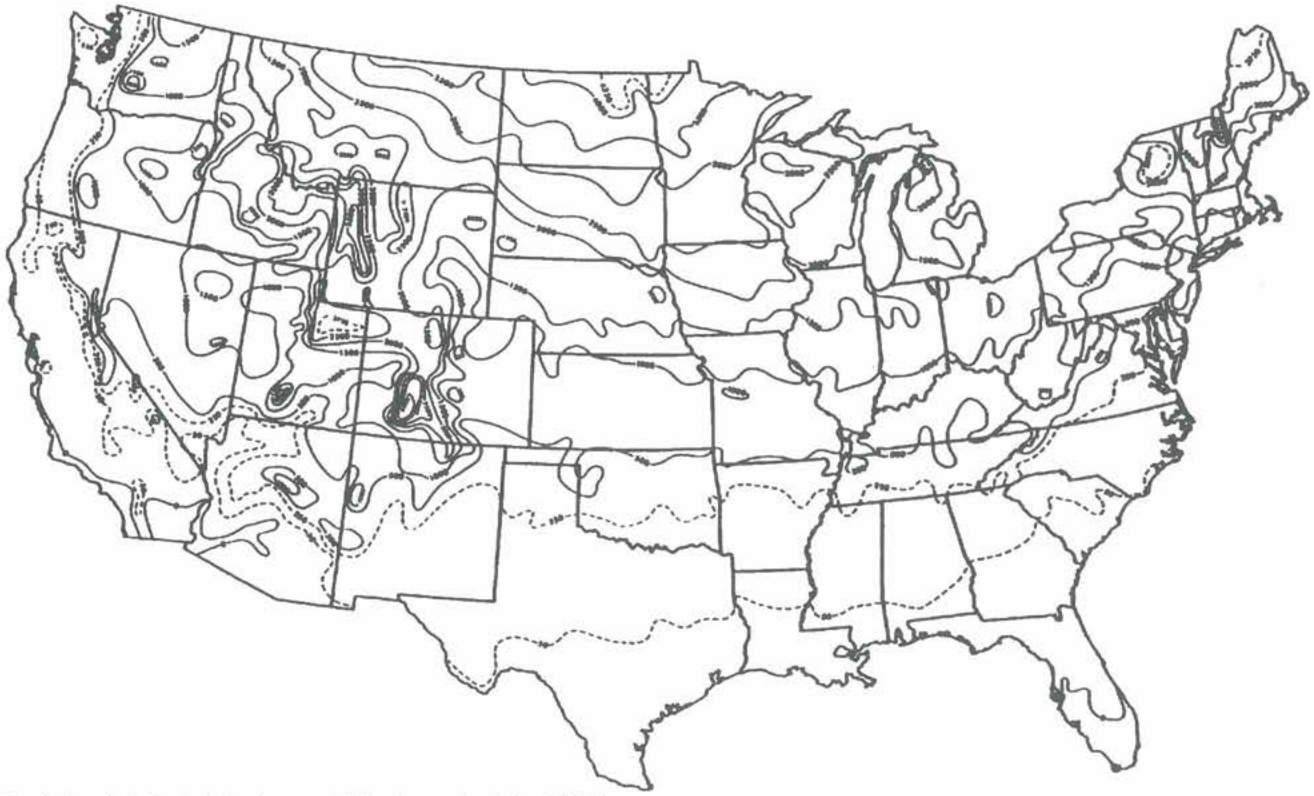


FIGURE 403.3a
INSULATION PLACEMENT FOR FROST–PROTECTED FOOTINGS IN HEATED BUILDINGS
(SEE APPENDIX E)



The air-freezing index is defined as cumulative degree days below 32°F. It is used as a measure of the combined magnitude and duration of air temperature below freezing. The index was computed over a 12-month period (July-June) for each of the 3,044 stations used in the above analysis. Data from the 1951-80 period were fitted to a Weibull probability distribution to produce an estimate of the 100-year return period.

FIGURE 403.3b
AIR–FREEZING INDEX (°F.)
An estimate of the 100–year return period

SECTION 404
FOUNDATION WALLS

404.1 Concrete and masonry foundation walls. Foundation walls shall be constructed in accordance with the provisions of this section or in accordance with ACI 318, ACI 318.1, NCMA TR68–A or ACI 530/ASCE 5/TMS 402 or other approved structural systems.

Exception: When ACI 530/ASCE 5/TMS 402 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.

404.1.1 Masonry and concrete wall construction. Masonry and concrete foundation walls shall be constructed using the following criteria:

1. Masonry or concrete foundation walls located in Seismic Zone 0, 1 or 2, as established in Table 301.2a, shall be constructed as set forth in Table 404.1.1a.
   Exception: Where unstable soil conditions exist or where the foundation extends to or below the seasonal high groundwater table, foundation walls shall be constructed in accordance with Table 404.1.1b.
2. Masonry or concrete foundation walls located in Seismic Zone 3 or 4, as established in Table 301.2a, shall be constructed as set forth in Table 404.1.1b.

404.1.2 Design required. Foundation walls subject to more pressure than would be exerted by backfill having an equivalent fluid weight of 30 pounds per cubic foot (141 kN/m3) shall be designed in accordance with accepted engineering practice.

TABLE 404.1.1a
MINIMUM THICKNESS AND ALLOWABLE DEPTH OF UNBALANCED FILL FOR UNREINFORCED MASONRY AND CONCRETE FOUNDATION WALLS [1,2] WHERE UNSTABLE SOIL OR GROUNDWATER CONDITIONS DO NOT EXIST IN SEISMIC ZONES 0, 1 OR 2

FOUNDATION WALL CONSTRUCTION	NOMINAL THICKNESS[3] (inches)	MAXIMUM DEPTH OF UNBALANCED FILL[1] (feet)
Masonry of Hollow Units,	8	4
	10	5
	12	6
Masonry of Solid Units	6	3
	8	5
	10	6
	12	7
Masonry of Hollow or Solid Units, Fully Grouted	6	3
	8	7
	10	8
	12	8
Plain Concrete	6[4]	6
	8	7
	10	8
	12	8
Rubble Stone Masonry	16	8
Masonry of hollow units reinforced vertically with No. 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

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

1. Unbalanced fill is the difference in height of the exterior and interior finish ground levels. Where an interior concrete slab is provided, the unbalanced fill shall be measured from the exterior finish ground level to the top of the interior concrete slab.
2. The height between lateral supports shall not exceed 8 feet.
3. The actual thickness shall not be more than 1/2 inch less than the required nominal thickness specified in the table.
4. Six–inch plain concrete walls shall be formed on both sides.

TABLE 404.1.1b
REQUIREMENTS FOR MASONRY OR CONCRETE FOUNDATION WALLS SUBJECTED TO NO MORE PRESSURE THAN WOULD BE EXERTED BY BACKFILL HAVING AN EQUIVALENT FLUID WEIGHT OF 30 POUNDS PER CUBIC FOOT LOCATED IN SEISMIC ZONE 3 OR 4 OR SUBJECTED TO UNSTABLE SOIL CONDITIONS

MATERIAL TYPE	HEIGHT OF UNBALANCED FILL IN FEET[1]	LENGTH OF WALL BETWEEN SUPPORTING MASONRY OR CONCRETE WALLS IN FEET	REQUIRED REINFORCING MINIMUM[2] WALL THICKNESS IN INCHES[3]	Horizontal Bar in Upper 12 Inches of Wall	Size and Spacing of Vertical Bars
Hollow Masonry	4 or less	unlimited	8	not required	not required
	more than 4	design required	design required	design required	design required
Concrete or Solid Masonry[4]	4 or less	unlimited	8	not required	not required
	more than 4	less than 8	8	2–No. 3	No. 3 @ 18" o.c.
	8 or less	8 to 10	8	2–No. 4	No. 3 @ 18" o.c.
	8 or less	10 to 12	8	2–No. 5	No. 3 @ 18" o.c.
	more than 8	design required	design required	design required	design required

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per cubic foot (pcf) = 0.1572 kN/m3.

1. Backfilling shall not be commenced until after the wall is anchored to the floor.
2. Thickness of concrete walls may be 6 inches, provided reinforcing is placed not less than 1 inch or more than 2 inches from the face of the wall not against the earth.
3. The actual thickness shall not be more than 1/2 inch less than the required thickness specified in the table.
4. Solid masonry shall include solid brick or concrete units and hollow masonry units with all cells grouted.

404.1.3 Backfill. Foundation walls shall extend at least 8 inches (153 mm) 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 (102 mm) above the finished grade.

404.1.3.1 Backfill placement. Backfill adjacent to the wall shall not be placed until the wall has sufficient strength and has been anchored to the floor, or has been sufficiently braced to prevent damage by the backfill.

Exception: Such bracing is not required for walls having less than 3 feet (914 mm) of unbalanced backfill.

404.1.3.2 Unbalanced fill. Exterior walls of houses on foundation systems with more than 30 inches of unbalanced fill, and slab on grade houses shall be anchored to the foundation system or slab with at least 1/2" diameter bolts placed 6 feet on center and not more than 12 inches from corners. Bolts shall extend a minimum of 15 inches into into masonry or 7 inches into concrete (See Figure 403.1a).

404.2 Design required. Foundation walls subject to more lateral pressure than would be exerted by backfill consisting of freely draining sands and gravel classified as Group 1 according to the United States Soil Classification System or soils having an equivalent fluid weight of greater than 30 pounds per cubic foot (4.72 kN/m3) shall be designed in accordance with accepted engineering practices.

404.3 Wood foundation walls. Wood foundation walls shall be constructed in accordance with the provisions of Sections 404.3.1 through 404.3.5 and with the details shown in Figures 403.1b and 403.1c.

404.3.1 Wood grade. All load–bearing lumber and plywood shall conform to applicable standards or grading rules and be identified by a grade mark or certificate of inspection issued

TABLE 404.3.3
PLYWOOD GRADE AND THICKNESS FOR WOOD FOUNDATION CONSTRUCTION
(30 pcf equivalent–fluid weight soil pressure)

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

For **SI**: 1 inch = 25.4 mm, 1 pound per cubic foot = 0.1572 kN/m3.

1. Plywood shall be of the following minimum grades in accordance with DOC PS 1 or DOC PS 2:
   (i) DOC PS 1 Plywood grades marked:
      a. Structural I C–D (Exposure 1)
      b. C–D (Exposure 1)
   (ii) DOC PS 2 Plywood grades marked:
      a. Structural I Sheathing (Exposure 1)
      b. Sheathing (Exposure 1)
   (iii) Where a major portion of the wall is exposed above ground and a better appearance is desired, the following plywood grades marked Exterior are suitable:
      a. Structural I A–C, Structural I B–C or Structural I C–C (Plugged) in accordance with DOC PS 1
      b. A–C Group 1, B–C Group 1, C–C (Plugged) Group 1 or MDO Group 1 in accordance with DOC PS 1
      c. Single Floor in accordance with DOC PS 2
2. 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.
3. 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.

404.3.2 Stud size. The studs used in foundation walls shall be 2 by 6 (51 by 153) members. When spaced 16 inches (406 mm) on center, a wood species with an Fb value of not less than 1,250 (8612 kPa) as listed in Table 502.3.1c shall be used. When spaced 12 inches (305 mm) on center, an Fb of not less than 875 (6029 kPa) shall be required.

404.3.3 Height of backfill. The height of backfill against a foundation wall shall not exceed 4 feet (1219 mm). When the height of fill is more than 12 inches (305 mm) above the interior grade of a crawl space or floor of a basement, the thickness of the plywood sheathing shall meet the requirements of Table 404.3.3.

404.3.4 Backfilling. Wood foundation walls shall not be backfilled until the basement floor and first floor have been constructed or the walls have been braced. For crawl space construction, backfill or bracing shall be installed on the interior of the walls prior to placing backfill on the exterior.

404.3.5 Drainage and dampproofing. Wood foundation basements shall be drained and dampproofed in accordance with Section 405 and Section 406, respectively.

SECTION 405
FOUNDATION DRAINAGE

405.1 Concrete or masonry foundations. Drains shall be provided around all concrete or masonry foundations 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 (305 mm) beyond the outside edge of the footing and 6 inches (153 mm) 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 (51 mm) of washed gravel or crushed rock at least one sieve size larger than the tile joint opening or perforation and covered with not less than6 inches (153 mm) 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, as detailed Table 405.1.

405.2 Wood foundations. Wood foundations enclosing habitable or usable spaces located below grade shall be adequately drained in accordance with Sections 405.2.1 through 405.2.3.

405.2.1 Base. A porous layer of gravel, crushed stone or coarse sand shall be placed to a minimum thickness of 4 inches (102 mm) under the basement floor. Provision shall be made for automatic draining of this layer and the gravel or crushed stone wall footings.

405.2.2 Moisture barrier. A 6–mil–thick (0.15 mm) polyethylene moisture barrier shall be applied over the porous layer with the basement floor constructed over the polyethylene.

405.2.3 Drainage system. 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 (610 mm) in diameter or 20 inches square (0.0129 m2), shall extend at least 24 inches (610 mm) 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 406
FOUNDATION WATERPROOFING AND DAMPPROOFING

406.1 Concrete and masonry foundation dampproofing. Except where required to be waterproofed by Section 406.2, foundation wall shall be dampproofed from the top of the footing to the finished grade. Masonry walls shall be dampproofed by applying not less than 3/8 inch (9.5 mm) portland cement parging to the exterior of the wall. The parging shall be covered with a bituminous coating,3 pounds per square yard (1.63 kg/m2) of acrylic modified cement, 1/8–inch (3.2 mm) coat of surface–bonding mortar complying with ASTM C 887 or any material permitted for waterproofing in Section 406.2. Concrete walls shall be dampproofed by applying any one of the above listed dampproofing materials or any one of the waterproofing materials listed in Section 406.2 to the exterior of the wall.

Exception: Waterproofing and dampproofing 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, as detailed in Table 405.1

406.2 Concrete and masonry foundation waterproofing. In areas where a high water table or other severe soil–water conditions are known to exist, exterior foundation walls enclosing habitable space shall be waterproofed with a membrane extending from the top of the footing to the finished grade. The membrane shall consist of 2–ply hot–mopped felts, 55 pound (25 kg) roll roofing, 6–mil (0.15 mm) polyvinyl chloride, 6–mil (0.15 mm) polyethylene or 40–mil (1 mm) polyner–modified asphalt. The joints in the membrane shall be lapped and sealed with an adhesive compatible with the waterproofing membrane.

TABLE 405.1
PROPERTIES OF SOILS CLASSIFIED ACCORDING TO THE UNIFIED SOIL CLASSIFICATION SYSTEM

SOIL GROUP	UNIFIED SOIL CLASSIFICATION SYSTEM SYMBOL	SOIL DESCRIPTION	DRAINAGE CHARACTERISTICS[1]	FROST HEAVE POTENTIAL	VOLUME CHANGE POTENTIAL EXPANSION
Group I	GW	Well–graded gravels, gravel sand mixtures, little or no fines.	Good	Low	Low
	GP	Poorly graded gravels or gravel sand mixtures, little or no fines.	Good	Low	Low
	SW	Well–graded sands, gravelly sands, little or no fines.	Good	Low	Low
	SP	Poorly graded sands or gravelly sands, little or no fines.	Good	Low	Low
	GM	Silty gravels, gravel–sand–silt mixtures.	Good	Medium	Low
	SM	Silty sand, sand–silt mixtures.	Good	Medium	Low
Group II	GC	Clayey gravels, gravel–sand–clay mixtures.	Medium	Medium	Low
	SC	Clayey sands, sand–clay mixture.	Medium	Medium	Low
	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.	Medium	High	Low
	CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.	Medium	Medium	Medium[2] to Low
Group III	CH	Inorganic clays of high plasticity, fat clays.	Poor	Medium	High[2]
	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.	Poor	High	High
Group IV	OL	Organic silts and organic silty clays of low plasticity.	Poor	Medium	Medium
	OH	Organic clays of medium to high plasticity, organic silts.	Unsatisfactory	Medium	High
	Pt	Peat and other highly organic soils.	Unsatisfactory	Medium	High

For SI: 1 inch = 25.4 mm.

1. The percolation rate for good drainage is over 4 inches per hour, medium drainage is 2 to 4 inches per hour, and poor is less than 2 inches per hour.
2. Dangerous expansion might occur if these two soil types are dry but subject to future wetting.

406.3 Dampproofing for wood foundations. Wood foundations enclosing habitable or usable spaces located below grade shall be dampproofed in accordance with Sections 406.3.1 through 406.3.5.

406.3.1 Panel joint sealed. 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.

406.3.2 Below grade moisture barrier. A 6–mil–thick (0.15 mm) 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 (153 mm) 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 (229 mm) 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.

406.3.3 Porous fill. 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 (305 mm) 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 (13.6 kg) asphalt paper or 6–mil (0.15 mm) polyethylene to permit water seepage while avoiding infiltration of fine soils.

406.3.4 Backfill. 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 (153 mm to 203 mm) layers and tamped to consolidate the fill and remove voids where water might collect.

406.3.5 Final grading. Final grading shall provide a downward slope away from the house along all foundation walls. The final grade shall provide a minimum slope of one–half unit vertical in 12 units horizontal (4–percent slope) for a minimum of 6 feet (1829 mm) from the house.

SECTION 407
FOUNDATION INSULATION

407.1 Protection of exposed foundation insulation. Foundation walls and the edges of slab–on–ground floors with exterior applied insulation shall have a rigid, opaque and weather–resistant protective covering to prevent the degradation of thermal performance. The protective covering shall cover the exposed insulation and extend to a minimum of 6 inches (153 mm) below grade.

407.2 See Chapter 39 Energy Conservation

SECTION 408
COLUMNS

408.1 Wood column protection. Wood columns shall be protected against decay as set forth in Section 322.

408.2 Steel column protection. All surfaces (inside and outside) of steel columns shall be given a shop coat of rust–inhibitive paint, except for corrosion–resistant steel and steel treated with coatings to provide corrosion resistance.

408.3 Structural requirements. The columns shall be restrained to prevent lateral displacement at the bottom end. Wood columns shall not be less in nominal size than 4 inches by4 inches (102 mm by 102 mm) and steel columns shall not be less than 3–inch–diameter (76 mm) standard pipe or approved equivalent.

SECTION 409
CRAWL SPACE

409.1 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 ventilation openings through foundation walls or exterior walls. Ventilation openings shall be provided with corrosion–resistant wire mesh, with the least dimension being 1/8 inch (3.2 mm). The minimum net area of ventilation openings shall not be less than1 square foot for each 150 square feet (0.67 m2 for each 100 m2) of crawl space area.

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 (914 mm) 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 2104.
5. Ventilation openings may be omitted when continuously operated mechanical ventilation is provided at a rate of 1.0 cfm for each 50 square feet (1.02 L/s for each 10 m2) of crawl space floor area and ground surface is covered with an approved vapor barrier material.

409.2 Access. An access crawl hole 18 inches high by 24 inches wide (457 mm by 610 mm) shall be provided to the under–floor space. See Chapter 14 for mechanical equipment.

409.3 Removal of debris. The under–floor grade shall be cleaned of all vegetation and organic material. All wood forms used for placing concrete shall be removed before a building is occupied or used for any purpose. All construction materials shall be removed before a building is occupied or used for any purpose.

409.4 Finished grade. The finished grade of under–floor surface may be located at the bottom of the footings; however, where there is evidence that the groundwater table can rise to within 6 inches (153 mm) of the finished floor at the building perimeter or where there is evidence that the 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 5
FLOORS

SECTION 501
GENERAL

501.1 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 108 shall be accepted as complying with this code.

501.2 Requirements. Floor construction shall be capable of accommodating all loads imposed according to Section 301 and transmitting the resulting loads imposed according to structural elements.

501.3 Exterior Decks. Exterior Decks shall be constructed in accordance with Appendix A.

SECTION 502
FLOOR FRAMING

502.1 General. Load-bearing dimension lumber for joists, beams and girders shall conform to DOC PS 20-70 and to other 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 Fb, the allowable stress in bending a, and E, the modulus of elasticity.

502.1.1 Preservation-treated lumber. Preservation treated dimension lumber shall also be identified by the quality mark of an approved agency.

502.1.2 Blocking and subflooring. Blocking shall be a minimum of Utility grade lumber or No., 4 Common grade boards.

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

502.2 Design and construction. Floors of wood construction shall be designed and constructed in accordance with the provisions of this chapter and Figure 502.2.

502.3 Allowable girder spans. Joists, girders and floor sheathing shall comply with Sections 502.3.1 through 502.3.3 and Section 503.

502.3.1 Allowable joist spans. The clear span of floor joists shall not exceed the values set forth in Tables 502.3.1a and 502.3.1b. The modulus of elasticity, E, and the actual stress in bending, F_b, shown in the tables shall not exceed the values specified in Tables 502.3.1c and 502.3.1d listed at the end of this chapter. The values for F_b, specified as "repetitive member use" may be used when floor joists are spaced not more than 24 inches (610) on center.

502.3.2 Joists under bearing partitions. Joists under parallel bearing partitions shall be doubled or a beam of adequate size to support the load shall be provided. Double joists which are separated to permit the installation of piping or vents shall be solid blocked spaced not more than 4 feet (1219 mm) on center.

502.3.3 Allowable girder spans. The allowable spans of girders shall not exceed the values set forth in Tables 502.3.3a thru 502.3.3(c).

502.4 Bearing. The ends of each joist, beam or girder shall have not less than 1½ inches (38 mm) of bearing on wood or metal and not less than 3 inches 76 mm on masonry except where supported on a 1-inch-by-4-inch (25 mm by 102 mm) ribbon strip and nailed to the adjacent stud or by the use of approval joist hangers.

502.4.1 Floor systems. Floor systems having joists framing from opposite sides over a bearing support shall be tied together by lapping joists a minimum of 3 inches (76 mm) or with a wood or metal splice, or by continuity of floor sheathing overlapping the ends of joist as least 3 inches (76 mm), or by other approved methods.

502.4.2 Joist framing. 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 (51 mm by 51 mm) with 3/16d nails spaced @ 2" o.c. under each joist.

502.5 Lateral restraint at supports. Joists shall be supported laterally at the ends by full-depth solid blocking not less than 2 inches (51 mm) in thickness; or by attachment to a header, band or rim joist, or to an adjoining stud; or shall be otherwise provided with lateral support to prevent rotation. Such lateral support is not required over intermediate supports such as center girders or bearing walls.

502.5.1 Bridging. Joist 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 continuous 1-inch-by-3-inch (25 mm by 76 mm) strip nailed across the bottom of joists perpendicular to joists at intervals not exceeding 10 feet (3048 mm).

502.6 Drilling 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 for a ledger, the notch shall not exceed one-fourth the joist depth. Cantilevered joists shall not be notched unless the reduced section properties and lumber defects are considered in the design. See Figure 502.6.

502.7 Holes. Holes drilled or bored in joists shall not be within 2 inches (51 mm) of the top or bottom of joists, and their diameter shall not exceed one-third the depth of the joist. Exception: See Figure 502.7.

502.8 Fastening. Floor framing shall be nailed in accordance with Table 602.3a. 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.

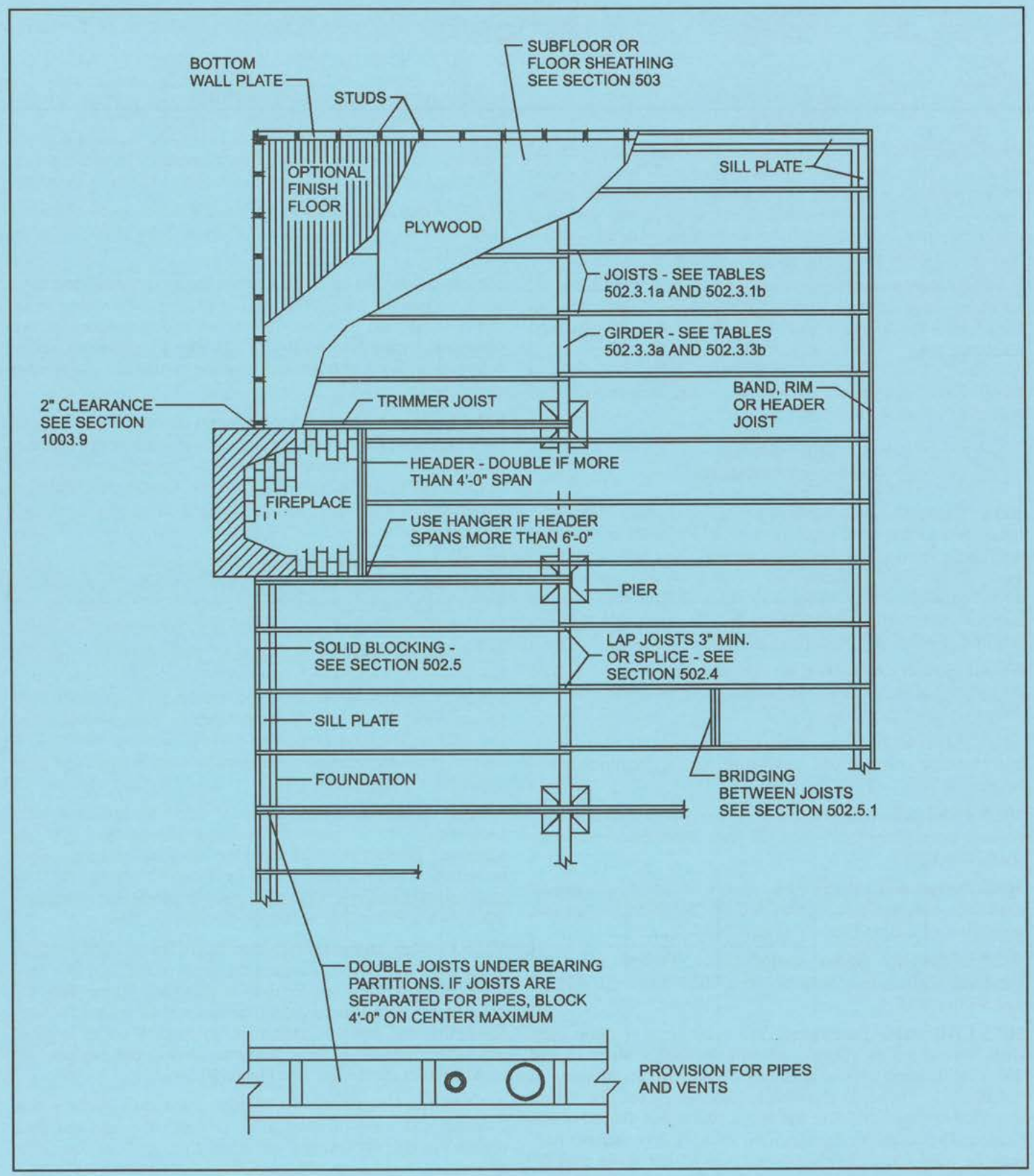


FIGURE 502.2
FLOOR CONSTRUCTION

TABLE 502.3.1a—continued

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 AND SPACING		MODULUS OF ELASTICITY, "E," IN 1,000,000 PSI								
(inches)	(inches)	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.2	2.4
2 x 6	12.0	10-3	10-6	10-9	10-11	11-2	11-4	11-7	11-11	12-3
		1,040	1,090	1,140	1,190	1,230	1,280	1,320	1,410	1,490
	13.7	9-10	10-0	10-3	10-6	10-8	10-10	11-1	11-5	11-9
		1,090	1,140	1,190	1,240	1,290	1,340	1,380	1,470	1,560
	16.0	9-4	9-6	9-9	9-11	10-2	10-4	10-6	10-10	11-2
		1,150	1,200	1,250	1,310	1,360	1,410	1,460	1,550	1,640
	19.2	8-9	9-0	9-2	9-4	9-6	9-8	9-10	10-2	10-6
		1,220	1,280	1,330	1,390	1,440	1,500	1,550	1,650	1,750
	24.0	8-2	8-4	8-6	8-8	8-10	9-0	9-2	9-6	9-9
		1,310	1,380	1,440	1,500	1,550	1,610	1,670	1,780	1,880
	32.0	7-5	7-7	7-9	7-11	8-0	8-2	8-4	8-7	8-10
		1,450	1,520	1,590	1,660	1,690	1,760	1,840	1,950	2,060
2 x 8	12.0	13-6	13-10	14-2	14-5	14-8	15-0	15-3	15-9	16-2
		1,040	1,090	1,140	1,190	1,230	1,280	1,320	1,410	1,490
	13.7	12-11	13-3	13-6	13-10	14-1	14-4	14-7	15-0	15-6
		1,090	1,140	1,190	1,240	1,290	1,340	1,380	1,470	1,560
	16.0	12-3	12-7	12-10	13-1	13-4	13-7	13-10	14-3	14-8
		1,150	1,200	1,250	1,310	1,360	1,410	1,460	1,550	1,640
	19.2	11-7	11-10	12-1	12-4	12-7	12-10	13-0	13-5	13-10
		1,220	1,280	1,330	1,390	1,440	1,500	1,550	1,650	1,750
	24.0	10-9	11-0	11-3	11-5	11-8	11-11	12-1	12-6	12-10
		1,310	1,380	1,440	1,500	1,550	1,610	1,670	1,780	1,880
	32.0	9-9	10-0	10-2	10-5	10-7	10-10	11-0	11-4	11-8
		1,450	1,520	1,570	1,650	1,700	1,790	1,840	1,950	2,070
2 x 10	12.0	17-3	17-8	18-0	18-5	18-9	19-1	19-5	20-1	20-8
		1,040	1,090	1,140	1,190	1,230	1,280	1,320	1,410	1,490
	13.7	16-6	16-11	17-3	17-7	17-11	18-3	18-7	19-2	19-9
		1,090	1,140	1,190	1,240	1,290	1,340	1,380	1,470	1,560
	16.0	15-8	16-0	16-5	16-9	17-0	17-4	17-8	18-3	18-9
		1,150	1,200	1,250	1,310	1,360	1,410	1,460	1,550	1,640
	19.2	14-9	15-1	15-5	15-9	16-0	16-4	16-7	17-2	17-8
		1,220	1,280	1,330	1,390	1,440	1,500	1,550	1,650	1,750
	24.0	13-8	14-0	14-4	14-7	14-11	15-2	15-5	15-11	16-5
		1,310	1,380	1,440	1,500	1,550	1,610	1,670	1,780	1,880
	32.0	12-5	12-9	13-0	13-3	13-6	13-9	14-0	14-6	14-11
		1,440	1,520	1,580	1,640	1,700	1,770	1,830	1,970	2,080
2 x 12	12.0	21-0	21-6	21-11	22-5	22-10	23-3	23-7	24-5	25-1
		1,040	1,090	1,140	1,190	1,230	1,280	1,320	1,410	1,490
	13.7	13-3	20-6	15-2	15-11	16-8	17-4	22-7	23-4	24-0
		1,090	1,140	1,190	1,240	1,290	1,340	1,380	1,470	1,560
	16.0	19-1	19-6	19-11	20-4	20-9	21-1	21-6	22-2	22-10
		1,150	1,200	1,250	1,310	1,360	1,410	1,460	1,550	1,640
	19.2	17-11	18-4	18-9	19-2	19-6	19-10	20-2	20-10	21-6
		1,220	1,280	1,330	1,390	1,440	1,500	1,550	1,650	1,750
	24.0	16-8	17-0	17-5	17-9	18-1	18-5	18-9	19-4	19-11
		1,310	1,380	1,440	1,500	1,550	1,610	1,670	1,780	1,880
	32.0	15-2	15-6	15-10	16-2	16-5	16-9	17-0	17-7	18-1
		1,450	1,520	1,580	1,650	1,700	1,770	1,830	1,950	2,070

For **SI:** 1 inch = 25.4 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot = 0.0479 kN/m^2.

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

TABLE 502.3.1b
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 AND SPACING		MODULUS OF ELASTICITY, "E," IN 1,000,000 PSI									
(inches)	(inches)	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3
2 x 6	12.0	7-5	8-0	8-6	8-11	9-4	9-9	10-1	10-5	10-9	11-0
		440	510	570	640	700	750	810	860	910	960
	13.7	7-1	7-8	8-2	8-7	8-11	9-4	9-8	10-0	10-3	10-6
		460	530	600	670	730	790	840	900	950	1,010
	16.0	6-9	7-3	7-9	8-2	8-6	8-10	9-2	9-6	9-9	10-1
		480	560	630	700	770	830	890	950	1,000	1,060
	19.2	6-4	6-10	7-3	7-8	8-0	8-4	8-8	8-11	9-2	9-5
		510	600	670	740	810	880	940	1,010	1,070	1,130
	24.0	5-11	6-4	6-9	7-1	7-5	7-9	8-0	8-3	8-6	8-9
		550	640	720	800	880	950	1,020	1,080	1,1590	1,210
	32.0					6-9	7-0	7-3	7-6	7-9	7-11
						960	1,040	1,110	1,190	1,270	1,330
2 x 8	12.0	9-10	10-7	11-3	11-10	12-4	12-10	13-4	13-9	14-2	14-6
		440	510	570	640	700	750	810	860	910	960
	13.7	9-4	10-1	10-9	11-4	11-10	12-3	12-9	13-2	13-6	13-11
		460	530	600	670	730	790	840	900	950	1,010
	16.0	8-11	9-7	10-2	10-9	11-3	11-8	12-1	12-6	12-10	13-2
		480	560	630	700	770	830	890	950	1,000	1,060
	19.2	8-5	9-0	9-7	10-1	10-7	11-0	11-4	11-9	12-1	12-5
		510	600	670	740	810	880	940	1,010	1,070	1,130
	24.0	7-9	8-5	8-11	9-4	9-10	10-2	10-7	10-11	11-3	11-6
		550	640	720	800	880	950	1,020	1,080	1,150	1,210
	32.0					8-11	9-3	9-7	9-11	10-2	10-6
						970	1,040	1,120	1,200	1,260	1,340
2 x 10	12.0	12-6	13-6	14-4	15-1	15-9	16-5	17-0	17-6	18-0	18-6
		440	510	570	640	700	750	810	860	910	960
	13.7	11-11	12-11	13-8	14-5	15-1	15-8	16-3	16-9	17-3	17-9
		460	530	600	670	730	790	840	900	950	1,010
	16.0	11-4	12-3	13-0	13-8	14-4	14-11	15-5	15-11	16-5	16-10
		480	560	630	700	770	830	890	950	1,000	1,060
	19.2	10-8	11-6	12-3	12-11	13-6	14-0	14-6	15-0	15-5	15-10
		510	600	670	740	810	880	940	1,010	1,070	1,130
	24.0	9-11	10-8	11-4	11-11	12-6	13-0	13-6	13-11	14-4	14-8
		550	640	720	800	880	950	1,020	1,080	1,150	1,210
	32.0					11-4	11-10	12-3	12-8	13-0	13-4
						960	1,050	1,120	1,200	1,260	1,330
2 x 12	12.0	15-2	16-5	17-5	18-4	19-2	19-11	20-8	21-4	21-11	22-6
		440	510	570	640	700	750	810	860	910	960
	13.7	14-7	15-8	16-8	17-6	18-4	19-1	19-9	20-5	21-0	21-7
		460	530	600	670	730	790	840	900	950	1,010
	16.0	13-10	14-11	15-10	16-8	17-5	18-1	18-9	19-4	19-11	20-6
		480	560	630	700	770	830	890	950	1,000	1,060
	19.2	13-0	14-0	14-11	15-8	16-5	17-0	17-8	18-3	18-9	19-3
		510	600	670	740	810	880	940	1,010	1,070	1,130
	24.0	12-1	13-0	13-10	14-7	15-2	15-10	16-5	16-11	17-5	17-11
		550	640	720	800	880	950	1,020	1,080	1,150	1,210
	32.0					13-10	14-4	14-11	15-4	15-10	16-3
						970	1,040	1,130	1,190	1,270	1,340

For **SI:** 1 inch = 25.4 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot = 0.0479 kN/m^2.

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

TABLE 502.3.1b—continued

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 AND SPACING		MODULUS OF ELASTICITY, "E," IN 1,000,000 PSI								
(inches)	(inches)	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.2	2.4
2 x 6	12.0	11-3 1,010	11-7 1,060	11-10 1,100	12-0 1,150	12-6 1,200	12-6 1,240	12-9 1,280	13-1 1,370	13-6 1,450
	13.7	10-10 1,060	11-1 1,110	11-3 1,160	11-6 1,200	11-9 1,250	11-11 1,300	12-2 1,340	12-7 1,430	12-11 1,510
	16.0	10-3 1,110	10-6 1,160	10-9 1,220	10-11 1,270	11-2 1,320	11-4 1,360	11-7 1.410	11-11 1,500	12-3 1,590
	19.2	9-8 1,180	9-10 1,240	10-1 1,290	10-4 1,350	10-6 1,400	10-8 1,450	10-10 1,500	11-3 1,600	11-7 1,690
	24.0	8-11 1,270	9-2 1,330	9-4 1,390	9-7 1,450	9-9 1,510	9-11 1,560	10-1 1,620	10-5 1,720	10-9 1,820
	32.0	8-2 1,410	8-4 1,470	8-6 1,530	8-8 1,590	8-10 1,650	9-0 1,710	9-2 1,780	9-6 1,910	9-9 2,010
2 x 8	12.0	14-11 1,010	15-3 1,060	15-7 1,100	15-10 1,150	16-2 1,200	16-6 1,240	16-9 1,280	17-4 1,370	17-10 1,450
	13.7	14-3 1,060	14-7 1,110	14-11 1,160	15-2 1,200	15-6 1,250	15-9 1,300	16-0 1,340	16-7 1,430	17-0 1,510
	16.0	13-6 1,110	13-10 1,160	14-2 1,220	14-5 1,270	14-8 1,320	15-0 1,360	15-3 1,410	15-9 1,500	16-2 1,590
	19.2	12-9 1,180	13-0 1,240	13-4 1,290	13-7 1,350	13-10 1,400	14-1 1,450	14-4 1,500	1`4-9 1,600	15-3 1,690
	24.0	11-10 1,270	12-1 1,330	12-4 1,390	12-7 1,450	12-10 1,510	13-1 1,560	13-4 1,620	13-9 1,720	14-2 1,820
	32.0	10-9 1,410	11-0 1,470	11-3 1,540	11-5 1,590	11-8 1,660	11-11 1,730	12-1 1,780	12-6 1,900	12-10 2,010
2 x 10	12.0	19-0 1,010	19-5 1,060	19-10 1,100	20-3 1,150	20-8 1,200	21-0 1,240	21-5 1,280	22-1 1,370	22-9 1,450
	13.7	18-2 1,060	18-7 1,110	19-0 1,160	19-4 1,200	19-9 1,250	20-1 1,300	20-5 1,340	21-1 1,430	21-9 1,510
	16.0	17-3 1,110	17-8 1,160	18-0 1,220	18-5 1,270	18-9 1,320	19-1 1,360	19-5 1,410	20-1 1,500	20-8 1,590
	19.2	16-3 1,180	16-7 1,240	17-0 1,290	17-4 1,350	17-8 1,400	18-0 1,450	18-3 1,500	18-10 1,600	19-5 1,690
	24.0	15-1 1,270	15-5 1,330	15-9 1,390	16-1 1,450	16-5 1,510	16-8 1,560	17-0 1,620	17-6 1,720	18-0 1,820
	32.0	13-8 1,400	14-0 1,470	14-4 1,540	14-7 1,590	14-11 1,660	15-2 1,720	15-5 1,780	15-11 1,890	16-5 2,020
2 x 12	12.0	23-1 1,010	23-7 1,060	24-2 1,100	24-8 1,150	25-1 1,200	25-7 1,240	26-0 1,280	26-10 1,370	27-8 1,450
	13.7	22-1 1,060	22-7 1,110	23-1 1,160	23-7 1,200	24-0 1,250	24-5 1,300	24-10 1,340	25-8 1,430	26-5 1,510
	16.0	21-0 1,110	21-6 1,160	21-11 1,220	22-5 1,270	22-10 1,320	23-3 1,360	23-7 1,410	24-5 1,500	25-1 1,590
	19.2	19-9 1,180	20-2 1,240	20-8 1,290	21-1 1,350	21-6 1,400	21-10 1,450	22-3 1,500	22-11 1,600	23-7 1,690
	24.0	18-4 1,270	18-9 1,330	19-2 1,390	19-7 1,450	19-11 1,510	20-3 1,560	20-8 1,620	21-4 1,720	21-11 1,820
	32.0	16-8 1,400	17-0 1,460	17-5 1,530	17-9 1,590	18-1 1,650	18-5 1,720	18-9 1,780	19-4 1,890	19-11 2,010

For **SI:** 1 inch = 25.4 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot = 0.0479 kN/m^2.

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

Table No. 502.3.3(a)
ALLOWABLE SPAN FOR GIRDERS SUPPORTING ONE FLOOR ONLY

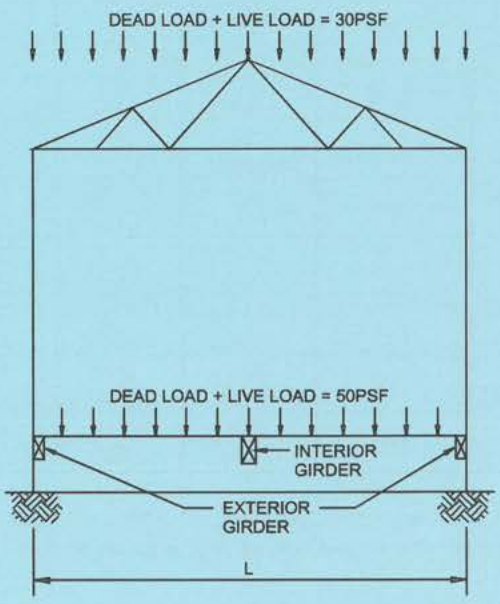
Nominal Lumber Size	INTERIOR GIRDER CLEAR SPANS [1,2] (FEET) HOUSE WIDTH (FEET) [4]									
	20		24		28		32		36	
	#2SPF	#2SP	#2SPF	#2SP	#2SPF	#2SP	#2SPF	#2SP	#2SPF	#2SP
2-2 x 8	5' -3"	6' -5"	4' -7"	5' -7"	4' -1"	4' -11"	3' -9"	4' -6"	3' -6"	4' -1"
3-2 x 8	7' -4"	7' -11"	6' -3"	7' -3"	5' -7"	6' -8"	5' -0"	6' -1"	4' -7"	5' -7"
2-2 x 10	6' -9"	7' -9"	5' -10"	7' -1"	5' -3"	6' -4"	4' -9"	5' -8"	4' -5"	5' -3"
3-2 x 10	9' -1"	9' -6"	8' -0"	8' -8"	7' -1"	8' -0"	6' -5"	7' -6"	5' -10"	7' -1"
2-2 x 12	8' -2"	9' -1"	7' -1"	8' -3"	6' -4"	7' -8"	5' -10"	6' -11"	5' -4"	6' -4"
3-2 x 12	10' -6"	11' -1"	9' -7"	10' -2"	8' -8"	9' -5"	7' -9"	8' -9"	7' -2"	8' -3"

Nominal Lumber Size	EXTERIOR GIRDER CLEAR SPANS [1,2,3] (FEET) HOUSE WIDTH (FEET)									
	20		24		28		32		36	
	#2SPF	#2SP	#2SPF	#2SP	#2SPF	#2SP	#SPF	#2SP	#2SPF	#2SP
2-2 x 8	5' -9"	6' -10"	5' -0"	6' -2"	4' -6"	5' -6"	4' -2"	5' -0"	3' -10"	4' -7"
2-2 x 10	7' -4"	8' -2"	6' -5"	7' -6"	5' -9"	7' -0"	5' -4"	6' -4"	4' -11"	5' -10"
2-2 x 12	8' -10"	9' -7"	7' -10"	8' -10"	7' -0"	8' -2"	6' -5"	7' -9"	6' -0"	7' -2"

1. Girder clear span is the distance from face of support to face of support.
2. #2SPF = Number 2 grade Spruce-Pine-Fir.
   #2SP = Number 2 grade Southern Pine (19% Max Moisture Content)
3. Exterior girder tables are for use with pier and curtain wall construction. Pier and curtain wall construction is limited to two stories in height.
4. House width is equal to 2 x girder spacing.

PSF = POUNDS PER SQUARE FOOT
(TYPICAL - ALL DIAGRAMS)

PLF = POUNDS PER LINEAR FOOT
(TYPICAL - ALL DIAGRAMS)



ONE STORY

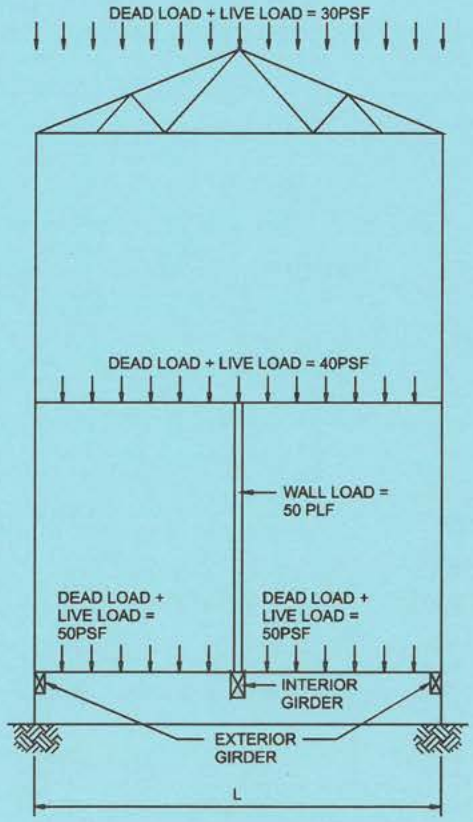
Table No.502.3.3(b)
ALLOWABLE SPAN FOR GIRDERS SUPPORTING 2-STORY ONLY

Nominal Lumber Size	INTERIOR GIRDER CLEAR SPANS[1,2,4] (FEET) HOUSE WIDTH (FEET)[5]									
	20		24		28		32		36	
	#2SPF	#2SP	#2SPF	#2SP	#2SPF	#2SP	#2SPF	#2SP	#2SPF	#2SP
3-2 x 10	5' -8"	6' -10"	5' -0"	6' -0"	4' -6"	5' -4"	4' -2"	4' -11"	3' -10"	4' -6"
4-2 x 10	7' -0"	7' -11"	6' -2"	7' -3"	5' -6"	6' -8"	5' -0"	6' -0"	4' -8"	5' -6"
3-2 x 12	6' -10"	8' -1"	6' -1"	7' -3"	5' -6"	6' -6"	5' -1"	5' -11"	4' -8"	5' -6"
4-2 x 12	8' -6"	9' -4"	7' -5"	8' -6"	6' -8"	7' -11"	6' -1"	7' -4"	5' -8"	6' -9"

Nominal Lumber Size	EXTERIOR GIRDER CLEAR SPANS[1,2,3,4] (FEET) HOUSE WIDTH (FEET)									
	20		24		28		32		36	
	#2SPF	#2SP	#2SPF	#2SP	#2SPF	#2SP	#2SPF	#2SP	#2SPF	#2SP
2-2 x 10	5' -3"	6' -4"	4' -8"	5' -7"	4' -4"	5' -1"	4' -0"	4' -8"	3' -9"	4' -4"
3-2 x 10	7' -1"	8' -0"	6' -3"	7' -5"	5' -8"	6' -10"	5' -2"	6' -3"	4' -10"	5' -9"
2-2 x 12	6' -4"	7' -8"	5' -9"	6' -10"	5' -3"	6' -2"	4' -10"	5' -8"	4' -7"	5' -4"
3-2 x 12	8' -8"	9' -5"	7' -8"	8' -8"	6' -11"	8' -1"	6' -4"	7' -7"	5' -11"	7' -0"

FOOTNOTES:

1. Girder clear span is the distance from face of support to face of support.
2. #2SPF = Number 2 grade Spruce-Pine-Fir
   #2SP = Number 2 grade Southern Pine (19% Max Moisture Content)
3. Exterior girder tables are for use with pier and curtain wall construction. Pier and curtain wall construction is limited to two stories in height.
4. For 1-1/2 story houses, use girder tables for 2 story houses.
5. House width is equal to 2 x girder spacing.



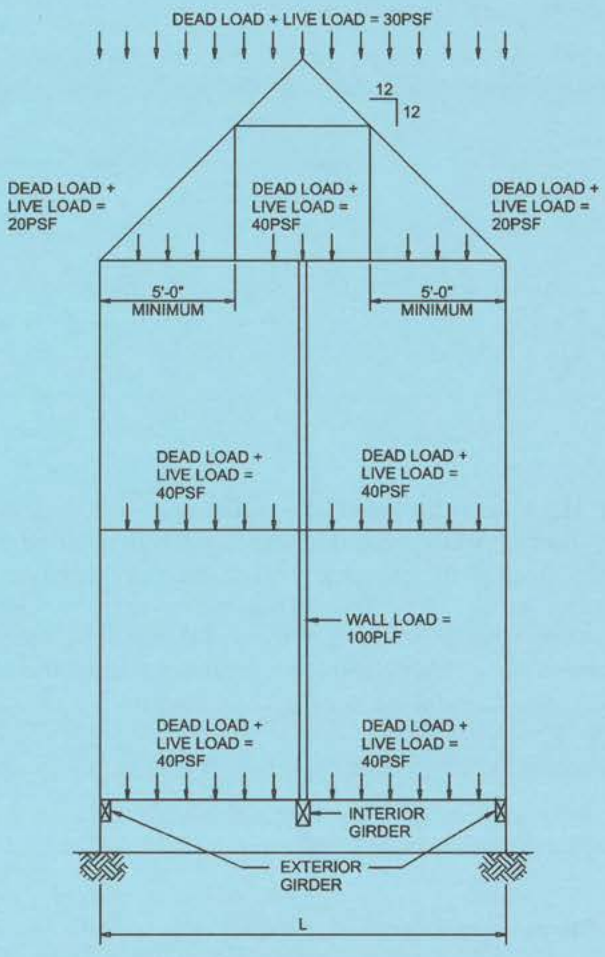
TWO STORY

Table No. 502.3.3(c)
ALLOWABLE SPAN FOR GIRDERS SUPPORTING 2 1/2 STORY ONLY

Nominal Lumber Size	INTERIOR GIRDER CLEAR SPANS [1,2,3] (FEET) HOUSE WIDTH (FEET) [4]									
	20		24		28		32		36	
	#2SPF	#2SP	#2SPF	#2SP	#2SPF	#2SP	#2SPF	#2SP	#2SPF	#2SP
4-2x10	5' -9"	6' -11"	4' -9"	5' -7"	4' -2"	4' -11"	3' -9"	4' -4"	3' -5"	3' -11"
3-2x12	5' -8"	6' -9"	4' -9"	5' -7"	4' -3"	4' -11"	3' -10"	4' -5"	3' -7"	4' -1"
4-2x12	7' -0"	8' -2"	5' -9"	6' -10"	5' -1"	5' -11"	4' -6"	5' -3"	4' -2"	4' -10"

FOOTNOTES:

1. Girder clear span is the distance from face of support to face of support.
2. #2SPF = Number 2 grade Spruce-Pine-Fir.
   #2SP = Number 2 grade Southern Pine (19% Max Moisture Content)
3. A live load reduction is taken in accordance with Volume I, Chapter 16, for 2 1/2 story construction.
4. House width is equal to 2 x girder spacing.



TWO AND ONE - HALF STORIES

502.9 Framing of openings. Openings in floor framing shall be framed with a header and trimmer joists. When the header joist span does not exceed 4 feet (1219 mm), the header joist may be a single member the same size as the floor joist. Single trimmer joists may be used to carry a single header joist that is located within 3 feet (914 mm) of the trimmer joist bearing. When the header joist span exceeds 4 feet (1219 mm), the trimmer joists and the header joist shall be doubled and of sufficient cross section to support the floor joists framing into the header. Approved hangers shall be used for the header joist to trimmer joist connections when the header joist span exceeds 6 feet (1829 mm).

502.10 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 Specifications for Metal Plate Connected Wood Trusses." 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. Truss members shall not by drilled, cut, notched or altered in any manner unless so designed.

502.11 Draftstopping required. When there is usable space above and below the concealed space of a floor/ceiling assembly, draftstops shall be installed so that the area of the concealed space does not exceed 1,000 square feet (93 m^2). Draftstopping shall divide the concealed space into approximately equal areas. Draftstopping shall be provided in floor/ceiling assemblies under the following circumstances:

1. Ceiling is suspended under the floor framing; or
2. Floor framing is constructed of truss-type open-web or perforated members.
3. The assembly is enclosed by a floor membrane above and a ceiling membrane below.

502.11.1 Materials. Draftstopping materials shall not be less that 1/2-inch (12.7 mm) gypsum board, 3/8-inch (9.5 mm) wood structural panels, 3/8-inch (9.5 mm) Type 2-M-W particleboard or other approved materials adequately supported. Draftstopping shall be installed parallel to the floor framing members unless otherwise approved by the building official. The integrity of all draftstops shall be maintained.

SECTION 503
FLOOR SHEATHING

503.1 Lumber sheathing. Maximum allowable spans for lumber used as floor sheathing shall conform to Tables 503.1, 503.2.1.1a and 503.2.1.1b.

503.1.1 End joints. 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 (406 mm) and a 1-inch (25 mm) nominal tongue-and-groove wood strip flooring is applied perpendicular to the joists.

TABLE 503.1
MINIMUM THICKNESS OF LUMBER FLOOR SHEATHING

JOIST OR BEAM SPACING (inches)	MINIMUM NET THICKNESS	
	Perpendicular to Joist	Diagonal to Joist
24	11/16	3/4
26	5/8	5/8
48[1]	1 1/2 T & G	N/A
54[2]		
60[3]		

For **SI:** 1 inch = 25.4 mm, 1 psi = 6.895 kPa..

1 Minimum *840* F_b 1,000,000 *E*.
2 Minimum *950* F_b 1,300,000 *E*.
3 Minimum *1,060* F_b 1,600,000 *E*.

503.2 Plywood sheathing.

503.2.1 Identification and grade. Plywood used for structural purposes shall conform to DOC PS 1, DOC PS 2 and HPMA (ANSI) HP, and wood structural panels shall conform to DOC PS 2. All panels shall be identified by a grade mark of certificate of Inspection issued by an approved agency.

503.2.1.1 Subfloor and combined subfloor underlayment. Where used as subflooring or combination subfloor underlayment, wood structural panels shall be of one of the grades specified in Table 503.2.1.1b.

503.2.1.2 Wood structural panels. Wood structural-use panels conforming to DOC PS 2 includes performance-rated plywood, oriented strandboard and composite panels. Oriented strandboard structural-use panels manufactured in Canada shall conform to CSA 0437.

503.2.2 Allowable spans. The maximum allowable span for wood structural panels used as subfloor or combination subfloor underlayment shall be as set forth in Table 503.2.1.1b.

503.2.3 Installation. Plywood and wood structural panels used as subfloor or combination subfloor underlayment shall be attached to framing in accordance with Table 503.2.1.1b.

503.3. Particleboard.

503.3.1 Identification and grade. Particleboard shall conform to ANSI A208.1 and shall be so identified by a grade mark or certificate of inspection issued by an approved agency.

503.3.2 Floor underlayment. Particleboard floor underlayment shall conform to Type PBU and shall not be less than 1/4 inch (6.4 mm) in thickness.

503.3.3 Installation. Particleboard underlayment shall be installed in accordance with the recommendations of the manufacturer and attached to framing in accordance with Table 602.3a.

Table 503.2.1.1a
ALLOWABLE SPANS AND LOADS FOR PLYWOOD AND WOOD STRUCTURAL PANELS FOR ROOF AND SUBFLOOR SHEATHING AND COMBINATION SUBFLOOR UNDERLAYMENT[1,2,3]

SPAN RATING	NOMINAL PANEL THICKNESS (inch)	MAXIMUM SPAN (inches)[4]		LOAD (pounds per square foot, at maximum span)		Maximum Span
		With Edge Support	Without Edge Support	Total Load	Live Load	
C-D, C-C, SHEATHING[5]		ROOF[6]				SUBFLOOR[6]
12/0	5/16	12	12	40	30	0
16/0	5/16, 3/8	16	16	40	30	0
20/0	5/16, 3/8	20	16	40	30	0
24/0	3/8, 7/16, 1/2	24	20[7]	40	30	0
24/16	7/16, 1/2	24	24	50	40	16
32/16	15/32, 1/2, 5/8	32	28	40	30	16[8]
40/20	19/32, 5/8, 3/4, 7/8	40	32	40	30	20[8,9]
48/24	23/32, 3/4, 7/8	48	36	45	35	24
UNDERLAYMENT, C-C PLUGGED, SINGLE FLOOR[10]		ROOF[6]				COMBINATION SUBFLOOR UNDERLAYMENT[11]
16 o.c.	19/32, 5/8	24	24	50	40	16[8]
20 o.c.	19/32, 5/8, 3/4	32	32	40	30	20[8,9]
24 o.c.	23/32, 3/4	48	36	35	25	24
32 o.c.	7/8, 1	48	40	50	40	32
48 o.c.	1 3/32, 1 1/8	60	48	50	40	48

For **SI:** 1 inch = 25.4 mm, 1 psf = 0.0479 kN/m^2.

1 The allowable loads were determined using a deadload of 10 psf, then the live load shall be reduced accordingly.

2 Panels continuous over two or more spans with long dimension perpendicular to supports. Spans shall be limited to values shown because of possible effect of concentrated loads.

3 Applies to panels 24 inches or wider.

4 Lumber blocking, panel edge clips (one midway between each support, except two equally spaced between supports when span is 48 inches), tongue-and-groove panel edges, or other approved type of edge support.

5 Includes Structural 1 panels in these grades.

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

7 Maximum span 24 inches for 1/2-inch panels.

8 Maximum span 24 inches where 3/4-inch wood finish flooring is installed at right angles to joists.

9 Maximum span 24 inches where 1-1/2 inches of lightweight concrete or approved cellular concrete is places over the subfloor.

10 Unsupported edges shall have tongue-and-groove joints or shall be supported with blocking unless nominal 1/4-inch-thick underlayment or 1 1/2 inches of lightweight concrete or approved cellular concrete is placed over the subfloor, or 3/4-inch wood finish flooring is used. Allowable uniform live load at maximum span, based on deflection of 1/360 of span, is 100 psf.

11 Unsupported edges shall have tongue-and-groove joints or shall be supported with blocking unless nominal 1/4-inch-thick underlayment or 3/4-inch wood finishflooring is used. Allowable uniform live load at maximum span, based on deflection of 1/360 of span, is 100 psf, except panels with a Span Rating of 48 o.c. are limited to 65 psf total uniform load at maximum span.

Table 503.2.1.1b
ALLOWABLE SPANS FOR PLYWOOD COMBINATION SUBFLOOR UNDERLAYMENT[1]

IDENTIFICATION	SPACING OF JOISTS		
	16	20	24
Species Group[2]			
1	1/2	5/8	3/4
2, 3	5/8	3/4	7/8
4	3/4	7/8	1

For **SI:** 1 inch = 25.4 mm, 1 psf = 0.0479 kN/m^2.

1 Plywood continuous over two or more spans and face grain perpendicular to supports. Unsupported edges shall be tongue-and-groove or blocked except where nominal 1/4-inch-thick underlayment or 3/4-inch wood finish floor is used. Allowable uniform live load at maximum span based on deflection of 1/360 of span is 100 psf.

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

SECTION 504
TREATED-WOOD FLOORS (ON GROUND)

504.1 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 301.

504.1.1 Unbalanced soil loads. 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 (610 mm) or less.

504.1.2 Construction. 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 overlapped 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.

504.1.3 Uplift and buckling. 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.

504.2 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.

504.2.1 Base. A minimum 4-inch-thick (102mm) granular base of gravel having a maximum size of 3/4 inch (19 mm) or crushed stone having a maximum size of 1/2 inch (12.7 mm) shall be placed over the compacted earth.

504.2.2 Moisture barrier. Polyethylene sheeting of minimum 6-mil (0.15 mm) thickness shall be placed over the granular base. Joints shall be lapped 6 inches (153 mm) 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.

504.3 Materials. All framing materials, including sleepers, joists, blocking and plywood subflooring, shall be pressure preservation treated and dried after treatment in accordance with AWPA C22.

SECTION 505
CONCRETE FLOORS (ON GROUND)

505.1 General. Concrete slab-on-ground floors shall be constructed in accordance with Figure 403.1a. The specified compressive strength of concrete at 28 days shall not be less than 2,500 pounds per square inch (17 225 kPa), except where weather exposure requires greater strength and air-entrained concrete, as set forth in Table 402.2.

505.2 Site preparation. The area within the foundation walls shall have all vegetation, top soil and foreign material removed.

505.2.1 Fill. Fill material shall be free of vegetation and foreign material. The fill shall be compacted to assure uniform support of the slab, and except where approved, the fill depths shall not exceed 24 inches (610 mm) for clean sand or gravel and 8 inches (203 mm) for earth.

505.2.2 Base. A 4-inch-thick (102 mm) base course consisting of clean graded sand, gravel, crushed stone or crushed blast-furnace slag passing a 2-inch (51 mm) sieve shall be placed on the prepared subgrade when the slab is below grade.

Exception: A base course is not required when the concrete slab is installed on well-drained or sand-gravel mixture soils according to the United Soil Classification System. Group I Soils.

505.2.3 Vapor barrier. An approved vapor barrier with joints lapped not less than 6 inches (153 mm) shall be placed between the concrete floor slab and the base course or the prepared sub- grade 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 on local site conditions.

SECTION 506
METAL

506.1 General. Elements shall be straight and free of any defects which would significantly affect structural performance.

Table 502.3.1c
DESIGN VALUES FOR DIMENSION LUMBER–VISUAL GRADING

These "F_b" values are for use where three or more repetitive members are spaced not more than 24 inches apart. For wider spacing or for single or double member headers or beams, 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	NORMAL DURATION	DESIGN VALUE IN BENDING "F_b"		MODULES OF ELASTICITY "E"	GRADING RULES AGENCY
			Snow Loading	7-Day Loading		
ASPEN						
Select Structural		1,510	1,735	1,885	1,100,000	
No. 1		1,080	1,240	1,350	1,100,000	
No. 2		1,035	1,190	1,295	1,000,000	
No. 3	2" x 4"	605	695	755	900,000	
Stud		600	690	750	900,000	
Construction		805	925	1,005	900,000	
Standard		430	495	540	900,000	Northeastern Lumber Manufacturers Association
Utility		200	230	250	800,000	
Select Structural		1,310	1,505	1,635	1,100,000	
No. 1		935	1,075	1,170	1,100,000	
No. 2	2" x 6"	895	1,030	1,120	1,000,000	Northern Softwood Lumber Bureau
No. 3		525	600	655	900,000	
Stud		545	630	685	900,000	
Select Structural		1,210	1,390	1,510	1,100,000	
No. 1		865	990	1,080	1,100,000	Western Wood Products Association
No. 2	2" x 8"	830	950	1,035	1,000,000	
No. 3		485	555	605	900,000	
Select Structural		1,105	1,275	1,385	1,100,000	
No. 1		790	910	990	1,100,000	(See Footnotes 1 and 2)
No. 2	2" x 10"	760	875	950	1,000,000	
No. 3		445	510	555	900,000	
Select Structural		1,005	1,155	1,260	1,100,000	
No. 1		720	825	900	1,100,000	
No. 2	2" x 12"	690	795	865	1,000,000	
No. 3		405	465	505	900,000	
BEECH-BIRCH-HICKORY						
Select Structural		2,500	2,875	3,125	1,700,000	
No. 1		1,810	2,085	2,265	1,600,000	
No. 2		1,725	1,985	2,155	1,500,000	
No. 3	2" x 4"	990	1,140	1,240	1,300,000	
Stud		980	1,125	1,225	1,300,000	Northeastern Lumber Manufacturers Association
Construction		1,325	1,520	1,655	1,400,000	
Standard		750	860	935	1,300,000	
Utility		345	395	430	1,200,000	
Select Structural		2,170	2,495	2,710	1,700,000	
No. 1		1,570	1,805	1,960	1,600,000	(See Footnotes
No. 2	2" x 6"	1,495	1,720	1,870	1,500,000	1 and 2)
No. 3		860	990	1,075	1,300,000	
Stud		890	1,025	1,115	1,300,000	

(Continued)

Table 502.3.1c — continued
DESIGN VALUES FOR DIMENSION LUMBER–VISUAL GRADING

Species and Grade	Size	Design Value in Bending "F_b"			Modules of Elasticity "E"	Grading Rules Agency
		Normal Duration	Snow Loading	7-Day Loading		
Select Structural		2,000	2,300	2,500	1,700,000	
No. 1		1,450	1,665	1,810	1,600,000	Northeastern
No. 2	2"x8"	1,380	1,585	1,725	1,500,000	Lumber
No. 3		795	915	990	1,300,000	Manufacturers
Select Structural		1,835	2,110	2,295	1,700,000	Association
No. 1		1,330	1,525	1,660	1,600,000	
No. 2	2"x10"	1,265	1,455	1,580	1,500,000	(See Footnotes
No. 3		725	835	910	1,300,000	1 and 2)
Select Structural		1,670	1,920	2,085	1,700,000	
No. 1		1,210	1,390	1,510	1,600,000	
No. 2	2"x12"	1,150	1,325	1,440	1,500,000	
No. 3		660	760	825	1,300,000	
COTTONWOOD						
Select Structural		1,510	1,735	1,885	1,200,000	
No. 1		1,080	1,240	1,350	1,200,000	
No. 2		1,080	1,240	1,350	1,100,000	
No. 3	2" x 4"	605	695	755	1,000,000	
Stud		600	690	750	1,000,000	
Construction		805	925	1,005	1,000,000	
Standard		460	530	575	900,000	
Utility		200	230	250	900,000	
Select Structural		1,310	1,505	1,635	1,200,000	
No. 1		935	1,075	1,170	1,200,000	Northern
No. 2	2" x 6"	935	1,075	1,170	1,100,000	Softwood
No. 3		525	600	655	1,000,000	Lumber
Stud		545	630	685	1,000,000	Bureau
Select Structural		1,210	1,390	1,510	1,200,000	
No. 1		865	990	1,080	1,200,000	
No. 2	2" x 8"	865	990	1,080	1,100,000	(See Footnotes 1
No. 3		485	555	605	1,000,000	and 2)
Select Structural		1,105	1,275	1,385	1,200,000	
No. 1		790	910	910	1,200,000	
No. 2	2" x 10"	790	910	990	1,100,000	
No. 3		445	510	555	1,000,000	
Select Structural		1,005	1,155	1,260	1,200,000	
No. 1		720	825	900	1,200,000	
No. 2	2" x 12"	720	825	900	1,100,000	
No. 3		405	465	505	1,000,000	
DOUGLAS FIR-LARCH						
Select Structural		2,500	2,875	3,125	1,900,000	West Coast
No. 1 & Btr		1,985	2,280	2,480	1,800,000	Lumber
No. 1		1,725	1,985	2,155	1,700,000	Inspection
No. 2	2" x 4"	1,510	1,735	1,885	1,600,000	Bureau
No. 3		865	990	1,080	1,400,000	Western Wood
Stud		855	980	1,065	1,400,000	Products
Construction		1,150	1,325	1,440	1,500,000	Association
Standard		635	725	790	1,400,000	(See Footnotes
Utility		315	365	395	1,300,000	1 and 2)

(Continued)

Table 502.3.1c — continued
DESIGN VALUES FOR DIMENSION LUMBER–VISUAL GRADING

Species and Grade	Size	Design Value in Bending "F_b"			Modules of Elasticity "E"	Grading Rules Agency
		Normal Duration	Snow Loading	7-Day Loading		
Select Structural		2,170	2,495	2,710	1,900,000	
No. 1 & Btr		1,720	1,975	2,150	1,800,000	
No. 1	2" x 6"	1,495	1,720	1,870	1,700,000	
No. 2		1,310	1,505	1,635	1,600,000	
No. 3		750	860	935	1,400,000	
Stud		775	895	970	1,400,000	
Select Structural		2,000	2,300	2,500	1,900,000	West Coast
No. 1 & Btr		1,585	1,825	1,985	1,800,000	Lumber
No. 1	2" x 8"	1,380	1,585	1,725	1,700,000	Inspection
No. 2		1,210	1,390	1,510	1,600,000	Bureau
No. 3		690	795	865	1,400,000	
Select Structural		1,835	2,110	2,295	1,900,000	Western Wood
No. 1 & Btr		1,455	1,675	1,820	1,800,000	Products
No. 1	2" x 10"	1,265	1,455	1,580	1,700,000	Association
No. 2		1,105	1,275	1,385	1,600,000	
No. 3		635	725	790	1,400,000	
Select Structural		1,670	1,920	2,085	1,900,000	(See Footnotes
No. 1 & Btr		1,325	1,520	1,655	1,800,000	1 and 2)
No. 1	2" x 12"	1,150	1,325	1,440	1,700,000	
No. 2		1,005	1,155	1,260	1,600,000	
No. 3		575	660	720	1,400,000	
DOUGLAS FIR-LARCH (NORTH)						
Select Structural		2,245	2,580	2,805	1,900,000	
No. 1/No. 2		1,425	1,635	1,780	1,600000	
No. 3		820	940	1,025	1,400,000	
Stud	2" x 4"	820	945	1,030	1,400,000	
Construction		1,095	1,255	1,365	1,500,000	
Standard		605	695	755	1,400,000	
Utility		290	330	360	1,300,000	
Select Structural		1,945	2,235	2,430	1,900,000	National
No. 1/No. 2		1,235	1,420	1,540	1,600,000	Lumber
No. 3	2" x 6"	710	815	890	1,400,000	Grades
Stud		750	860	935	1,400,000	Authority
Select Structural		1,795	2,065	2,245	1,900,000	
No. 1/No. 2	2" x 8"	1,140	1,310	1,425	1,600,000	(See Footnotes
No. 3		655	755	820	1,400,000	1 and 2)
Select Structural		1,645	1,890	2,055	1,900,000	
No. 1/No. 2	2" x 10"	1,045	1,200	1,305	1,600,000	
No. 3		600	690	750	1,400,000	
Select Structural		1,495	1,720	1,870	1,900,000	
No. 1/No. 2	2" x 12"	950	1,090	1,185	1,600,000	
No.3		545	630	685	1,400,000	

(Continued)

Table 502.3.1c — continued
DESIGN VALUES FOR DIMENSION LUMBER–VISUAL GRADING

Species and Grade	Size	Design Value in Bending "F_b"			Modules of Elasticity "E"	Grading Rules Agency
		Normal Duration	Snow Loading	7-Day Loading		
DOUGLAS FIR — SOUTH						
Select Structural		2,245	2,580	2,805	1,400,000	
No. 1		1,555	1,785	1,940	1,300,000	
No. 2		1,425	1,635	1,780	1,200,000	
No.3	2" x 4"	820	940	1,025	1,100,000	
Stud		820	945	1,030	1,100,000	
Construction		1,065	1,225	1,330	1,200,000	Western
Standard		605	695	755	1,100,000	Wood
Utility		290	330	360	1,000,000	Products
Select Structural		1,945	2,235	2,430	1,400,000	Association
No. 1		1,345	1,545	1,680	1,300,000	
No.2	2" x 6"	1,235	1,420	1,540	1,200,000	(See Footnotes
No.3		710	815	890	1,100,000	1 and 2)
Stud		750	860	935	1,100,000	
Select Structural		1,795	2,065	2,245	1,400,000	
No.1	2" x 8"	1,240	1,430	1,555	1,300,000	
No. 2		1,140	1,310	1,425	1,200,000	
No. 3		655	755	820	1,100,000	
EASTERN SOFTWOODS						
Select Structural		2,155	2,480	2,695	1,200,000	
No. 1		1,335	1,535	1,670	1,100,000	
No. 2		990	1,140	1,240	1,100,000	
No. 3	2" x 4"	605	695	755	900,000	
Stud		570	655	710	900,000	
Construction		775	895	970	1,000,000	
Standard		430	495	540	900,000	
Utility		200	230	250	800,000	Northeastern
Select Structural		1,870	2,150	2,335	1,200,000	Lumber
No. 1		1,160	1,330	1,450	1,100,000	Manufacturers
No. 2	2" x 6"	860	990	1,075	1,100,000	Association
No. 3		525	600	655	900,000	
Stud		520	595	645	900,000	Northern
Select Structural		1,725	1,985	2,155	1,200,000	Softwood
No. 1		1,070	1,230	1,335	1,100,000	Lumber
No. 2	2" x 8"	795	915	990	1,100,000	Bureau
No. 3		485	555	605	900000	
Select Structural		1,580	1,820	1,975	1,200,000	(See Footnotes
No. 1		980	1,125	1,225	1,100,000	1 and 2)
No. 2	2" x 10"	725	835	910	1,100,000	
No. 3		445	510	555	900,000	
Select Structural		1,440	1,655	1,795	1,200,000	
No. 1		890	1,025	1,115	1,100,000	
No. 2	2" x 12"	660	760	825	1,100,000	
No. 3		405	465	505	900,000	

(Continued)

Table 502.3.1c — continued
DESIGN VALUES FOR DIMENSION LUMBER–VISUAL GRADING

Species and Grade	Size	Design Value in Bending "F_b"			Modules of Elasticity "E"	Grading Rules Agency
		Normal Duration	Snow Loading	7-Day Loading		
EASTERN WHITE PINE						
Select Structural		2,155	2,480	2,695	1,200,000	
No. 1		1,335	1,535	1,670	1,100,000	
No. 2		990	1,140	1,240	1,100,000	
No.3	2" x 4"	605	695	755	900,000	
Stud		570	655	710	900,000	
Construction		775	895	970	1,000,000	
Standard		430	495	540	900,000	
Utility		200	230	250	800,000	Northeastern
Select Structural		1,870	2,150	2,335	1,200,000	Lumber
No. 1		1,160	1,330	1,450	1,100,000	Manufacturers
No. 2	2"x6"	860	990	1,075	1,100,000	Association
No.3		525	600	655	900,000	
Stud		520	595	645	900,000	Northern
Select Structural		1,725	1,985	2,155	1,200,000	Softwood
No. 1	2"x8"	1,070	1,230	1,335	1,100,000	Lumber
No. 2		795	915	990	1,100,000	Bureau
No.3		485	555	605	900,000	
Select Structural		1,580	1,820	1,975	1,200,000	(See Footnotes
No. 1	2"x10"	980	1,125	1,225	1,100,000	1 and 2)
No. 2		725	835	910	1,100,000	
No. 3		445	510	555	900,000	
Select Structural		1,440	1,655	1,795	1,200,000	
No. 1	2"x12"	890	1,025	1,115	1,100,000	
No. 2		660	760	825	1,100,000	
No. 3		405	465	505	900,000	
HEM-FIR						
Select Structural		2,415	2,775	3,020	1,600,000	
No. 1 & Btr		1,810	2,085	2,265	1,500,000	
No. 1		1,640	1,885	2,050	1,500,000	
No. 2		1,465	1,685	1,835	1,300,000	
No. 3	2"x4"	865	990	1,080	1,200,000	
Stud		855	980	1,065	1,200,000	West Coast
Construction		1,120	1,290	1,400	1,300,000	Lumber
Standard		635	725	790	1,200,000	Inspection
Utility		290	330	360	1,100,000	Bureau
Select Structural		2,095	2,405	2,615	1,600,000	
No. 1 & Btr		1,570	1,805	1,960	1,500,000	Western
No. 1	2"x6"	1,420	1,635	1,775	1,500,000	Wood
No. 2		1,270	1,460	1,590	1,300,000	Products
No. 3		750	860	935	1,200,000	Association
Stud		775	895	970	1,200,000	
Select Structural		1,930	2,220	2,415	1,600,000	(See Footnotes
No. 1 & Btr		1,450	1,665	1,810	1,500,000	1 and 2)
No. 1	2"x8"	1,310	1,510	1,640	1,500,000	
No. 2		1,175	1,350	1,465	1,300,000	
No. 3		690	795	865	1,200,000	

(Continued)

Table 502.3.1c — continued
DESIGN VALUES FOR DIMENSION LUMBER–VISUAL GRADING

Species and Grade	Size	Design Value in Bending "F_b"			Modules of Elasticity "E"	Grading Rules Agency
		Normal Duration	Snow Loading	7-Day Loading		
Select Structural		1,770	2,035	2,215	1,600,000	West Coast
No. 1 & Btr		1,330	1,525	1,660	1,500,000	Lumber
No 1	2" x 10"	1,200	1,380	1,500	1,500,000	Inspection
No. 2		1,075	1,235	1,345	1,300,000	Bureau
No. 3		635	725	790	1,200,000	
Select Structural		1,610	1,850	2,015	1,600,000	Western
No. 1 & Btr		1,210	1,390	1,510	1,500,000	Wood
No. 1	2" x 12"	1,095	1,255	1,365	1,500,000	Products
No. 2		980	1,125	1,220	1,300,000	(See Footnotes
No. 3		575	660	720	1,200,000	1 and 2)
HEM-FIR (NORTH)						
Select Structural		2,245	2,580	2,805	1,700,000	
No. 1/No.2		1,725	1,985	2,155	1,600,000	
No. 3		990	1,140	1,240	1,400,000	
Stud	2" x 4"	980	1,125	1,225	1,400,000	
Construction		1,325	1,520	1,655	1,500,000	
Standard		720	825	900	1,400,000	
Utility		345	395	430	1,300000	
Select Structural		1,945	2,235	2,430	1,700,000	National
No. 1/No. 2	2" x 6"	1,495	1,720	1,870	1,600,000	Lumber
No. 3		860	990	1,075	1,400,000	Grades
Stud		890	1,025	1,115	1,400,000	Authority
Select Structural		1,795	2,065	2,245	1,700,000	
No. 1/No. 2	2" x 8"	1,380	1,585	1,725	1,600,000	(See Footnotes 1
No. 3		795	915	990	1,400,000	and 2)
Select Structural		1,645	1,890	2,055	1,700,000	
No. 1/No. 2	2" x 10"	1,265	1,455	1,580	1,600,000	
No. 3		725	835	910	1,400,000	
Select Structural		1,495	1,720	1,870	1,700,000	
No. 1/No. 2	2" x 12"	1,150	1,325	1,440	1,600,000	
No. 3		660	760	825	1,400,000	
MIXED MAPLE						
Select Structural		1,725	1,985	2,155	1,300,000	
No. 1		1,250	1,440	1,565	1,200,000	
No. 2		1,210	1,390	1,510	1,100,000	Northeastern
No. 3	2" x 4"	690	795	865	1,000,000	Lumber
Stud		695	800	870	1,000,000	Manufacturers
Construction		920	1,060	1,150	1,100,000	Association
Standard		520	595	645	1,000,000	
Utility		260	300	325	900,000	
Select Structural		1,495	1,720	1,870	1,300,000	(See Footnotes
No. 1		1,085	1,245	1,355	1,200,000	1 and 2)
No. 2	2" x 6"	1,045	1,205	1,310	1,100,000	
No. 3		600	690	750	1,000,000	
Stud		635	725	790	1,000,000	

(Continued)

Table 502.3.1c — continued
DESIGN VALUES FOR DIMENSION LUMBER–VISUAL GRADING

Species and Grade	Size	Design Value in Bending "F_b"			Modules of Elasticity "E"	Grading Rules Agency
		Normal Duration	Snow Loading	7-Day Loading		
Select Structural		1,380	1,585	1,725	1,300,000	
No. 1		1,000	1,150	1,250	1,200,000	
No. 2	2" x 8"	965	1,110	1,210	1,100,000	Northeastern
No. 3		550	635	690	1,000,000	Lumber
Select Structural		1,265	1,455	1,580	1,300,000	Manufacturers
No. 1		915	1,055	1,145	1,200,000	Association
No. 2	2" x 10"	885	1,020	1,105	1,100,000	
No. 3		505	580	635	1,000,000	
Select Structural		1,150	1,325	1,440	1,300,000	(See Footnotes
No. 1		835	960	1,040	1,200,000	1 and 2)
No. 2	2" x 12"	805	925	1,005	1,100,000	
No. 3		460	530	575	1,000,000	
MIXED OAK						
Select Structural		1,985	2,280	2,480	1,100,000	
No. 1		1,425	1,635	1,780	1,000,000	
No. 2		1,380	1,585	1,725	900,000	
No. 3	2" x 4"	820	940	1,025	800,000	
Stud		790	910	990	800,000	
Construction		1,065	1,225	1,330	900,000	
Standard		605	695	755	800,000	
Utility		290	330	360	800,000	
Select Structural		1,720	1,975	2,150	1,100,000	
No. 1		1,235	1,420	1,540	1,000,000	
No. 2	2" x 6"	1,195	1,375	1,495	900,000	Northeastern
No. 3		710	815	890	800,000	Lumber
Stud		720	825	900	800,000	Manufacturers
Select Structural		1,585	1,825	1,985	1,100,000	Association
No. 1		1,140	1,310	1,425	1,000,000	
No. 2	2" x 8"	1,105	1,270	1,380	900,000	See Footnotes
No. 3		655	755	820	800,000	1 and 2)
Select Structural		1,455	1,675	1,820	1,100,000	
No. 1		1,045	1,200	1,305	1,000,000	
No. 2	2" x 10"	1,010	1,165	1,265	900,000	
No. 3		600	690	750	800,000	
Select Structural		1,325	1,520	1,655	1,100,000	
No. 1	2" x 12"	950	1,090	1,185	1,000,000	
No. 2		920	1,060	1,150	900,000	
No. 3		545	630	685	800,000	

(Continued)

Table 502.3.1c — continued
DESIGN VALUES FOR DIMENSION LUMBER–VISUAL GRADING

Species and Grade	Size	Design Value in Bending "F_b"			Modules of Elasticity "E"	Grading Rules Agency
		Normal Duration	Snow Loading	7-Day Loading		
MIXED SOUTHERN PINE						
Select Structural		2,360	2,710	2,945	1,600,000	
No. 1		1,670	1,920	2,085	1,500,000	
No. 2		1,495	1,720	1,870	1,400,000	
No. 3	2" x 4"	865	990	1,080	1,200,000	
Stud		890	1,025	1,115	1,200,000	
Construction		1,150	1,325	1,440	1,300,000	
Standard		635	725	790	1,200,000	
Utility		315	365	395	1,100,000	
Select Structural		2,130	2,445	2,660	1,600,000	
No. 1		1,495	1,720	1,870	1,500,000	
No. 2	2" x 6"	1,325	1,520	1,655	1,400,000	Southern
No. 3		775	895	970	1,200,000	Pine
Stud		775	895	970	1,200,000	Inspection
Select Structural		2,015	2,315	2,515	1,600,000	Bureau
No. 1	2" x 8"	1,380	1,585	1,725	1,500,000	
No. 2		1,210	1,390	1,510	1,400,000	(See Footnotes
No. 3		720	825	900	1,200,000	1 and 2)
Select Structural		1,725	1,985	2,155	1,600,000	
No. 1	2" x 10"	1,210	1,390	1,510	1,500,000	
No. 2		1,065	1,225	1,330	1,400,000	
No. 3		605	695	755	1,200,000	
Select Structural		1,610	1,850	2,015	1,600,000	
No. 1	2" x 12"	1,120	1,290	1,400	1,500,000	
No. 2		1,005	1,155	1,260	1,400,000	
No. 3		575	660	720	1,200,000	
NORTHERN RED OAK						
Select Structural		2,415	2,775	3,020	1,400,000	
No. 1		1,725	1,985	2,155	1,400,000	
No. 2		1,680	1,935	2,100	1,300,000	
No. 3	2" x 4"	950	1,090	1,185	1,200,000	
Stud		950	1,090	1,185	1,200,000	
Construction		1,265	1,455	1,580	1,200,000	
Standard		720	825	900	1,100,000	
Utility		345	395	430	1,000,000	
Select Structural		2,095	2,405	2,615	1,400,000	
No. 1		1,495	1,720	1,870	1,400,000	Northeastern
No. 2	2" x 6"	1,460	1,675	1,820	1,300,000	Lumber
No. 3		820	945	1,030	1,200,000	Manufacturers
Stud		865	990	1,080	1,200,000	Association
Select Structural		1,930	2,220	2,415	1,400,000	
No. 1		1,380	1,585	1,725	1,400,000	
No. 2	2" x 8"	1,345	1,545	1,680	1,300,000	(See Footnotes 1
No. 3		760	875	950	1,200,000	and 2)
Select Structural		1,770	2,035	2,215	1,400,000	
No. 1		1,265	1,455	1,580	1,400,000	
No. 2	2" x 10"	1,235	1,420	1,540	1,300,000	
No. 3		695	800	870	1,200,000	

(Continued)

Table 502.3.1c — continued
DESIGN VALUES FOR DIMENSION LUMBER–VISUAL GRADING

Species and Grade	Size	Design Value in Bending "F_b"			Modules of Elasticity "E"	Grading Rules Agency
		Normal Duration	Snow Loading	7-Day Loading		
Select Structural		1,610	1,850	2,015	1,400,000	
No. 1		1,150	1,325	1,440	1,400,000	
No. 2	2" x 12"	1,120	1,290	1,400	1,300,000	
No. 3		635	725	790	1,200,000	
NORTHERN SPECIES						
Select Structural		1,640	1,885	2,050	1,100,000	
No. 1/No. 2		990	1,140	1,240	1,100,000	
No. 3		605	695	755	1,000,000	
Stud	2" x 4"	570	655	710	1,000,000	
Construction		775	895	970	1,000,000	
Standard		430	495	540	900,000	
Utility		200	230	250	900000	
Select Structural		1,420	1,635	1,775	1,100,000	National
No. 1/No. 2	2" x 6"	860	990	1,075	1,100,000	Lumber
No. 3		525	600	655	1,000,000	Grades
Stud		520	595	645	1,000,000	Authority
Select Structural		1,310	1,510	1,640	1,100,000	
No. 1/No. 2	2" x 8"	795	915	990	1,100,000	(See Footnotes 1
No. 3		485	555	605	1,000,000	and 2)
Select Structural		1,200	1,380	1,500	1,100,000	
No. 1/No. 2	2" x 10"	725	835	910	1,100,000	
No. 3		445	510	555	1,000,000	
Select Structural		1,095	1,255	1,365	1,100,000	
No. 1/No. 2	2" x 12"	660	760	825	1,100,000	
No. 3		405	465	505	1,000,000	
NORTHERN WHITE CEDAR						
Select Structural		1,335	1,535	1,670	800,000	
No. 1		990	1,140	1,240	700,000	
No. 2		950	1,090	1,185	700,000	
No. 3	2" x 4"	560	645	700	600,000	
Stud		540	620	670	600,000	
Construction		720	825	900	700,000	
Standard		405	465	505	600,000	
Utility		200	230	250	600,000	
Select Structural		1,160	1,330	1,450	800,000	Northeastern
No. 1		860	990	1,075	700,000	Lumber
No. 2	2" x 6"	820	945	1,030	700,000	Manufacturers
No. 3		485	560	605	600,000	Association
Stud		490	560	610	600,000	
Select Structural		1,070	1,230	1,335	800,000	(See Footnotes
No. 1	2" x 8"	795	915	990	700,000	1 and 2)
No. 2		760	875	950	700,000	
No. 3		450	515	560	600,000	
Select Structural		980	1,125	1,225	800,000	
No. 1	2" x 10"	725	835	910	700,000	
No. 2		695	800	870	700,000	
No. 3		410	475	515	600,000	
Select Structural		890	1,025	1,115	800,000	
No. 1	2" x 12"	660	760	825	700,000	
No. 2		635	725	790	700,000	
No. 3		375	430	465	600,000	

(Continued)

Table 502.3.1c — continued
DESIGN VALUES FOR DIMENSION LUMBER–VISUAL GRADING

Species and Grade	Size	Design Value in Bending "F_b"			Modules of Elasticity "E"	Grading Rules Agency
		Normal Duration	Snow Loading	7-Day Loading		
RED MAPLE						
Select Structural	2" x 4"	2,245	2,580	2,805	1,700,000	Northeastern Lumber Manufacturers Association (See Footnotes 1 and 2)
No. 1		1,595	1,835	1,995	1,600,000	
No. 2		1,555	1,785	1,940	1,500,000	
No. 3		905	1,040	1,130	1,300,000	
Stud		885	1,020	1,105	1,300,000	
Construction		1,210	1,390	1,510	1,400,000	
Standard		660	760	825	1,300,000	
Utility		315	365	395	1,200,000	
Select Structural	2" x 6"	1,945	2,235	2,430	1,700,000	
No. 1		1,385	1,590	1,730	1,600,000	
No. 2		1,345	1,545	1,680	1,500,000	
No. 3		785	905	980	1,300,000	
Stud		805	925	1,005	1,300,000	
Select Structural	2" x 8"	1,795	2,065	2,245	1,700,000	
No. 1		1,275	1,470	1,595	1,600,000	
No. 2		1,240	1,430	1,555	1,500,000	
No. 3		725	835	905	1,300,000	
Select Structural	2" x 10"	1,645	1,890	2,055	1,700,000	
No. 1		1,170	1,345	1,465	1,600,000	
No. 2		1,140	1,310	1,425	1,500,000	
No. 3		665	765	830	1,300,000	
Select Structural	2" x 12"	1,495	1,720	1,870	1,700,000	
No. 1		1,065	1,225	1,330	1,600,000	
No. 2		1,035	1,150	1,295	1,500,000	
No. 3		605	695	755	1,300,000	
RED OAK						
Select Structural	2" x 4"	1,985	2,280	2,480	1,400,000	Northeastern Lumber Manufacturers Association (See Footnotes 1 and 2)
No. 1		1,425	1,635	1,780	1,300,000	
No. 2		1,380	1,585	1,725	1,200,000	
No. 3		820	940	1,025	1,100,000	
Stud		790	910	990	1,100,000	
Construction		1,065	1,225	1,330	1,200,000	
Standard		605	695	755	1,100,000	
Utility		290	330	360	1,000,000	
Select Structural	2" x 6"	1,720	1,975	2,150	1,400,000	
No. 1		1,235	1,420	1,540	1,300,000	
No. 2		1,195	1,375	1,495	1,200,000	
No. 3		710	815	890	1,100,000	
Stud		720	825	900	1,100,000	
Select Structural	2" x 8"	1,585	1,825	1,985	1,400,000	
No. 1		1,140	1,310	1,425	1,300,000	
No. 2		1,105	1,270	1,380	1,200,000	
No. 3		655	755	820	1,100,000	
Select Structural	2" x 10"	1,455	1,675	1,820	1,400,000	
No. 1		1,045	1,200	1,305	1,300,000	
No. 2		1,010	1,165	1,265	1,200,000	
No. 3		600	690	750	1,100,000	

(Continued)

Table 502.3.1c — continued
DESIGN VALUES FOR DIMENSION LUMBER–VISUAL GRADING

Species and Grade	Size	Design Value in Bending "F_b"			Modules of Elasticity "E"	Grading Rules Agency
		Normal Duration	Snow Loading	7-Day Loading		
Select Structural		1,325	1,520	1,655	1,400,000	
No. 1		950	1,090	1,185	1,300,000	
No. 2	2" x 12"	920	1,060	1,150	1,200,000	
No. 3		545	630	685	1,100,000	
REDWOOD						
Clear Structural		3,020	3,470	3,775	1,400,000	
Select Structural		2,330	2,680	2,910	1,400,000	
Select Structural, open grain		1,900	2,180	2,370	1,100,000	
No. 1		1,680	1,935	2,100	1,300,000	
No. 1, open grain		1,335	1,535	1,670	1,100,000	
No. 2		1,595	1,835	1,995	1,200,000	
No. 2, open grain	2" x 4"	1,250	1,440	1,565	1,000,000	
No. 3		905	1,040	1,130	1,100,000	
No. 3, open grain		735	845	915	900,000	
Stud		725	835	910	900,000	
Construction		950	1,090	1,185	900,000	
Standard		520	595	645	900,000	
Utility		260	300	325	800,000	
Clear Structural		2,615	3,010	3,270	1,400,000	
Select Structural		2,020	2,320	2,525	1,400,000	
Select Structural, open grain		1,645	1,890	2,055	1,100,000	
No. 1		1,460	1,675	1,820	1,300,000	
No. 1, open grain	2" x 6"	1,160	1,330	1,450	1,100,000	
No. 2		1,385	1,590	1,730	1,200,000	Redwood
No. 2, open grain		1,085	1,245	1,335	1,000,000	Inspection
No. 3		785	905	980	1,100,000	Service
No. 3, open grain		635	730	795	900,000	
Stud		660	760	825	900,000	(See Footnotes
Clear Structural		2,415	2,775	3,020	1,400,000	1 and 2)
Select Structural		1,865	2,140	2,330	1,400,000	
Select Structural, open grain		1,520	1,745	1,900	1,100,000	
No. 1		1,345	1,545	1,680	1,300,000	
No. 1, open grain	2" x 8"	1,070	1,230	1,335	1,100,000	
No. 2		1,275	1,470	1,595	1,203,000	
No. 2, open grain		1,000	1,150	1,250	1,000,000	
No. 3		725	835	905	1,100,000	
No. 3, open grain		585	675	735	900,000	
Clear Structural		2,215	2,545	2,765	1,400,000	
Select Structural		1,710	1,965	2,135	1,400,000	
Select Structural, open grain		1,390	1,600	1,740	1,100,000	
No. 1		1,235	1,420	1,540	1,300,000	
No. 1, open grain	2" x 10"	980	1,125	1,225	1,100,000	
No. 2		1,170	1,345	1,465	1,200,000	
No. 2, open grain		915	1,055	1,145	1,000,000	
No. 3		665	765	830	1,100,000	
No. 3, open grain		540	620	670	900,000	

(Continued)

Table 502.3.1c — continued
DESIGN VALUES FOR DIMENSION LUMBER–VISUAL GRADING

Species and Grade	Size	Design Value in Bending "F_b"			Modules of Elasticity "E"	Grading Rules Agency
		Normal Duration	Snow Loading	7-Day Loading		
Clear Structural	2" x 12"	2,015	2,315	2,515	1,400,000	
Select Structural		1,555	1,785	1,940	1,400,000	
Select Structural, open grain		1,265	1,455	1,580	1,100,000	
No. 1		1,120	1,290	1,400	1,300,000	
No. 1, open grain		890	1,025	1,115	1,100,000	
No. 2		1,065	1,225	1,330	1,200,000	
No. 2, open grain		835	960	1,040	1,000,000	
No. 3		605	695	755	1,100,000	
No. 3, open grain		490	560	610	900,000	
SOUTHERN PINE						
Dense Select Structural	2" x 4"	3,510	4,035	4,385	1,900,000	Southern Pine Inspection Bureau (See Footnotes 1 and 2)
Select Structural		3,280	3,770	4,095	1,800,000	
Non-Dense Select Structural		3,050	3,505	3,810	1,700,000	
No. 1 Dense		2,300	2,645	2,875	1,800,000	
No. 1		2,130	2,445	2,660	1,700,000	
No. 1 Non-Dense		1,955	2,250	2,445	1,600,000	
No. 2 Dense		1,955	2,250	2,445	1,700,000	
No. 2		1,725	1,985	2,155	1,600,000	
No. 2 Non-Dense		1,555	1,785	1,940	1,400,000	
No. 3		980	1,125	1,220	1,400,000	
Stud		1,005	1,155	1,260	1,400,000	
Construction		1,265	1,455	1,580	1,500,000	
Standard		720	825	900	1,300,000	
Utility		345	395	430	1,300,000	
Dense Select Structural	2" x 6"	3,105	3,570	3,880	1,900,000	
Select Structural		2,935	3,370	3,665	1,800,000	
Non-Dense Select Structural		2,705	3,110	3,380	1,700,000	
No. 1 Dense		2,015	2,315	2,515	1,800,000	
No. 1		1,900	2,180	2,370	1,700,000	
No. 1 Non-Dense		1,725	1,985	2,155	1,600,000	
No. 2 Dense		1,670	1,920	2,085	1,700,000	
No. 2		1,440	1,655	1,795	1,600,000	
No. 2 Non-Dense		1,325	1,520	1,655	1,400,000	
No. 3		865	990	1,080	1,400,000	
Stud		890	1,025	1,115	1,400,000	
Dense Select Structural	2" x 8"	2,820	3,240	3,520	1,900,000	
Select Structural		2,645	3,040	3,305	1,800,000	
Non-Dense Select Structural		2,415	2,775	3,020	1,700,000	
No 1 Dense		1,900	2,180	2,370	1,800,000	
No. 1		1,725	1,985	2,155	1,700,000	
No. 1 Non-Dense		1,555	1,785	1,940	1,600,000	
No. 2 Dense		1,610	1,850	2,015	1,700,000	
No. 2		1,380	1,585	1,725	1,600,000	
No. 2 Non-Dense		1,265	1,455	1,580	1,400,000	
No. 3		805	925	1,005	1,400,000	

(Continued)

Table 502.3.1c — continued
DESIGN VALUES FOR DIMENSION LUMBER–VISUAL GRADING

Species and Grade	Size	Design Value in Bending "F_b"			Modules of Elasticity "E"	Grading Rules Agency
		Normal Duration	Snow Loading	7-Day Loading		
Dense Select Structural	2" x 10"	2,475	2,845	3,090	1,900,000	
Select Structural		2,360	2,710	2,945	1,800,000	
Non-Dense Select Structural		2,130	2,445	2,660	1,700,000	
No. 1 Dense		1,670	1,920	2,085	1,800,000	
No. 1		1,495	1,720	1,870	1,700,000	
No. 1 Non-Dense		1,380	1,585	1,725	1,600,000	
No. 2 Dense		1,380	1,585	1,725	1,700,000	
No. 2		1,210	1,390	1,510	1,600,000	
No. 2 Non-Dense		1,095	1,255	1,365	1,400,000	
No. 3		690	795	865	1,400,000	
Dense Select Structural	2" x 12"	2,360	2,710	2,945	1,900,000	
Select Structural		2,185	2,515	2,730	1,800,000	
Non-Dense Select Structural		2,015	2,315	2,515	1,700,000	
No. 1 Dense		1,555	1,785	1,940	1,800,000	
No. 1		1,440	1,655	1,795	1,700,000	
No. 1 Non-Dense		1,325	1,520	1,655	1,600,000	
No. 2 Dense		1,325	1,520	1,655	1,700,000	
No. 2		1,120	1,290	1,400	1,600,000	
No. 2 Non-Dense		1,035	1,190	1,295	1,400,000	
No. 3		660	760	825	1,400,000	
SPRUCE-PINE-FIR						
Select Structural	2" x 4"	2,155	2,480	2,695	1,500,000	National Lumber Grades Authority (See Footnotes 1 and 2)
No. 1/No. 2		1,510	1,735	1,885	1,400,000	
No. 3		865	990	1,080	1,200,000	
Stud		855	980	1,065	1,200,000	
Construction		1,120	1,290	1,400	1,300,000	
Standard		635	725	790	1,200,000	
Utility		290	330	360	1,100,000	
Select Structural	2" x 6"	1,870	2,150	2,335	1,500,000	
No. 1/No. 2		1,310	1,505	1,635	1,400,000	
No. 3		750	860	935	1,200,000	
Stud		775	895	970	1,200,000	
Select Structural	2" x 8"	1,725	1,985	2,155	1,500,000	
No. 1/No. 2		1,210	1,390	1,510	1,400,000	
No. 3		690	795	865	1,200,000	
Select Structural	2" x 10"	1,580	1,820	1,975	1,500,000	
No. 1/No. 2		1,105	1,275	1,385	1,400,000	
No. 3		635	725	790	1,200,000	
Select Structural	2" x 12"	1,440	1,655	1,795	1,500,000	
No. 1/No. 2		1,005	1,155	1,260	1,400,000	
No. 3		575	660	720	1,200,000	
No. 3, open grain		540	620	670	900,000	

(Continued)

Table 502.3.1c — continued
DESIGN VALUES FOR DIMENSION LUMBER–VISUAL GRADING

Species and Grade	Size	Design Value in Bending "F_b"			Modules of Elasticity "E"	Grading Rules Agency
		Normal Duration	Snow Loading	7-Day Loading		
SPRUCE-PINE-FIR (SOUTH)						
Select Structural	2" x 4"	2,245	2,580	2,805	1,300,000	Northeastern Lumber Manufacturers Association
No. 1		1,465	1,685	1,835	1,200,000	
No. 2		1,295	1,490	1,615	1,100,000	
No. 3		735	845	915	1,000,000	
Stud		725	835	910	1,000,000	
Construction		980	1,125	1,220	1,000,000	
Standard		545	630	685	900,000	
Utility		260	300	335	900,000	
Select Structural	2" x 6"	1,945	2,235	2,430	1,300,000	Northern Softwood Lumber Bureau
No. 1		1,270	1,460	1,590	1,200,000	
No. 2		1,120	1,290	1,400	1,100,000	
No. 3		635	730	795	1,000,000	
Stud		660	760	825	1,000,000	
Select Structural	2" x 8"	1,795	2,065	2,245	1,300,000	West Coast Lumber Inspection Bureau
No. 1		1,175	1,350	1,465	1,200,000	
No. 2		1,035	1,190	1,295	1,100,000	
No. 3		585	675	735	1,000,000	
Select Structural	2" x 10"	1,645	1,890	2,055	1,300,000	Western Wood Products Association (See Footnotes 1 and 2)
No. 1		1,075	1,235	1,345	1,200,000	
No.2		950	1,090	1,185	1,100,000	
No. 3		540	620	670	1,000,000	
Select Structural	2" x 12"	1,495	1,720	1,870	1,300,000	
No. 1		980	1,125	1,220	1,200,000	
No. 2		865	990	1,080	1,100,000	
No. 3		490	560	610	1,000,000	
WESTERN CEDARS						
Select Structural	2" x 4"	1,725	1,985	2,155	1,100,000	West Coast Lumber Inspection Bureau Western Wood Products Association (See Footnotes 1 and 2)
No. 1		1,250	1,440	1,565	1,000,000	
No. 2		1,210	1,390	1,510	1,000,000	
No. 3		690	795	865	900,000	
Stud		695	800	870	900,000	
Construction		920	1,060	1,150	900,000	
Standard		520	595	645	800,000	
Utility		260	300	325	800,000	
Select Structural	2" x 6"	1,495	1,720	1,870	1,100,000	
No. 1		1,085	1,245	1,355	1,000,000	
No. 2		1,045	1,205	1,310	1,000,000	
No. 3		600	690	750	900,000	
Stud		635	725	790	900,000	
Select Structural	2" x 8"	1,380	1,585	1,725	1,100,000	
No. 1		1,000	1,150	1,250	1,000,000	
No. 2		965	1,110	1,210	1,000,000	
No. 3		550	635	690	900,000	
Select Structural	2" x 10"	1,265	1,455	1,580	1,100,000	
No. 1		915	1,055	1,145	1,000,000	
No. 2		885	1,020	1,105	1,000,000	
No. 3		505	580	635	900,000	

(Continued)

Table 502.3.1c — continued
DESIGN VALUES FOR DIMENSION LUMBER–VISUAL GRADING

Species and Grade	Size	Design Value in Bending "F_b"			Modules of Elasticity "E"	Grading Rules Agency
		Normal Duration	Snow Loading	7-Day Loading		
Select Structural	2" x 12"	1,150	1,325	1,440	1,100,000	
No. 1		835	960	1,040	1,000,000	
No. 2		805	925	1,005	1,000,000	
No. 3		460	530	575	900,000	
WESTERN WOODS						
Select Structural	2" x 4"	1,510	1,735	1,885	1,200,000	West Coast Lumber Inspection Bureau Western Wood Products Association (See Footnotes 1 and 2)
No. 1		1,120	1,290	1,400	1,100,000	
No. 2		1,120	1,290	1,400	1,000,000	
No. 3		645	745	810	900,000	
Stud		635	725	790	900,000	
Construction		835	960	1,040	1,000,000	
Standard		460	530	575	900,000	
Utility		230	265	290	800,000	
Select Structural	2" x 6"	1,310	1,505	1,635	1,200,000	
No. 1		970	1,120	1,215	1,100,000	
No. 2		970	1,120	1,215	1,000,000	
No. 3		560	645	700	900,000	
Stud		575	660	720	900,000	
Select Structural	2" x 8"	1,210	1,390	1,510	1,200,000	
No. 1		895	1,030	1,120	1,100,000	
No. 2		895	1,030	1,120	1,000,000	
No. 3		520	595	645	900,000	
Select Structural	2" x 10"	1,105	1,275	1,385	1,200,000	
No. 1		820	945	1,030	1,100,000	
No. 2		820	945	1,030	1,000,000	
No. 3		475	545	594	900,000	
Select Structural	2" x 12"	1,005	1,155	1,260	1,200,000	
No. 1		750	860	935	1,100,000	
No. 2		750	860	935	1,000,000	
No. 3		430	495	540	900,000	
WHITE OAK						
Select Structural	2" x 4"	2,070	2,380	2,590	1,100,000	Northeastern Lumber Manufacturers Association (See Footnotes 1 and 2)
No. 1		1,510	1,735	1,885	1,000,000	
No. 2		1,465	1,685	1,835	900,000	
No. 3		820	940	1,025	800,000	
Stud		820	945	1,030	800,000	
Construction		1,095	1,255	1,365	900,000	
Standard		605	695	755	800,000	
Utility		290	330	360	800,000	
Select Structural	2" x 6"	1,795	2,065	2,245	1,100,000	
No. 1		1,310	1,505	1,635	1,000,000	
No. 2		1,270	1,460	1,590	900,000	
No. 3		710	815	890	800,000	
Stud		750	860	935	800,000	
Select Structural	2" x 8"	1,655	1,905	2,070	1,100,000	
No. 1		1,210	1,390	1,510	1,000,000	
No. 2		1,175	1,350	1,465	900,000	
No. 3		655	755	820	800,000	

(Continued)

Table 502.3.1c — continued
DESIGN VALUES FOR DIMENSION LUMBER–VISUAL GRADING

Species and Grade	Size	Design Value in Bending "F_b"			Modules of Elasticity "E"	Grading Rules Agency
		Normal Duration	Snow Loading	7-Day Loading		
Select Structural		1,520	1,745	1,900	1,100,000	
No. 1		1,105	1,275	1,385	1,000,000	Northeastern
No. 2	2" x 10"	1,075	1,235	1,345	900,000	Lumber
No. 3		600	690	750	800,000	Manufacturers
Select Structural		1,380	1,585	1,725	1,100,000	Association
No. 1		1,005	1,155	1,260	1,000,000	
No. 2	2" x 12"	980	1,125	1,220	900,000	(See Footnotes
No. 3		545	630	685	800,000	1 and 2)
YELLOW POPLAR						
Select Structural		1,725	1,985	2,155	1,500,000	
No. 1		1,250	1,440	1,565	1,400,000	
No. 2		1,210	1,390	1,510	1,300,000	
No. 3	2" x 4"	690	795	865	1,200,000	
Stud		695	800	870	1,200,000	
Construction		920	1,060	1,150	1,300,000	
Standard		520	595	645	1,100,000	
Utility		230	265	290	1,100,000	
Select Structural		1,495	1,720	1,870	1,500,000	
No. 1		1,085	1,245	1,355	1,400,000	Northern
No. 2	2" x 6"	1,045	1,205	1,310	1,300,000	Softwood
No. 3		600	690	750	1,200,000	Lumber
Stud		635	725	790	1,200,000	Bureau
Select Structural		1,380	1,585	1,725	1,500,000	
No. 1	2" x 8"	1,000	1,150	1,250	1,400,000	(See Footnotes
No. 2		965	1,110	1,210	1,300,000	1 and 2)
No. 3		550	635	690	1,200,000	
Select Structural		1,265	1,455	1,580	1,500,000	
No. 1	2" x 10"	915	1,055	1,145	1,400,000	
No. 2		885	1,020	1,105	1,300,000	
No. 3		505	580	635	1,200,000	
Select Structural		1,150	1,325	1,440	1,500,000	
No. 1	2" x 12"	835	960	1,040	1,400,000	
No. 2		805	925	1,005	1,300,000	
No. 3		460	530	575	1,200,000	

For SI: 1 inch = 25.4mm, 1 psi = 6.895 kPa

1. When dimension lumber is used where moisture content will exceed 19% for an extended time period, F_b shall be multiplied by 0.85 if F_b exceeds 1150 psi, and E shall be multiplied by 0.9.
2. Following is a list of agencies certified by the American Lumber Standards Committee Board of Review (as of 1991) for inspection and grading of untreated lumber under the rules indicated.

For the most up-to-date list of certified agencies write to:

American Lumber Standards Committee
P.O. Box 210
Germantown, Maryland, 20874

Rules Writing Agencies	Rules for Which Grading is Authorized
Northeastern Lumber Grades Authority (NLGA) 260-1055 W. Hastings Street Vancouver, BC V6E 2E9 Canada	NLGA
Northeastern Lumber Manufacturers Association (NELMA) 272 Tuttle Road, P.O. Box 87A Cumberland Center, Maine 04021	NELMA, NLGA, WCLIB, WWPA,
Northern Softwood Lumber Bureau (NSLB) 272 Tuttle Road, P.O. Box 87A Cumberland Center, Maine 04021	NSLB, WCLIB, WWPA, NLGA
Redwood Inspection Service (RIS) 405 Enfrente Drive, Suite 200	RIS, WCLIB, WWPA

Novato, California 94949	
Southern Pine Inspection Bureau (SPIB) 4709 Scenic Highway Pensacola, Florida 32504	SPIB, NELMA, WCLIB, WWPA, NLGA
West Coast Lumber Inspection Bureau (WCLIB) 6980 SW Varnes Road, PO Box 23145 Portland, Oregon 97223	WCLIB, RIS, WWPA, NLGA, SPIB
Western Wood Products Association (WWPA) 522 S.W. 5th Avenue, Yeon Building Portland, OR 97204	WWPA, WCLIB, NLGA, RIS, SPIB

Non-Rules Writing Agencies

California Lumber Inspection Service	RIS, WCLIB, WWPA, NLGA, SPIB
Pacific Lumber Inspection Bureau, Inc.	RIS, WCLIB, WWPA, NLGA
Timber Products Inspection	RIS, SPIB, WCLIB, WWPA
Alberta Forest Products Association	NLGA
Canadian Lumbermen's Association	NLGA, NELMA
Cariboo Lumber Manufacturers Association	NLGA
Central Forest Products Association	NLGA
Council of Forest Industries of British Columbia	NLGA
Interior Lumber Manufacturers Association	NLGA
Macdonald Inspection	NLGA
Maritime Lumber Bureau	NLGA, NELMA
Ontario Lumber Manufacturers Association	NLGA, NELMA
Pacific Lumber Inspection Bureau	NLGA
Quebec Lumber Manufacturers Association	NLGA, NELMA

Table 502.3.1d
DESIGN VALUES FOR DIMENSION LUMBER — 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"			MODULES OF ELASTICITY "E"
			Normal Duration	Snow Loading	7-Day Loading	
900f.1.0*E*	3, 4		1,050	1,210	1,310	1,000,000
1200f.1.2*E*	1, 2, 3, 4		1,400	1,610	1,750	1,200,000
1350f.1.3*E*	2, 4		1,550	1,780	1,940	1,300,000
1450f.1.3*E*	1, 3, 4		1,650	1,900	2,060	1,300,000
1500f.1.3*E*	2		1,750	2,010	2,190	1,300,000
1500f.1.4*E*	1, 2, 3, 4		1,750	2,010	2,190	1,400,000
1650f.1.4*E*	2		1,900	2,190	2,370	1,400,000
1650f.1.6*E*	1, 2, 3, 4		1,900	2,180	2,380	1,500,000
1800f.1.6*E*	1, 2, 3, 4	Machine	2,050	2,360	2,560	1,600,000
1950f.1.5*E*	2	rated	2,250	2,590	2,810	1,500,000
1950f.1.7*E*	1, 2, 4	lumber	2,250	2,590	2,810	1,700,000
2100f.1.8*E*	1, 2, 3, 4	2x4	2,400	2,760	3,000	1,800,000
2250f.1.6*E*	2	and	2,600	2,990	3,250	1,600,000
2250f.1.9*E*	1, 2, 4	wider	2,600	2,990	3,250	1,900,000
2400f.1.7*E*	2		2,750	3,160	3,440	1,700,000
2400f.2.0*E*	1, 2, 3, 4		2,750	3,160	3,440	2,000,000
2550f.2.1*E*	1, 2, 4		2,950	3,390	3,690	2,100,000
2700f.2.2*E*	1, 2, 3, 4		3,100	3,570	3,880	2,200,000
2850f.2.3*E*	2		3,300	3,800	4,130	2,300,000
3000f.2.4*E*	1, 2		3,450	3,970	4,310	2,400,000
3150f.2.5*E*	2		3,600	4,140	4,500	2,500,000
3300f.2.6*E*	2		3,800	4,370	4,750	2,600,000
900f.1.0*E*	1, 2, 3		1,050	1,210	1,310	1,000,000
900f.1.2*E*	1, 2, 3		1,050	1,210	1,310	1,200,000
1200f.1.5*E*	1, 2, 3	See	1,400	1,610	1,750	1,500,000
1350f.1.8*E*	1, 2	footnotes	1,550	1,780	1,940	1,800,000
1500f.1.8*E*	3		1,750	2,010	2,190	1,800,000
1800f.2.1*E*	1, 2, 3		2,050	2,360	2,560	2,100,000

For SI: 1 inch = 25.4 mm, 1 psi = 6.895 kPa

Table 502.3.1c footnotes are applicable to machine stress rated joists and rafters.

1. National Lumber Grades Authority (see Footnote 2, Table 502.3.1c); Machine Rates Lumber, 2x4 and wider.
2. Southern Pine Inspection Bureau; Machine Rated Lumber, 2x4 and wider.
3. West Coast Lumber Inspection Bureau; Machine Rated Lumber, 2x4 and wider; Machine Rated Joists, 2x6 and wider.
4. Western Wood Products Association; Machine Rated Lumber, 2x4 and wider.

CHAPTER 6
WALL CONSTRUCTION

SECTION 601
GENERAL

601.1 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 108 shall be accepted as complying with this code.

601.2 Requirements. The wall construction shall be capable of accommodating all loads imposed according to Section 301 and transmitting the resulting loads to its supporting structural elements.

601.2.1 Compressible floor-covering materials. Compressible floor-covering materials that compress more than 1/32 inch (0.794 mm) when subjected to 50 pounds (23 kg) applied over 1 inch square (645 mm) of material and are greater than 1/8 inch (3.2 mm) in thickness in the uncompressed state shall not extend beneath walls, partitions or columns which are fastened to the floor.

SECTION 602
WALL FRAMING

602.1 Identification. Load-bearing dimension lumber for studs, plates and headers shall conform to DOC PS 20-70, and to other applicable standards and 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 endjointed lumber may be used interchangeably with solid-sawn members of the same species and grade.

602.2 Grade. Studs shall be a minimum No. 3, Standard or Stud grade lumber.

Exception: Nonbearing interior studs may be Utility grade lumber, provided the studs are spaced in accordance with Table No. 602.3(d)

602.3 Exterior walls. Exterior walls of wood-frame construction shall be designed and constructed in accordance with the provisions of this chapter and Figures 602.3a and 602.3b. Components of exterior walls shall be fastened in accordance with Tables 602.3a through 602.3e.

602.3.1 Stud spacing. In bearing walls, studs which are not more than 10 feet (3048 mm) in length shall be spaced not more than is specified in Table 602.3(d&e) for the corresponding stud size.

602.3.2 Top plate. Exterior wall studs shall be capped with a double top plate installed to provide overlapping at corners and intersections with bearing partitions. End joints in top plates shall be offset at least 48 inches (1219 mm).

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 3-inch-by-6-inch by a 0.036-inch-thick (76 mm by 153 mm by 0.914 mm) galvanized steel plate that is nailed to each wall or segment of wall by three 8d nails, provided the rafters or joists are centered over the studs with a tolerance of no more than 1 inch (25 mm). The top plate may be omitted over lintels which are adequately tied to adjacent wall sections with steel plates or equivalent as previously described.

602.3.3 Bearing studs. Where floor or roof framing members are spaced more than 16 inches (406 mm) on center and the bearing studs are spaced 24 inches (610 mm) on center, such members shall bear within 5 inches (127 mm) of the studs beneath.

Exceptions:

1. The top plates are two 2 by 6 (51 by 153) or two 3 by 4 (76 by 102) members.
2. A third top plate is installed.
3. Solid blocking equal in size to the studs is installed to reinforce the double top plate.

602.4 Interior load-bearing 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 (51 mm by 76 mm) studs spaced 24 inches (610 mm) on center or 2-inch-by-4-inch (51 mm by 102 mm) flat studs spaced 16 inches (406 mm) on center.

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

602.5 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 (15.9 mm) 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 602.3a
FASTENER SCHEDULE FOR STRUCTURAL MEMBERS

DESCRIPTION OF BUILDING ELEMENTS	NUMBER & TYPE OF FASTENER [1,2,3,4]	SPACING OF FASTENERS
Joist to sill or girder, toe nail	3-8d	—
1" x 6" subfloor or less to each joist, face nail	2-8d	—
	2 staples, 1 3/4"	—
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	10d	24" o.c.
Double top plates, face nail	10d	24" o.c.
Double top plates, minimum 48" offset of end joints, face nail in lapped area	4-10d	—
Top plates, laps at corners and intersections, face nail	2-10d	—
Built-up header. two pieces with 1/2" spacer	16d	16" o.c. along each edge
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, lap over partitions, face nail	3-10d	—
Ceiling joist to parallel rafters, face nail	3-10d	—
Rafter to plate, toe nail	2-16d	—
1" brace to each stud and plate, face nail	2-8d	—
	2 staples, 1 3/4"	—
1" x 6" sheathing to each bearing, face nail	2-8d	—
	2 staples, 1 3/4"	—
1" x 8" sheathing to each bearing, face nail	2-8d	—
	3 staples, 1 3/4"	—
Wider than 1" x 8" sheathing to each bearing. face nail	3-8d	—
	4 staples, 1 3/4"	—
Built-up corner studs	10d	24" o.c.
Built-up girders and beams, 2" lumber layers	10d	Nail each layer as follows: 32" o.c. at top and bottom and staggered. Two nails at ends and at each splice.
2" planks	2-16d	At each bearing
Roof rafters to ridge, valley or hip rafters:		
toe nail	4-16d	—
face nail	3-16d	—
Rafter ties to rafters, face	3-8d	—

DESCRIPTION OF BUILDING MATERIALS	DESCRIPTION OF FASTENER [2,3,4,5]	SPACING OF FASTENERS: Edges (inches)	SPACING OF FASTENERS: Intermediate Supports [3,5] (inches)
Plywood and wood structural panels, subfloor, roof and wall sheathing to framing, and particleboard wall sheathing to framing			
5/16" – 1/2"	6d common nail (subfloor, wall) 8d common nail (roof)[6]	6	12[7]
19/32" – 1"	8d common nails	6	12[7]
1 1/8" – 1 1/4"	10d common nail or 8d deformed nail	6	12
Other wall sheathing[8]			
1/2" gypsum sheathing	1 1/2" galvanized roofing nail; 6d common nail; Staple galvanized, 1 1/2" long; 1 1/4" screws, Type W or S	4	8
5/8" gypsum sheathing	1 3/4" galvanized roofing nail; 8d common nail; Staple galvanized, 1 5/8" long; 1 5/8" screws, Type W or S	4	8
Plywood and wood structural panels, combination subfloor underlayment to framing			
3/4" and less	6d deformed nail or 8d common nail	6	12
7/8" – 1"	8d common nail or 8d deformed nail	6	12
1 1/8" – 1 1/4"	10d common nail or 8d deformed nail	6	12

For **SI:** 1 inch = 25.4 mm, 1 foot = 304.8 mm. 1 mph = 1.609 km/h

1. All nails are smooth-common, box or deformed shanks except where otherwise stated.
2. Staples are 16 gage wire and have a minimum 7/16-inch O.D. crown width.
3. Nails shall be spaced at not more than 6 inches o.c. at all supports where spans are 48 inches or greater.

4. 4' x 8' or 4' x 9' panels shall be applied vertically.
5. Spacing of fasteners not included in this table shall be based on Table 602.3a(1).
6. For regions having basic wind speed of 90 mph or greater, 8d deformed nails shall be used for attaching plywood and wood structural panel roof sheathing to framing within minimum 48-inch distance from gable end walls, if mean roof height is more than 25 feet, up to 35 feet maximum.
7. For regions having basic wind speed of 80 mph or less, nails for attaching plywood and wood structural panel roof sheathing to gable end wall framing shall be spaced 6 inches o.c. When basic wind speed is greater than 80 mph, nails for attaching panel roof sheathing to intermediate supports shall be spaced 6 inches o.c. for minimum 48-inch distance from ridges, eaves and gable end walls; and 4 inches o.c. to gable end wall framing.
8. Gypsum sheathing shall conform to ASTM C 79 and shall be installed in accordance with GA 253. Fiberboard sheathing shall conform to either AHA 194.1 or ASTM C 208.

Table 602.3a(1)
ALTERNATE ATTACHMENTS

NOMINAL MATERIAL THICKNESS	DESCRIPTION[1, 2] OF FASTENER AND LENGTH	SPACING[3] OF FASTENERS	
		Edges (inches)	Intermediate Supports (inches)
Plywood and wood structural panels subfloor, roof and wall sheathing to framing and particleboard wall sheathing to framing			
5/16"	0.097 – 0.099 Nail 1 1/2"	6	12
	Staple 15 ga. 1 3/8"		
3/8"	Staple 15 ga. 1 3/8"	6	12
	0.097 – 0.099 Nail 1 1/2"	4	10
15/32" and 1/2"	Staple 15 ga. 1 1/2"	6	12
	0.097 – 0.099 Nail 1 5/8"	3	6
19/32" and 5/8"	0.113 Nail 1 7/8"		
	Staple 15 and 16 ga. 1 5/8"	6	12
	0.097 – 0.099 Nail 1 3/4"	3	6
23/32" and 3/4"	Staple 14 ga. 1 3/4"	6	12
	Staple 15 ga. 1 3/4"	5	10
	0.097 – 0.099 Nail 1 7/8"	3	6
1"	Staple 14 ga. 2"	5	10
	0.113 Nail 2 1/4"		
	Staple 15 ga. 2"	4	8
	0.097 – 0.099 Nail 2 1/8"	3	6
NOMINAL MATERIAL THICKNESS	DESCRIPTION [1,2] OF FASTENER AND LENGTH	SPACING[3] OF FASTENERS	
		Edges (inches)	Body of Panel[4]
Floor underlayment; plywood-hardboard-particleboard			
Plywood			
1/4" and 5/16"	1 1/4" ring or screw shank nail — minimum	6	8
	12 1/2 ga. (0.099") shank diameter		
11/32", 3/8", 15/32", and 1/2"	1 1/4" ring or screw shank nail — minimum	6	8[5]
	12 1/2 ga. (0.099") shank diameter		
19/32", 5/8", 23/32", and 3/4"	1 1/2" ring or screw shank nail — minimum	6	12
	12 1/2 ga. (0.099") shank diameter		
Hardboard	1 1/2" long ring-grooved underlayment nail	6	6
0.200"	4d cement-coated sinker nail	6	6
	Staple 18 ga. 7/8" long (plastic coated)	3	6
Particleboard	4d ring-grooved underlayment nail	3	6
1/4"	Staple 18 ga. 7/8" long, 3/16" crown	3	6
3/8"	6d ring-grooved underlayment nail	6	10
	Staple 16 ga. 1 1/8" long, 3/8" crown	3	6
1/2" – 5/8"	6d ring-grooved underlayment nail	6	10
	Staple 16 ga., 1 5/8" long, 3/8" crown	3	6

For SI: 1 inch = 25.4 mm

1. Nail is a general description and may be T-head, modified round head, or round head.
2. Staples shall have a minimum crown width of 7/16-inch o.d. except as noted.
3. Nails or staples shall be spaced at not more than 6 inches o.c. at all supports where spans are 48 inches or greater. Nails or staples shall be spaced at not more than 10 inches o.c. at intermediate supports for floors.
4. Fasteners shall be placed in a grid pattern throughout the body of the panel.
5. For 5-ply panels, intermediate nails shall be spaced not more than 12 inches o.c. each way.

Table 602.3b
ALLOWABLE STUD SPACING FOR WOOD STRUCTURAL PANEL WALL SHEATHING

PANEL SPAN RATING	PANEL NOMINAL THICKNESS (inches)	MAXIMUM STUD SPACING (inches) Siding Nailed To:[1]	
		Stud	Sheathing
12/0, 16/0, or Wall — 16 o.c.	5/16, 3/8	16	16[2]
24/0, 24/16, 32/16, or Wall — 24 o.c.	3/8, 7/16, 15/32, 1/2	24	24[3]

For **SI:** 1 inch = 25.4 mm

1. Blocking of horizontal joints shall not be required.
2. Plywood sheathing 3/8-inch thick or less shall be applied with long dimension across studs.
3. Three-ply plywood panels shall be applied with long dimension across studs.

Table 602.3c
ALLOWABLE SPANS FOR PARTICLEBOARD WALL SHEATHING[1]

THICKNESS (inches)	GRADE	STUD SPACING (inches)	
		When Siding is Nailed to Studs	When Siding is NAILED to Sheathing
3/8	M-1 Exterior Glue	16	—
1/2	M-2 Exterior Glue	16	16

For **SI:** 1 inch = 25.4 mm

1. Wall sheathing not exposed to the weather. If the panels 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.602.3d
MAXIMUM STUD SPACING (INCHES) FOR 70 AND 80 MPH

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

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

Table No. 602.3e
Exterior Bearing Walls [1,2,3,4,5]
First Floor of Three Story

	SPF		SP	
WIND Zone (mph)	2 X 4 @ 12" oc Structural Sheathing	3 X 4 or 2 X 6 Structural Sheathing	2 X 4 @ 12" oc Structural Sheathing	3 X 4 or 2 X 6 Structural Sheathing
70	#2, Stud, Std	Any Grade	Any Grade	Any Grade
80	#2, Stud, Std	Any Grade	Any Grade	Any Grade

Exterior Non-Bearing Walls [1,2,3,4,5,6]

	SPF			SP		
WIND Zone (mph)	2 X 4 @ 12" oc Blocking	2 X 4 @ 16" oc Blocking	3 X 4 or 2 X 6 @ 16" oc Blocking	2 X 4 @ 12" oc Blocking	2 X 4 @ 16" oc Blocking	3 X 4 or 2 X 6 @ 16" oc Blocking
70	Any Grade	Any Grade	Any Grade	Any Grade	Any Grade	Any Grade
80	Any Grade	#2, Stud	Any Grade	Any Grade	Any Grade	Any Grade

1. Any grade = any grade except Standard, Utility and Economy.
2. Corner bracing is REQUIRED where "Blocking" is specified
3. 2 - 2 x 4's @ 16" or 1 - 2 x 4 @ 8" may be used where 3 x 4 @ 16" is specified.
4. Refer to Chapter 40 and 41 for "COASTAL" sheathing requirements.
5. Bearing stud height is limited to 10 feet.
6. 2x full depth blocking @ mid-height.

602.5.1 Drilling and notching—top plate. When 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 gage steel angle spanning the distance between the adjacent studs.

602.6 Headers. The allowable spans for nominal 4-inch (102 mm) single headers and 2-inch (51 mm) double headers in bearing walls shall not exceed the spans set forth in Table 602.6(a)thru 602.6(c). The tables are not to be used where concentrated loads are supported by the headers.

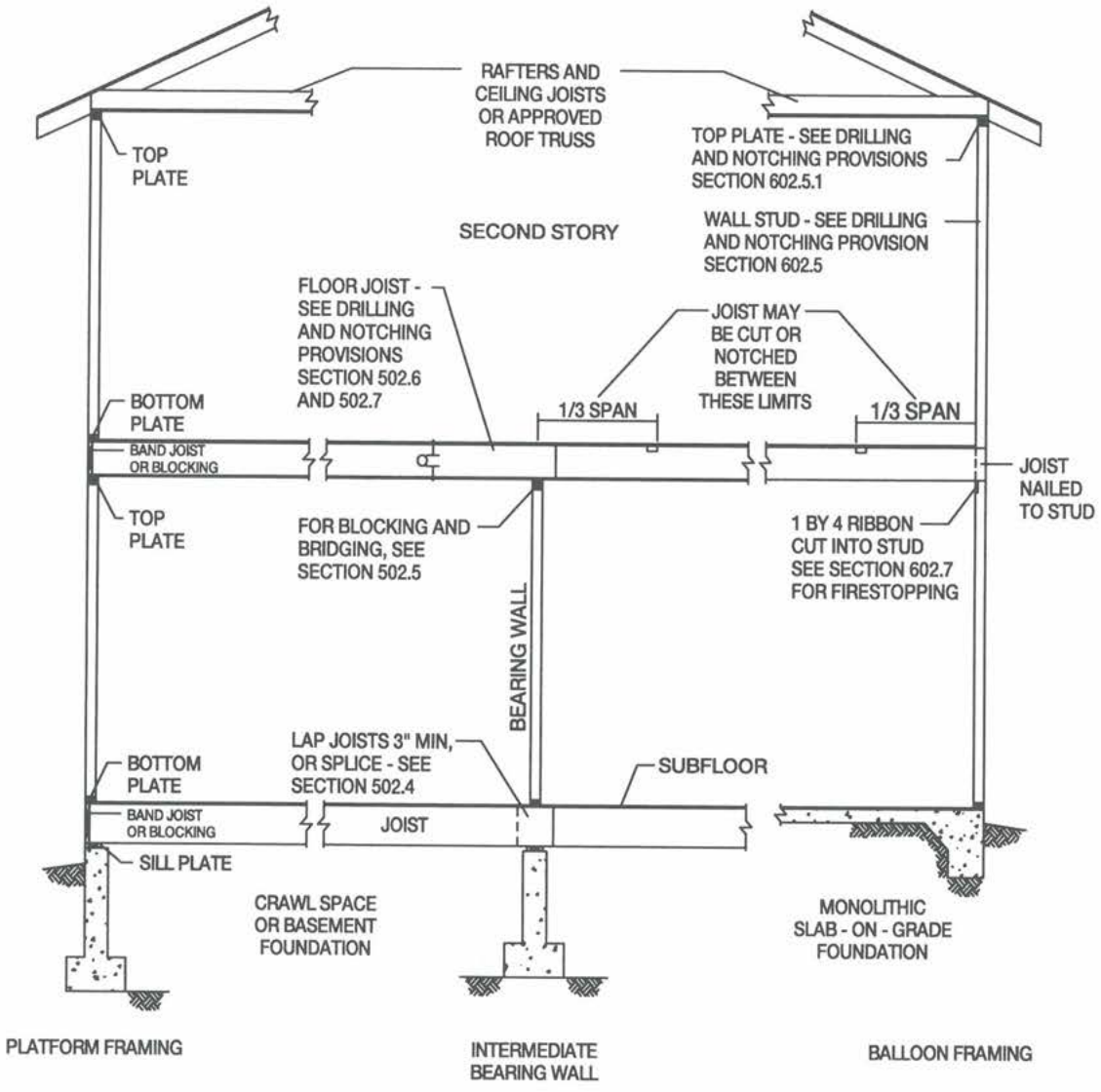
602.6.1 Single headers. Nominal 2-inch (51 mm) single headers may be used to span openings in load-bearing walls, provided the headers are of adequate size to support all imposed loads.

602.6.2 Plywood box headers. Plywood box headers shall be constructed in accordance with Figure 602.6.2 and Table 602.6.2.

602.6.3 Header Studs. A wall stud shall be at each side of the opening with the ends of the header supported as follows:

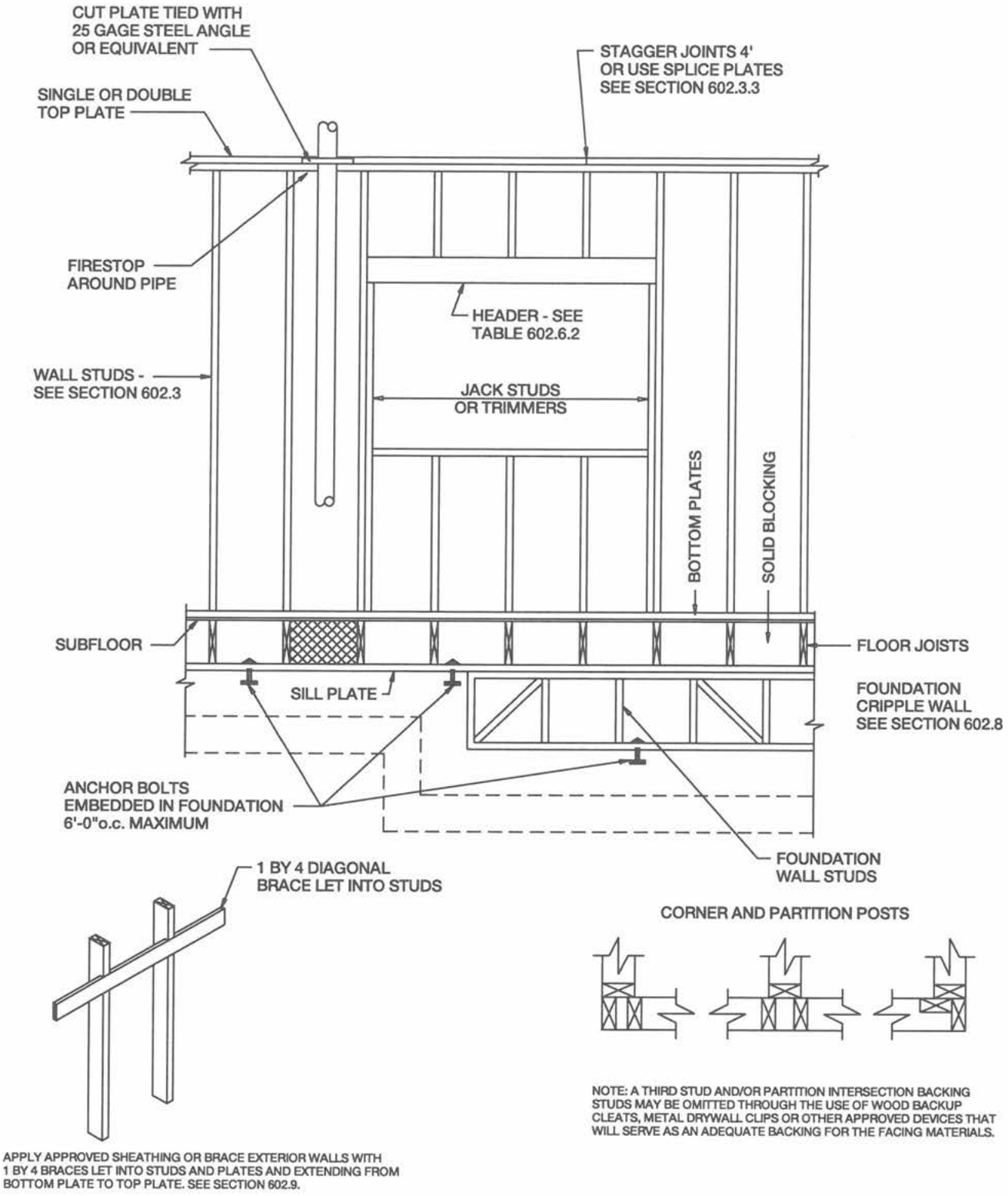
1. For openings 3 feet or less wide, each end of the header shall rest on a single header (jack) stud or may be supported by framing anchors attached to the wall stud.
2. For openings more than 3 feet but not more than 6 feet wide, each end or the header shall rest on a single header (jack) stud.
3. For opening more than 6 feet wide, each end of the header shall rest on two header (jack) studs.

602.6.4 Non-bearing walls. Load-hearing headers are not required in interior or exterior nonbearing walls. A single flat 2-inch-by-4-inch (51 mm by 102 mm) member may he used as a header in interior or exterior nonbearing walls for openings up to 8 feet (2438 mm) in width if the vertical distance to the parallel nailing surface above is not more than 24 inches (610 mm). For such nonbearing headers, no cripples or blocking are required above the header.



For **SI:** 1 inch = 25.4 mm

Figure 602.3a
TYPICAL WALL, FLOOR AND ROOF FRAMING



For **SI:** 1 inch = 25.4 mm, 1 foot = 304.8 mm

Figure 602.3b
FRAMING DETAILS

TABLE 602.6(a)

HEADER DESIGN CHART
(Douglas Fir-Larch, Southern Pine No. 2,
Roof Load = 20 LL + 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 (Fl.-in.) DESIGN PROCEDURE								
		Nonstruct. Sheath. House Depth (ft.)			1/2" Insul. Board Sheath.* House Depth (ft.)			1/2 " Plywood Sheath. ** House Depth (ft.)		
		24'	28'	32'	24'	28'	32'	24'	28'	32'
Roof	2-2 x 4	4-7	4-6	4-3	4-11	4-8	4-6	5-7	5-4	5-1
	2-2 x 6	6-8	6-4	5-11	6-11	6-7	6-4	7-7	7-3	7-0
	2-2 x 8	8-3	8-0	7-7	8-6	8-2	7-11	8-11	8-7	8-4
	2-2 x 10	9-10	9-6	9-3	10-0	9-8	9-4	10-4	10-0	9-9
	2-2 x 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 x 4	5-2	4-11	4-9	5-4	5-1	4-10	5-8	5-5	5-2
	2-2 x 6	6-9	6-5	6-0	6-11	6-7	6-3	7-4	7-0	6-8
	2-2 x 8	8-0	7-5	7-0	8-1	7-8	7-3	8-5	8-2	7-9
	2-2 x 10	9-3	8-9	8-3	9-4	9-0	8-5	9-7	9-3	8-11
	2-2 x 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 x 4	4-8	4-5	4-3	4-9	4-6	4-3	5-1	4-10	4-8
	2-2 x 6	5-10	5-5	5-1	6-0	5-7	5-3	6-7	6-2	5-9
	2-2 x 8	6-9	6-3	5-11	7-0	6-6	6-1	7-6	7-0	6-7
	2-2 x 10	8-0	7-5	6-11	8-2	7-7	7-1	8-8	8-1	7-7
	2-2 x 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 x 4	4-8	4-5	4-3	4-9	4-6	4-3	5-1	4-10	4-8
	2-2 x 6	5-10	5-5	5-1	6-0	5-7	5-3	6-7	6-2	5-9
	2-2 x 8	6-9	6-3	5-11	7-0	6-6	6-1	7-6	7-0	6-7
	2-2 x 10	8-0	7-5	6-11	8-2	7-7	7-1	8-8	8-1	7-7
	2-2 x 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 x 4	3-11	3-8	3-5	4-1	3-9	3-7	4-5	4-2	4-0
	2-2 x 6	4-8	4-4	4-0	4-10	4-5	4-2	5-3	4-11	4-7
	2-2 x 8	5-5	5-0	4-8	5-7	5-2	4-10	6-0	5-7	5-3
	2-2 x 10	6-4	5-1	5-6	6-6	6-0	5-8	6-11	6-5	6-0
	2-2 x 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 psf.

**Minimum 1/2-inch plywood 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 and 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.

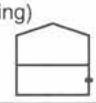
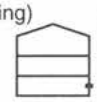
● symbol represents location of header.

Header span 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 nominal 2-inch headers.

TABLE 602.6(b)

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 (Fl.-in.) DESIGN PROCEDURE								
		Nonstruct. Sheath. House Depth (ft.)			1/2" Insul. Board Sheath.• House Depth (ft.)			1/2 " Plywood Sheath. •• House Depth (ft.)		
		24'	28'	32'	24'	28'	32'	24'	28'	32'
Roof 	2-2 x 4	4-5	4-2	3-11	4-8	4-5	4-3	5-4	5-1	4-10
	2-2 x 6	6-2	6-2	5-5	6-7	6-1	5-9	7-7	7-1	6-8
	2-2 x 8	7-10	7-10	6-11	8-3	7-8	7-3	9-1	8-6	8-0
	2-2 x 10	9-6	9-2	8-8	9-8	9-4	9-1	10-0	9-8	9-5
	2-2 x 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 x 4	4-12	4-12	4-9	5-1	4-10	4-8	5-5	5-2	5-0
	2-2 x 6	6-3	6-3	5-10	6-6	6-1	5-8	7-0	6-8	6-3
	2-2 x 8	7-4	7-4	6-10	7-6	7-0	6-7	8-1	7-7	7-1
	2-2 x 10	8-7	8-7	8-0	8-10	8-2	7-8	9-4	8-8	8-2
	2-2 x 12	10-0	10-0	9-4	10-2	9-6	8-11	10-5	10-0	9-4
Roof plus one Story (No Bearing) 	2-2 x 4	4-5	4-2	3-11	4-7	4-4	4-1	4-10	4-8	4-5
	2-2 x 6	5-4	4-11	4-7	5-6	5-1	4-9	6-1	5-7	5-3
	2-2 x 8	6-2	5-9	5-5	6-4	5-11	5-6	6-10	6-5	6-0
	2-2 x 10	7-3	6-9	6-4	7-5	6-11	6-6	7-11	7-4	6-11
	2-2 x 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 x 4	4-5	4-2	3-11	4-7	4-4	4-1	4-10	4-8	4-5
	2-2 x 6	5-4	4-11	4-7	5-6	5-1	4-9	6-1	5-7	5-3
	2-2 x 8	6-2	5-9	5-5	6-4	5-11	5-6	6-10	6-5	6-0
	2-2 x 10	7-3	6-9	6-4	7-5	6-11	6-6	7-11	7-4	6-11
	2-2 x 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 x 4	3-7	3-4	3-1	3-9	3-6	3-3	4-2	3-10	3-7
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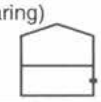
	2-2 x 8	4-11	4-7	4-3	5-1	4-9	4-5	5-6	5-1	4-9
	2-2 x 10	5-10	5-5	5-1	5-11	5-6	5-2	6-4	5-10	5-6
	2-2 x 12	6-9	6-9	5-10	6-10	6-4	6-0	7-3	6-8	6-3

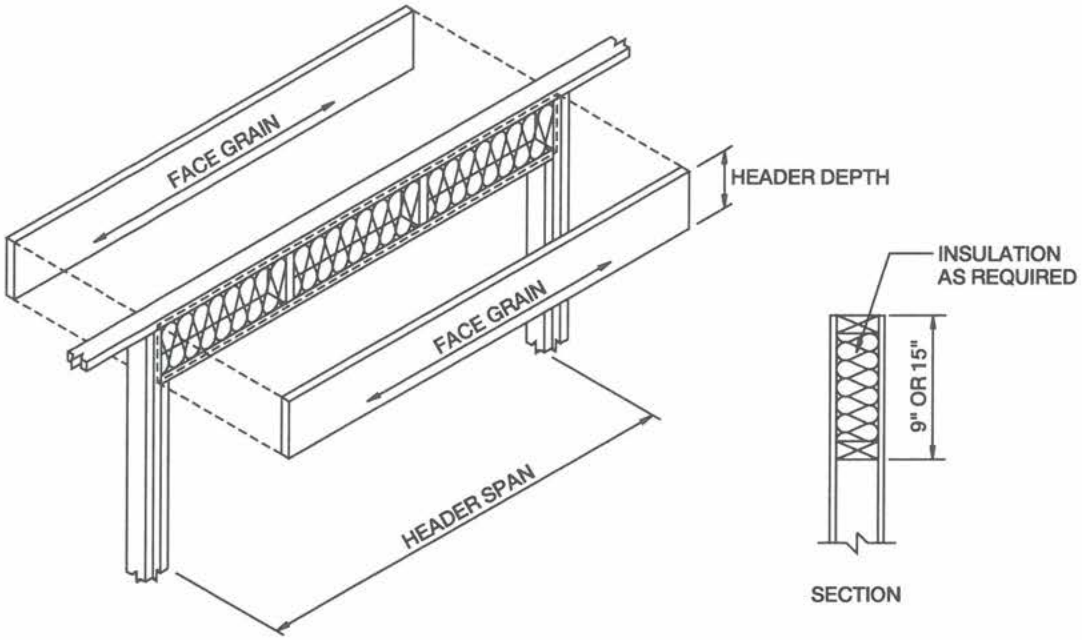
*** See notes to Table 602.6(a)**

TABLE 602.6(c)

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 (Fl.-in.) DESIGN PROCEDURE								
		Nonstruct. Sheath. House Depth (ft.)			1/2" Insul. Board Sheath.• House Depth (ft.)			1/2 " Plywood Sheath. •• House Depth (ft.)		
		24'	28'	32'	24'	28'	32'	24'	28'	32'
Roof 	2-2 x 4	4-2	3-11	3-8	4-5	4-3	4-0	5-2	5-0	4-9
	2-2 x 6	5-10	5-5	5-1	6-2	5-9	5-5	7-1	6-7	6-3
	2-2 x 8	7-4	6-10	6-6	7-8	7-2	6-9	8-6	7-11	7-6
	2-2 x 10	9-2	8-7	8-1	9-5	8-9	8-3	9-10	9-6	8-11
	2-2 x 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 x 4	4-10	4-7	4-4	5-0	4-9	4-6	5-4	5-1	4-10
	2-2 x 6	5-10	5-6	5-2	6-1	5-8	5-4	6-8	6-3	5-10
	2-2 x 8	6-10	6-4	6-0	7-1	6-7	6-2	7-7	7-1	6-8
	2-2 x 10	8-1	7-6	7-1	8-3	7-8	7-2	8-9	8-2	7-8
	2-2 x 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 x 4	4-3	3-11	3-8	4-5	4-1	3-10	4-9	4-6	4-3
	2-2 x 6	5-0	4-7	4-4	5-2	4-9	4-5	5-8	5-3	4-11
	2-2 x 8	5-9	5-4	5-0	6-0	5-6	5-2	6-5	6-0	5-7
	2-2 x 10	6-10	6-4	5-11	6-11	6-5	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	4-3	3-11	3-8	4-5	4-1	3-10	4-9	4-6	4-3
	2-2 x 6	5-0	4-7	4-4	5-2	4-9	4-5	5-8	5-3	4-11
	2-2 x 8	5-9	5-4	5-0	6-0	5-6	5-2	6-5	6-0	5-7
	2-2 x 10	6-10	6-4	5-11	6-11	6-5	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	3-4	3-1	2-11	3-6	3-3	3-0	3-10	3-7	3-4
	2-2 x 6	4-0	3-8	3-5	4-1	3-10	3-7	4-6	4-2	3-11
	2-2 x 8	4-7	4-3	4-0	4-9	4-5	4-2	5-1	4-9	4-5
	2-2 x 10	5-5	5-1	4-9	5-7	5-2	4-10	5-11	5-6	5-2
	2-2 x 12	6-4	5-10	5-6	6-5	6-0	5-7	6-9	6-3	5-11

*** See notes to Table 602.6(a)**



For **SI:** 1 inch = 25.4 mm, 1 foot = 304.8 mm

NOTES:

1. The top plate shall be continuous over header.
2. Jack studs shall be used for spans over 4 feet.
3. Cripple spacing shall be the same as for studs.
4. Plywood faces shall be single pieces of 15/32-inch-thick C-D (exterior glue) or better, installed on the interior or exterior or both sides of the header.
5. Plywood faces shall be nailed to framing and cripples with 8d common nails spaced 3 inches o.c. staggering alternate nails 1/2 inch.

Figure 602.6.2
TYPICAL PLYWOOD BOX HEADER CONSTRUCTION

Table 602.6.2
MAXIMUM SPANS FOR PLYWOOD BOX HEADERS (feet)[1]

HEADER CONSTRUCTION[2]	HEADER DEPTH (inches)	HOUSE DEPTH (feet)				
		24	26	28	30	32
Plywood One Side	9	4	4	3	3	—
	15	5	5	4	3	3
Plywood Both Sides	9	7	5	5	4	3
	15	8	8	7	7	6

For **SI:** 1 inch = 25.4 mm, 1 foot = 304.8 mm

1. Spans are based on single story with clear-span trussed roof or two story with floor and roof supported by interior-bearing walls.
2. See Figure 602.6.2 for construction details.

602.7 Firestopping required. 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.

602.7.1 Materials. Except as provided in Item 4 above, firestopping shall consist of 2-inch (51 mm) nominal lumber, or two thicknesses of 1-inch (25 mm) nominal lumber with broken lap joints, or one thickness of 23/32-inch (18 mm) wood structural panels with joints backed by 23/32-inch (18 mm) wood structural panels or one thickness of 3/4-inch (19 mm) particleboard with joints backed by 3/4-inch (19 mm) particleboard, 1/2-inch (12.7 mm) gypsum board, or 1/4-inch (6.4 mm) cement-based millboard.

602.7.1.1 Unfaced fiberglass. Unfaced fiberglass bat insulation used as firestopping shall fill the entire cross section of the wall cavity to a minimum height of 16 inches (406 mm) measured vertically. When piping, conduit or similar obstructions are encountered, the insulation shall be packed tightly around the obstruction.

602.7.1.2 Firestopping integrity. The integrity of all firestops shall be maintained.

602.8 Cripple walls. Foundation cripple walls shall be framed of studs not less in size than the studding above. When exceeding 4 feet (1219 mm) in height, such walls shall be framed of studs having the size required for an additional story.

602.8.1 Bracing. Such walls having a stud height exceeding 14 inches (356 mm) shall be considered to be first story walls for the purpose of determining the bracing required by Section 602.9. Stud walls less than 14 inches (356 mm) in height shall be sheathed with plywood or wood structural panels attached to both the top and bottom plates in accordance with Table 602.3a, or the walls shall be constructed of solid blocking.

602.9 Wall bracing. Exterior and foundation wall panels of frame construction shall be braced with 1-inch-by-4-inch (25 mm by 102 mm) let-in braces, or approved metal strap devices installed in accordance with the manufacturer's specifications; wood structural panels in accordance with Table 602.3b; particleboard in accordance with Table 602.3c, gypsum sheathing, wallboard or veneer base applied vertically or horizontally to studs spaced not more than 24 inches (610 mm) on center and fastened in accordance with Table 602.3a; fiberboard sheathing applied vertically to studs spaced not more than 16 inches (406 mm) on center and fastened in accordance with Table 602.3a; portland cement plaster applied over metal lath attached to studs spaced not more than 16 inches (406 mm) on center in accordance with Section 703.6, 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 degrees or less than 45 degrees from the horizontal and attached to the framing in conformance with Table 602.3a. Structural sheathing and 1-inch-by-4-inch (25 mm by 102 mm) let-in braces shall be installed in accordance with Table 602.9 and fastened in accordance with Table 602.3a.

Exception: The minimum 48-inch (1219 mm) braced wall panel width required by Table 602.9 may be replaced by an alternate braced wall panel constructed in accordance with the following:

1. In one-story buildings, each panel shall have a width of not less than 32 inches (813 mm) and a height of not more than 10 feet (3048 mm). Each panel shall be sheathed on one face with 3/8-inch (9.5 mm) minimum thickness wood structural panel sheathing nailed with 8d common or galvanized box nails in accordance with Table 602.3a and blocked at all edges. Two anchor bolts installed in accordance with Figure 403.1a or approved equivalent shear connectors shall be provided in each panel. Each panel end stud shall have a tie-down device fastened to the foundation, capable of providing an approved uplift capacity of not less than 1,800 pounds (816 kg). The tie-down device shall be installed in accordance with the manufacturer's recommendations. The panels shall be supported directly on a foundation or on floor framing supported directly on a foundation. This foundation or footing shall be continuous across the entire length of the braced wall line and shall be reinforced with not less than two No. 4 bars.
2. In the first story of two-story buildings, each braced wall panel shall be in accordance with Item 1 above, except that the wood structural panel sheathing shall be applied to both faced, three anchor bolts or approved equivalent shear connectors shall be provided, and tie-down device uplift capacity shall not be less than 3,000 pounds (1361 kg).

SECTION 603
METAL

603.1 General. Elements shall be straight and free of any defects which would significantly affect structural performance.

Table 602.9
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-inch-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.
3 and 4	One story Top of two or three story	1-inch-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

For **SI:** 1 inch = 25.4 mm, 1 foot = 304.8 mm

1. Foundation 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 604
GENERAL MASONRY CONSTRUCTION

604.1 General. Masonry construction shall be designed and constructed in accordance with the provisions of this section or in accordance with the provisions of ACI 530/ASCE 5/TMS 402.

604.1.1 Professional registration not required. When the empirical design provisions of National Masonry Standard Chapter 9 or the provisions of this section are used to design masonry, project drawings, typical details and specifications are not required to bear the seal of the architect or engineer responsible for design.

604.1.2 Used Brick or Materials. Used materials shall not be used, unless such materials conform to these requirements and have been thoroughly cleaned.

604.2 Thickness of masonry. The nominal thickness of masonry walls shall conform to the requirements of Sections 604.2.1 through 604.2.4.

604.2.1 Minimum thickness. The minimum thickness of masonry bearing walls more than one story high shall be 8 inches (203 mm). Solid masonry walls of one story dwellings and garages shall not be less than 6 inches (153 mm) in thickness when not greater than 9 feet (2743 mm) in height, provided that when gable construction is used, an additional 6 feet (1829 mm) 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 604.8.

604.2.2 Rubble stone masonry wall. The minimum thickness of rough or random or coursed rubble stone masonry walls shall be 16 inches (406 mm).

604.2.3 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.

604.2.4 Parapet walls. Unreinforced solid masonry parapet walls shall not be less than 8 inches (203 mm) 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 (203 mm) in thickness, and their height shall not exceed three times their thickness.

604.3 Corbeled masonry. Solid masonry units shall be used for corbeling. The maximum corbeled projection beyond the face of the wall shall not be more than one-half of the wall thickness or one-half the wythe thickness for hollow walls; the maximum projection of one unit shall not exceed one-half the height of the unit or one-third the 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.

604.3.1 Support conditions. Cavity wall or masonry veneer construction may be supported on an 8-inch (203 mm) foundation wall, provided the 8-inch (203 mm) 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 (51 mm) with individual corbels projecting not more than one-third the thickness of the unit or one-half the height of the unit. The top course of all corbels shall be a header course.

604.4 Allowable stresses. Allowable compressive stresses in masonry shall not exceed the values prescribed in Table 604.4. 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.

Table 604.4
ALLOWABLE COMPRESSIVE STRESSES FOR EMPIRICAL DESIGN OF MASONRY

CONSTRUCTION: COMPRESSIVE STRENGTH OF UNIT, GROSS AREA	ALLOWABLE COMPRESSIVE STRESSES[1] GROSS CROSS SECTIONAL AREA[2]	
	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[3] 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 loadbearing 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[4]) 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		
Course, rough, or random	120	100

For **SI:** 1 psi = 6.895 kPa

1. Linear interpolation shall be used for determining allowable stresses for masonry units having compressive strengths which are intermediate between those given in the table.
2. Gross cross-sectional area shall be calculated on the actual rather than nominal dimensions.
3. See Section 607.
4. 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.

604.4.1 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 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 (38 mm).

604.5 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 604.4.

604.5.1 Pier cap. Hollow piers shall be capped with 4 inches (102 mm) 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.

604.5.2 Pier and Curtain Walls: Curtain walls 4 inch (nominal) minimum thickness between piers and bonded into piers supported on concrete footings poured integrally with pier footing may be used for frame construction and for masonry veneer frame construction not more than 2 stories in height subject to the following limitations:

1. Maximum height above footing;
   Hollow Masonry: 18 times thickness of curtain wall.
   Solid Masonry: 20 times thickness of curtain wall.
2. Unbalanced fill placed placed against 4 inch curtain wall shall not exceed 24 inches for solid masonry or 16 inches for hollow masonry.
3. Pier size shall be based on Table 403.1(a).
4. See Chapter 40 for special anchorage and reinforcement in the 100E and 110 mph wind zones.

604.6 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 (1219 mm), and shall have at least 8 inches (203 mm) of masonry in back of the chases and recesses and between adjacent chases or recesses and the jambs of openings. 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. Masonry directly above chases or recesses wider than 12 inches (305 mm) shall be supported on noncombustible lintels.

604.7 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 inch (11 mm^2) shall be provided in horizontal bed joints spaced not more than 16 inches (406 mm) on center vertically.

604.8 Lateral support. Masonry walls shall be laterally supported in either the horizontal or the vertical direction. The maximum spacing between lateral supports shall not exceed the distances in Table 604.8. 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 when the limiting distance is taken vertically.

604.8.1 Horizontal lateral support. Lateral support in the horizontal direction provided by intersecting masonry walls shall be provided by one of the methods in Section 604.8.1.1 or 604.8.1.2.

604.8.1.1 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 (76 mm) on the unit below.

Table 604.8
SPACING OF LATERAL SUPPORT FOR MASONRY WALLS
70 ,80, and 90 MPH[3]

CONSTRUCTION	MAXIMUM WALL LENGTH TO THICKNESS OR WALL HEIGHT TO THICKNESS[1, 2]
Bearing walls	
Solid or solid grouted	20
All other	18
Nonbearing walls	
Exterior	18
Interior	36

For **SI:** 1 foot = 304.8 mm

1. For cavity walls and cantilevered 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 604.2.4.
2. An additional unsupported height of 6 feet is permitted for gable end walls.
3. For 100 mph or greater see Chapter 40 for h/t ratios.

604.8.1.2 Metal reinforcement. Interior nonload-bearing walls shall be anchored at their intersections, at vertical intervals of not more than 16 inches (406 mm) with joint reinforcement of at least 9 gage, or 1/4 inch (6.4 mm) galvanized mesh hardware cloth. Intersecting masonry walls, other than interior nonloadbearing walls, shall be anchored at vertical intervals of not more than 8 inches (203 mm) with joint reinforcement of at least 9 gage and shall extend at least 30 inches (762 mm) in each direction at the intersection. Other metal ties, joint reinforcement or anchors, if used, shall be spaced to provide equivalent area of anchorage to that required by this section.

604.8.2 Vertical lateral support. Vertical lateral support of masonry walls in Seismic Zones 0, 1 or 2 shall be provided in accordance with one of the methods in Section 604.8.2.1 or 604.8.2.2.

604.8.2.1 Roof structures. Masonry walls shall be anchored to roof structures with metal strap anchors, 1/2-inch (12.7 mm) bolts, or other approved anchors spaced not more than 6 feet (1829 mm) on center. Anchors shall be embedded at least 16 inches (406 mm) into the masonry, or be hooked or welded to bond beam reinforcement placed not less than 6 inches (153 mm) from the top of the wall.

604.8.2.2 Floor diaphragms. Masonry walls shall be anchored to floor diaphragms at intervals not to exceed 6 feet (1829 mm). Support shall be provided by metal strap anchors or l/2-inch-diameter (12.7 mm) bolts installed as shown in Figure 604.10a, or by other approved methods.

604.9 Lintels. Masonry over openings shall be supported by steel lintels, reinforced concrete or masonry lintels or masonry arches, designed to support load imposed.

604.10 Anchorage. Masonry walls shall be anchored to floor and roof systems in accordance with the details shown in Figure 604.10(a). Footings may be considered as points of lateral support.

604.11 Protection for reinforcement. All bars shall be completely embedded in mortar or grout. Joint reinforcement embedded in horizontal mortar joints shall not have less than 5/8-inch (15.9 mm) 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 (19 mm), except where exposed to weather or soil, in which case the minimum coverage shall be 2 inches (51 mm).

604.12 Beam supports. Beams, girders or other concentrated loads supported by a wall or column shall have a bearing of at least 3 inches (76 mm) in length measured parallel to the beam upon solid masonry not less than 4 inches (102 mm) 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 (102 mm) from the face of the wall.

604.12.1 Joist bearing. Joists shall have a bearing of not less than l l/2 inches (38 mm), except as provided in Section 604.13.

604.13 Metal accessories. Joint reinforcement, anchors, ties and wire fabric shall conform to the following: ASTM A 82 for joint reinforcement, wire anchors and ties; ASTM A 36 for plate, headed and bent-bar anchors; ASTM A 510 for corrugated sheet metal anchors and ties; ASTM B 227 for copper-clad steel wire ties; or ASTM A 167 for stainless steel hardware.

604.13.1 Corrosion protection. Minimum corrosion protection of joint reinforcement, anchor ties and wire fabric for use in masonry wall construction shall conform to Table 604.13.1.

Table 604.13.1
MINIMUM CORROSION PROTECTION

MASONRY METAL ACCESSORY	STANDARD
Joint reinforcement, interior walls	ASTM A 641, Class 1
Wire ties or anchors in exterior walls completely embedded in mortar or grout	ASTM A 641, Class 3
Wire ties or anchors in exterior walls not completely embedded in mortar or grout	ASTM A 153, Class B-2
Joint reinforcement in exterior walls or interior walls exposed to moist environment	ASTM A 153, Class B-2
Sheet metal ties or anchors exposed to weather	ASTM A 153, Class B-2
Sheet metal ties or anchors completely embedded in mortar or grout	ASTM A 525, Class G-60
Stainless steel hardware for any exposure	ASTM A 167, Type 304

SECTION 605
UNIT MASONRY

605.1 Placing mortar and masonry units.

605.1.1 Bed and head joints. Unless otherwise required or indicated on the project drawings, head and bed joints shall be 3/8 inch (9.5 mm) thick, except that the thickness of the bed joint of the starting course placed over foundations shall not be less than l/4 inch (6.4 mm) and not more than 3/4 inch (19 mm).

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

bed joint . . . . . -1/8 inch (3.2 mm), +3/8 inch (9.5 mm)
head joint . . . . . -1/4 inch (6.4 mm), +3/8 inch (9.5 mm)
collar joints . . . . -1/4 inch (6.4 mm), +3/8 inch (9.5 mm)

Exception: Nonload-bearing masonry elements and masonry veneers designed and constructed in accordance with Section 703.7 are not required to meet these tolerances.

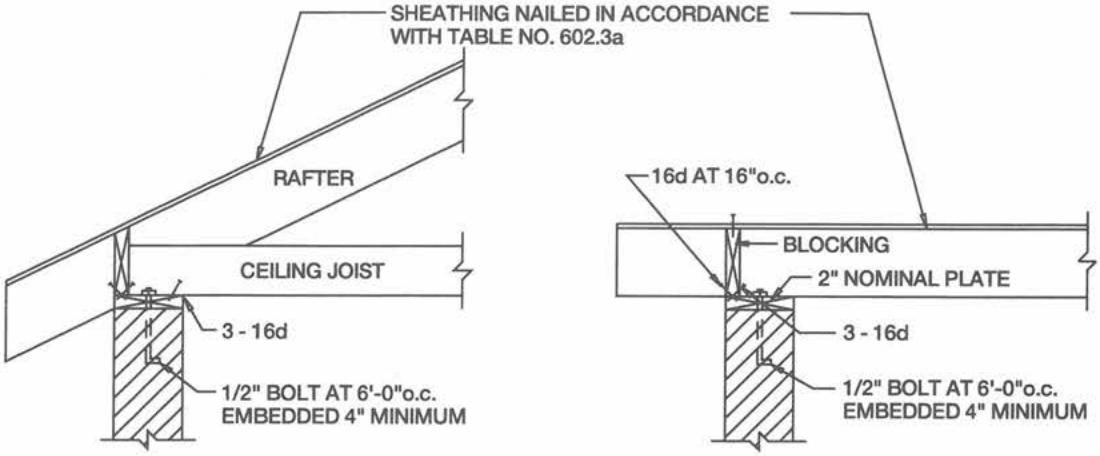
605.1.2 Masonry unit placement. The mortar shall be sufficiently plastic and units shall be placed with sufficient pressure to extrude mortar from the joint and produce a tight joint. Deep furrowing of bed joints which produces voids shall not be permitted. Any units disturbed to the extent that initial bond is broken after initial placement shall be removed and relaid in fresh mortar. Surfaces to be in contact with mortar shall be clean and free of deleterious materials.

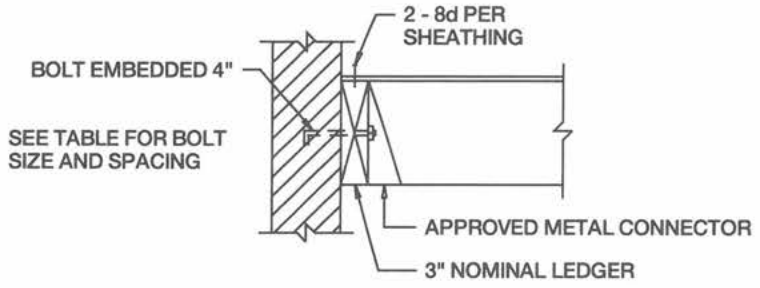
605.1.2.1 Solid masonry. All solid masonry units shall be laid with full head and bed joints and all interior vertical joints that are designed to receive mortar shall be filled.

605.1.2.2 Hollow masonry. For hollow masonry units, all head and bed joints shall be filled solidly with mortar for a distance in from the face of the unit not less than the thickness of the face shell.

605.2 Installation of wall ties. The installation of wall ties shall be as follows:

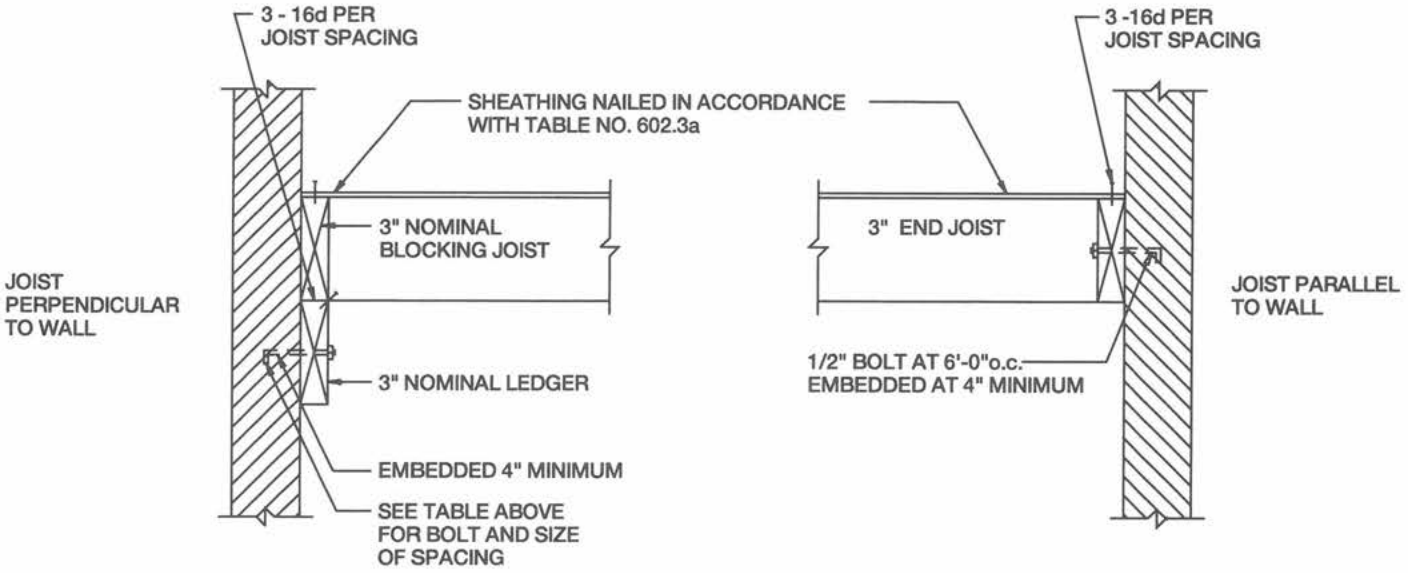
1. The ends of wall ties shall be embedded in mortar joints. Wall tie ends shall engage outer face shells of hollow units by at least l/2 inch (12.7 mm). Wire wall ties shall be embedded at least 1-1/2 inches (38 mm) into the mortar bed of solid masonry units or solid grouted hollow units.
2. Wall ties shall not be bent after being embedded in grout or mortar.





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'-0" 7/8 @ 2'-9"
10' - 15'	1/2 @ 1'-9" 7/8 @ 2'-6"	1/2 @ 1'-4" 7/8 @ 2'-0"
15' - 30'	1/2 @ 1'-3" 7/8 @ 2'-0"	1/2 @ 1'-0" 7/8 @ 1'-6"



WHERE BOLTS ARE LOCATED IN HOLLOW MASONRY, THE CELLS IN THE COURSES RECEIVING THE BOLTS SHALL BE GROUTED SOLID.

For **SI:** 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 psf = 0.0479 kN/m^2

Figure 604.10a
ANCHORAGE REQUIREMENTS FOR MASONRY WALLS LOCATED IN SEISMIC ZONE 0, 1 OR 2 AND WHERE WIND SPEEDS ARE 90 MPH OR LESS

SECTION 606
MULTIPLE WYTHE MASONRY

606.1 General. The facing and backing of multiple wythe masonry walls shall be bonded in accordance with Section 606.1.1, 606.1.2 or 606.1.3. In cavity walls, neither the facing nor the backing shall be less than 3 inches (76 mm) nominal in thickness and the cavity shall not be more than 4 inches (102 mm) nominal in width. The backing shall be at least as thick as the facing.

Exception: Cavities may exceed the 4-inch (102 mm) nominal dimension provided tie size and tie spacing have been established by calculation.

606.1.1 Bonding with masonry headers. Bonding with solid or hollow masonry headers shall comply with Sections 606.1.1.1 and 606.1.1.2.

606.1.1.1 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 (76 mm) into the backing. The distance between adjacent full-length headers shall not exceed 24 inches (610 mm) 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 (76 mm), or headers from opposite sides shall be covered with another header course overlapping the header below at least 3 inches (76 mm).

606.1.1.2 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 (864 mm) by lapping at least 3 inches (76 mm) over the unit below, or by lapping at vertical intervals not exceeding 17 inches (432 mm) with units which are at least 50 percent greater in thickness than the units below.

606.1.2 Bonding with wall ties or joint reinforcement. Bonding with wall ties or joist reinforcement shall comply with Sections 606.1.2.1 through 606.1.2.3.

606.1.2.1 Bonding with wall ties. Bonding with wall ties, except as required by Section 606.1.2.2, where the facing and backing (adjacent wythes) of masonry walls are bonded with 3/16-inch-diameter (4.8 mm) wall ties embedded in the horizontal mortar joints, there shall be at least one metal tie for each 4 1/2 square feet (0.418m^2) of wall area. Ties in alternate courses shall be staggered. The maximum vertical distance between ties shall not exceed 24 inches (610 mm), and the maximum horizontal distance shall not exceed 36 inches (914 mm). 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-degree angles to provide hooks no less than 2 inches (51 mm) long. Additional bonding ties shall be provided at all openings, spaced not more than 3 feet (914 mm) apart around the perimeter and within 12 inches (305 mm) of the opening.

606.1.2.2 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 square feet (0.248 m^2) of wall area. Neither the vertical nor horizontal spacing of the adjustable wall ties shall exceed 24 inches (610 mm). The maximum vertical offset of bed joints from one wythe to the other shall be l-l/4 inches (32 mm). The maximum clearance between connecting parts of the ties shall be 1/16 inch (1.6 mm). When pintle legs are used, ties shall have at least two 3/16-inch-diameter (4.8 mm) legs.

606.1.2.3 Bonding with prefabricated joint reinforcement. Where the facing and backing (adjacent wythes) of masonry are bonded with prefabricated joint reinforcement, there shall be at least one cross wire serving as a tie for each 2-2/3 square feet (0.248 m^2) of wall area. The vertical spacing of the joint reinforcement shall not exceed 16 inches (406 mm). Cross wires on prefabricated joint reinforcement shall not be smaller than No. 9 gage. The longitudinal wires shall be embedded in the mortar.

606.1.3 Bonding with natural or cast stone. Bonding with natural and cast stone shall conform to Sections 606.1.3.1 and 606. 1.3.2.

606.1.3.1 Ashlar masonry. In ashlar masonry, bonder units, uniformly distributed, shall be provided to the extent of not less than 10 percent of the wall area. Such bonder units shall extend not less than 4 inches (102 mm) into the backing wall.

606.1.3.2 Rubble stone masonry. Rubble stone masonry 24 inches (610 mm) or less in thickness shall have bonder units with a maximum spacing of 3 feet (914 mm) vertically and 3 feet (914 mm) horizontally, and if the masonry is of greater thickness than 24 inches (610 mm), shall have one bonder unit for each 6 square feet (0.557 m^2) of wall surface on both sides.

606.2 Masonry bonding pattern. Masonry laid in running and stack bond shall conform to Sections 606.2.1 and 606.2.2.

606.2.1 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 606.2.2.

606.2.2 Masonry laid in stack bond. Where unit masonry is laid with less head joint offset than in Section 606.2.1, the minimum area of horizontal reinforcement placed in mortar bed joints or in bond beams spaced not more than 48 inches (1,219 mm) apart, shall be 0.0007 times the vertical cross-sectional area of the wall.

Table 607.1.1a
MORTAR PROPORTIONS[1, 2]

PROPORTIONS BY VOLUME (Cementitious Materials)							
Mortar	Type	Portland Cement or Blended Cement	Masonry Cement			Hydrated Lime or Lime Putty	Aggregate Ratio (Measured in Damp, Loose Condition)
			M	S	N		
Cement-lime	M	1	—	—	—	1/4	Not less than 2-1/4 and not more than 3 times the sum of separate volumes of lime, if used, and cement
	S	1	—	—	—	over 1/4 to 1/2	
	N	1	—	—	—	over 1/2 to 1-1/4	
	O	1	—	—	—	over 1-1/4 to 2-1/2	
Masonry cement	M	1	—	—	1		
	M	—	1	—	—		
	S	1/2	—	—	1		
	S	—	—	1	—		
	N	—	—	—	1		
	O	—	—	—	1		

For **SI:** 1 cubic foot = 0.0283 m^3, 1 pound = 0.454 kg

1. For the purpose of these specifications, the weight of 1 cubic foot of the respective materials shall be considered to be as follows:

Portland Cement	94 lbs
Masonry Cement	Weight printed on bag
Hydrated Lime	40 lbs
Lime Putty (QuickLime)	80 lbs
Sand, damp and loose	80 lbs of dry sand

2. Two air-entraining materials shall not be combined in mortar.

Table 607.1.1b
GROUT PROPORTIONS BY VOLUME FOR MASONRY CONSTRUCTION

TYPE	PORTLAND CEMENT OR BLENDED CEMENT SLAG CEMENT	HYDRATED LIME OR LIME PUTTY	AGGREGATE MEASURED IN A DAMP, LOOSE CONDITION	
			Fine	Coarse
Fine	1	0 to 1/10	2-1/4 to 3 times the sum of the volume of the cementitious materials	—
Coarse	1	0 to 1/10	2-1/4 to 3 times the sum of the volume of the cementitious materials	1 to 2 times the sum of the volume of the cementitious materials

SECTION 607
GROUTED MASONRY

607.1 General. Grouted multiple-wythe masonry is a form of construction in which the space between the wythes is solidly filled with grout. It is not necessary for the cores of masonry units to be filled with grout. Grouted hollow unit masonry is a form of construction in which certain cells of hollow units are continuously filled with grout.

607.1.1 Mortar and grout. Only Type M or Type S mortar mix consisting of portland cement, hydrated lime and sand in accordance with ASTM C 270 and the proportion specifications of Table 607.1.1a shall be used to construct masonry wythes. Grout shall consist of cementitious material and aggregate in accordance with ASTM C 476 and the proportion specifications of Table 607.1.1b. Type M or Type S mortar to which sufficient water has been added to produce pouring consistency can be used as grout.

607.1.2 Grouting requirements. Maximum pour heights and the minimum dimensions of spaces provided for grout placement shall conform to Table 607.1.2. 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 (25 mm) below the top.

Table 607.1.2
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 43 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

For **SI:** 1 inch = 25.4 mm, 1 foot = 304.8 mm

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 percent of the area of the grout space.

607.1.3 Grout space (cleaning). Provision shall be made for cleaning grout space. Mortar projections which project more than l/2 inch (12.7 mm) into grout space and any other foreign matter shall be removed from grout space prior to inspection and grouting.

607.1.4 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 (1219 mm). It shall be consolidated by puddling or mechanical vibrating during placing and reconsolidated after excess moisture has been absorbed but before plasticity is lost.

607.1.4.1 Grout pumped through aluminum pipes. Grout shall not be pumped through aluminum pipes.

607.1.5 Cleanouts. Where required by the building official, cleanouts shall be provided as specified in this section. The cleanouts shall be sealed before grouting and after inspection.

607.1.5.1 Grouted multiple-wythe masonry. Cleanouts shall be provided at the bottom course of the exterior wythe at each pour of grout where such pour exceeds 5 feet (1524 mm) in height.

607.1.5.2 Grouted hollow unit masonry. Cleanouts shall be provided at the bottom course of each cell to be grouted at each pour of grout, where such pour exceeds 4 feet (1219 mm) in height.

607.1.6 Inspection. Special inspection during grouting shall be provided where required by the building official.

607.2 Grouted multiple-wythe masonry. Grouted multiple-wythe masonry shall conform to all the requirements specified in Section 607.1 and the requirements of this section.

607.2.1 Bonding of backup wythe. Where all interior vertical spaces are filled with grout in multiple-wythe construction, masonry headers shall not be permitted. Metal wall ties shall be used in accordance with Section 606.1.2 to prevent spreading of the wythes and to maintain the vertical alignment of the wall. Wall ties shall be installed in accordance with Section 606.1.2, when the backup wythe in multiple-wythe construction is fully grouted.

607.2.2 Grout spaces. Fine grout shall be used when interior vertical space to receive grout does not exceed 2 inches (51 mm) in thickness. Interior vertical spaces exceeding 2 inches (51 mm) in thickness shall use course or fine grout.

607.2.3 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 (7620 mm) apart. The grouting of any section of a wall between control barriers shall be completed in one day with no interruptions greater than one hour.

607.3 Reinforced grouted multiple-wythe masonry. Reinforced grouted multiple-wythe masonry shall conform to all the requirements specified in Sections 607.1 and 607.2 and the requirements of this section.

607.3.1 Construction. The thickness of grout or mortar between masonry units and reinforcement shall not be less than 1/4 inch (6.4 mm), except that l/4-inch (6.4 mm) bars may be laid in horizontal mortar joints at least 1/2 inch (12.7 mm) thick and steel wire reinforcement may be laid in horizontal mortar joints at least twice the thickness of the wire diameter.

607.4 Reinforced hollow unit masonry. Reinforced hollow unit masonry shall conform to all the requirements of Section 607.1 and the requirements of this section.

607.4.1 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 and 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.
2. Cells to be filled shall have vertical alignment sufficient to maintain a clear, unobstructed continuous vertical cell of dimensions prescribed in Table 607.1.2.
3. Vertical reinforcement shall be held in position at top and bottom and at intervals not exceeding 200 diameters of the reinforcement.

4. All cells containing reinforcement shall be filled solidly with grout. Grout shall be poured in lifts of 8-foot (2438 mm) maximum height. When total grout pour exceeds 8 feet (2438 mm) in height. the grout shall be placed in lifts not exceeding 4 feet (1219 mm) and special inspection during grouting shall be required.
5. Horizontal steel shall be fully embedded by grout in an uninterrupted pour.

SECTION 608
WINDOWS

608.1 Testing and certification. Windows shall be tested and certified to indicate compliance with the requirements of the following specifications:

AAMA/NWWDA 101/I.S.2
ASTM D 4099

608.2 Air infiltration. 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 cubic feet per minute per linear foot (0.236 L/s per mm) of crack when tested in accordance with ASTM E 283 at a pressure differential of l.56 psf (0.075 kN/m^2).

SECTION 609
SLIDING GLASS DOORS

609.1 Testing and certification. Sliding glass doors shall be tested and certified to indicate compliance with the requirements of the following specifications:

AAMA/NWWDA 101/I.S.2
ANSI/NWWDA l.S.3

609.2 Air infiltration. 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 cubic feet per minute per square foot (0.236 L/s per mm^2) of door area when tested in accordance with ASTM E 283 at a pressure differential of 1.6 pounds per square foot (0.075 kN/m^2).

SECTION 610
PLYWOOD AND WOOD STRUCTURAL PANELS

610.1 Identification and grade. Plywood shall conform to DOC PS l, DOC PS 2 or HPMA (ANSI) HP. Wood structural panels shall conform to DOC PS 2. All panels shall be identified by a grade mark or certificate of inspection issued by an approved agency. Wood structural panels shall comply with the grades specified in Table 602.3b.

610.2 Allowable spans. The maximum allowable spans for wood structural panel wall sheathing shall not exceed the values set forth in Table 602.3b.

610.3 Installation. Wood structural panel wall sheathing shall be attached to framing in accordance with Table 602.3a. Wood structural panels marked Exposure l or Exterior are considered water-repellent sheathing under the code.

SECTION 611
PARTICLEBOARD

611.1 Identification and grade. Particleboard shall conform to ANSI A 208.1 and shall be so identified by a grademark or certificate of inspection issued by an approved agency. Particleboard shall comply with the grades specified in Table 602.3c.

SECTION 612
SIDE HINGE AND GARAGE DOORS

612.1 Side Hinge and Garage Doors. Exterior side hinge doors and garage doors shall have a structural design pressure rating as required by Table 308.5(b) or Section 4002. These doors are not required to be rated for water resistance nor air infiltration.

612.2 Door Mounting. Wall framing around exterior doors shall be adequate to hold the door in place. The door manufacturer's installation instructions shall specify the proper anchorage required to enable the door to resist the required design pressure.

SECTION 613
MULLIONS

613.1 Mullions. Mullions shall be rated by either testing or by mathematical calculation.

613.2 Rating by testing. Mullions may be tested as part of an assembly or as independent elements.

613.2.1 When tested as part of an assembly the mullions shall meet the following requirements:

1. Mullions shall be capable of withstanding the loads applied by the elements the mullions support without allowing structural failure, water leakage, or air infiltration in excess of that allowed for the DP rating of the supported elements. The mullion shall allow the supported element to develop the required design pressure rating.
2. The permanent deformation after testing shall not exceed 0.4% of the mullion span.

613.2.2 When tested as an independent element the mullion shall meet the following requirements.

1. The maximum deflection under design loads shall be 1/175.
2. The mullion shall be capable of supporting a test load of 1.5 times the design load without structural failure.
3. The permanent deformation after testing shall not exceed 0.4% of the mullion span.

613.3 Rating by calculation. Mullions rated by mathematical calculation shall be capable of resisting the design loads applied by the elements to be supported without deflecting more than L/175.

CHAPTER 7
WALL COVERING

SECTION 701
GENERAL

701.1 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 108 shall be accepted as complying with this code.

701.2 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 702
INTERIOR COVERING

702.1 General. Interior coverings shall be installed in accordance with this chapter and Tables 702.1a, 702.1b, 702.1c and 702.3.4. Interior finishes and materials shall conform to the flame spread and smoke–density requirements of Section 318.

702.2 Interior plaster. Gypsum plaster or portland cement plastering materials shall conform to ASTM C 5, C 28, C 35, C 37,C 59, C 61, C 587, C 588, C 631, C 847, C 897, C 933, C 1032and C 1047, and shall be installed or applied in conformance with ASTM C 843, C 844 and C 1063. Plaster shall not be less than three coats when applied over metal lath and 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 (4.76 mm) thickness, provided the total thickness is as set forth in Table 702.1a.

702.2.1 Support. Support spacing for gypsum and metal lath on walls or ceilings shall not exceed 16 inches (406 mm) or 24 inches (610 mm) for 1/2 inch (12.7 mm) plain gypsum lath. Gypsum lath shall be installed at right angles to support framing with end joints staggered.

702.3 Gypsum wallboard.

702.3.1 Materials. All gypsum wallboard materials and accessories shall conform to ASTM C 36, C 475, C 514, C 960, C 1002 and C 1047, and shall be installed in accordance with the provisions of this section. Adhesives for the installation of gypsum wallboard shall conform to ASTM C 557.

702.3.2 Wood framing. Wood framing supporting gypsum wallboard shall not be less than 2 inches (51 mm) nominal thickness in the least dimension except that wood furring strips not less than 1–inch–by–2 inch (25 mm by 51 mm) nominal dimension may be used over solid backing or framing spaced not more than 24 inches (610 mm) on center.

702.3.3 Steel framing. Steel framing shall not be less than 1-1/4 inches (32 mm) wide in the least dimension. Light–gage nonload–bearing steel framing shall comply with ASTM C 645. Load–bearing steel framing and steel framing from 0.033 inch to 0.112 inch (0.838 mm to 2.84 mm) thick shall comply with ASTM C 955.

702.3.4 Application. Support spacing and size and spacing of fasteners shall comply with Table 702.3.4. Gypsum wallboard may be applied at right angles or parallel to framing members. 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. Interior gypsum wallboard shall not be installed where it is exposed to the weather construction.

702.3.5 Fastening. Screws for attaching gypsum wallboard to wood shall be Type W in accordance with ASTM C 1002 and shall penetrate the wood not less than 5/8 inch (15.9 mm). Screws for attaching gypsum wallboard to light–gage steel shall be Type S in accordance with ASTM C 1002 and shall penetrate the steel not less than 1/4 inch (6.4 mm). Screws for attaching gypsum wallboard to steel 0.033 inch to 0.112 inch (0.838 mm to 2.84 mm) thick shall comply with ASTM C 954.

702.4 Bathtub and shower spaces. Bathtub and shower floors and walls shall be finished with a smooth, hard and nonabsorbent surface. Ceramic tile surfaces shall be installed in accordance with ANSI A108.1, A108.4, A108.5, A108.6, A108.11, A118.1, A118.3, A136.1 and A137.1. Such wall surfaces shall extend to a height of not less than 6 feet (1829 mm) above the floor.

702.4.1 Ceramic tile. Gypsum board utilized as the base or backer board for adhesive application of ceramic tile or other nonabsorbent finish material shall conform with ASTM C 630. Water–resistant gypsum backing board shall be permitted tobe used on ceilings where framing spacing does not exceed 12 inches (305 mm) on center. All cut or exposed edges, including those at wall intersections, shall be sealed as recommended by the manufacturer.

702.5 Other finishes. Wood veneer or hardboard paneling not less than 1/4–inch (6.4 mm) nominal thickness [13/64–inch (5.2 mm) actual] shall conform to HPMA (ANSI) HP and stud spacing may not exceed 16 inches on center.

702.6 Wood shakes and shingles. Wood shakes and shingles shall conform to CSSB "Grading Rules for Wood Shakes and Shingles" and shall be permitted to be installed directly to the studs with maximum 24 inches (610 mm) on center spacing; wood veneer hardboard paneling less than 1/4–inch (6.4 mm) nominal thickness must not have less than 3/8–inch (9.5 mm) gypsum board backer.

702.6.1 Attachment. Nails, staples or glue are permitted for use in attaching shakes or shingles to the wall, and the shakes or shingles shall be permitted to be attached directly to the surface provided the fasteners are appropriate for the type of wall surface material. When nails or staples are used, two fasteners shall be provided and shall be placed so that they are covered by the course above.

702.6.2 Furring strips. Where furring strips are used, they shall be 1 inch by 2 inches or 1 inch by 3 inches (25 mm by 51 mm or 25 mm by 76 mm), spaced a distance on center equal to the desired exposure, and shall be attached to the wall by nailing through other wall material into the studs.

702.6.3 Bottom course. The bottom course shall be doubled.

TABLE 702.1a
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	

For SI: 1 inch = 25.4 mm.

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 form 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 702.3.4.

TABLE 702.1b
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

For SI: 1 inch = 25.4 mm, 1 cubic foot = 0.0283 m3, 1 pound = 0.454 kg.

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 702.1c
PORTLAND CEMENT PLASTER

COAT	MAXIMUM VOLUME AGGREGATE PER VOLUME CEMENTITIOUS MATERIAL[1]				MINIMUM PERIOD MOIST COATS	INTERVAL BETWEEN
	Portland Cement Plaster[2] Maximum Volume Aggregate per Volume Cement	Portland Cement–lime Plaster[3]		MINIMUM		
		Maximum Volume Lime per Volume Cement	Maximum Volume Send per Volume Cement and Lime	Approximate Minimum Thickness[4] Curing		
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]

For SI: 1 inch = 25.4 mm, 1 pound = 0.454 kg.

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 702.1a.
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 702.3.4
APPLICATION AND MINIMUM THICKNESS OF GYPSUM WALLBOARD

THICKNESS OF GYPSUM WALLBOARD (inch)	PLANE OF FRAMING SURFACE[4]	LONG DIMENSION OF GYPSUM WALLBOARD SHEETS IN RELATION DIRECTION OF FRAMING MEMBERS	MAXIMUM SPACING OF FRAMING TO MEMBERS (center–to–center in inches)	MAXIMUM SPACING OF FASTENERS center–to–center, in inches)		NAILS[1] TO WOOD
				Nails[1, 2]	Screws	
Fastening required without adhesive application.						
3/8	Horizontal[4]	Perpendicular	16	7	12	No. 13 gage 1-1/4 long, 19/64 head 0.098" diameter, 1-1/4" long, annular–ringed; 4d cooler nail
	Vertical	Either direction	16	8	12	
1/2	Horizontal[3]	Either direction	16	7	12	No. 13 gage 1-1/8 long, 19/64" head 0.098" diameter, 1-1/4" long, annular–ringed; 5d cooler nail
	Horizontal[3]	Perpendicular	24	7	12	
5/8	Vertical	Either direction	24	8	12	No. 13 gage 1-5/8" long, 19/64 head 0.098" diameter, 1-3/8" long, annular–ringed; 6d cooler nail
	Horizontal	Either direction	16	7	12	
	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[3]	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	

For SI: 1 inch = 25.4 mm.

1. Where the metal framing has a clinching design formed to receive the nails by two edges of metal, the nails shall not be 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, 13-1/2 gage, 1-5/8 inches long, 15/64–inch head for 1/2–inch gypsum wallboard; 6d, 13 gage, 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, or more than 2-1/2 inches apart may be used where the pairs are spaced 12 inches on center except around the perimeter of the boards.
3. Three–eighths–inch single–ply gypsum board shall not be installed if water–based textured finish is applied or to support insulation above a ceiling. On horizontal applications to receive a water–base texture material, either hand or spray applied, gypsum board shall be applied perpendicular to framing.
4. Horizontal refers to applications such as ceilings. Vertical refers to applications such as walls.

SECTION 703
EXTERIOR COVERING

703.1 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.

703.2 Weather–resistant sheathing paper. Asphalt–saturated felt free from holes and breaks and weighing not less than14 pounds per 100 square feet (0.683 kg/m2) or other approved weather–resistant material shall be applied over studs or sheathing of all exterior walls as required by Table 703.4. Such felt or material shall be applied horizontally, with the upper layer lapped over the lower layer not less than 2 inches (51 mm). Where joints occur, felt shall be lapped not less than 6 inches (153 mm).

703.2.1 Felt or material. Such felt or material 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 703.4.
4. Under paperbacked stucco lath.
5. Over water–repellent sheathing materials.

703.3 Wood, plywood and wood structural panel siding. Joints in wood, plywood or wood structural panel siding shall be made as follows unless otherwise approved. Vertical joints in panel siding shall occur over framing members, unless wood or wood structural panel sheathing is used, and shall be shiplapped or covered with a batten. Horizontal joints in panel siding shall be lapped a minimum of 1 inch (25 mm) or shall be flashed with Z–flashing.

703.3.1 Horizontal siding. Horizontal siding shall be lapped a minimum of 1 inch (25 mm), or 1/2 inch (12.7 mm) if rabbeted, and shall have the ends caulked, covered with a batten, or sealed and installed over a strip of flashing.

703.4 Attachments. Unless specified otherwise, all wall coverings shall be securely fastened in accordance with Table 703.4 or with other approved aluminum, stainless steel, zinc–coated, or other approved corrosion–resistive fasteners.

703.5 Wood shakes and shingles. Wood shakes and shingles shall conform to CSSB "Grading Rules for Wood Shakes and Shingles."

703.5.1 Application. Wood shakes or shingles shall be applied either single–course or double–course over nominal 1/2–inch (12.7 mm) wood–based sheathing or to furring strips over 1/2–inch (12.7 mm) nominal nonwood sheathing. A weather–resistant permeable membrane shall be provided over the sheathing, with horizontal overlaps in the membrane of not less than 2 inches (51 mm) and vertical overlaps of not less than 6 inches (153 mm). Where furring strips are used, they shall be 1 inch by3 inches or 1 inch by 4 inches (25 mm by 76 mm or 25 mm by 102 mm) and shall be fastened horizontally to the studs with 7d or 8d box nails and shall be spaced a distance on center equal to the actual weather exposure of the shakes or shingles, not to exceed the maximum exposure specified in Table 703.5.2. The spacing between adjacent shingles to allow for expansion shall not exceed 1/4 inch (6.4 mm), and between adjacent shakes, it shall not exceed 1/2 inch (12.7 mm). The offset spacing between joints in adjacent courses a minimum of 1-1/2 inches (38 mm).

703.5.2 Weather exposure. The maximum weather exposure for shakes and shingles shall not exceed that specified in Table 703.5.2.

703.5.3 Attachment. Each shake or shingle shall be held in place by two hot–dipped zinc–coated, stainless steel, or aluminum nails or staples. The fasteners shall be long enough to penetrate the sheathing or furring strips by a minimum of 1/2 inch (12.7 mm) and shall not be overdriven.

703.5.3.1 Staple attachment. Staples shall not be less than16 gage and shall have a crown width of not less than 7/16 inch (11 mm), and the crown of the staples shall be parallel with the butt of the shake or shingle. In single–course application, the fasteners shall be concealed by the course above and shall be driven approximately 1 inch (25 mm) above the butt line of the succeeding course and 3/4 inch (19 mm) from the edge. In double–course applications, the exposed shake or shingle shall be face–nailed with two casing nails, driven approximately 2 inches (51 mm) above the butt line and 3/4 inch (19 mm) from each edge. Staples shall not be permitted for face–nailing. With shingles wider than 8 inches (203 mm), two additional nails shall be required and shall be nailed approximately 1 inch (25 mm) apart near the center of the shingle.

703.6 Exterior lath. All lath and lath attachments shall be of corrosion–resistant materials. Expanded metal or woven wire lath shall be attached with 1-1/2 inch (38 mm) long, 11 gage nails having a 7/16–inch (11 mm) head, or 7/8 inch (22 mm) long,16 gage staples, spaced at no more than 6 inches (153 mm), or as otherwise approved.

703.7 Masonry veneer, general. All masonry veneer shall be installed in accordance with this chapter, Table 703.4 and Figure 703.7. Exterior masonry veneer shall not be laterally supported by wood frame at any point more than 25 feet (7620 mm) above the adjacent ground elevation in Seismic Zones 3 and 4 or more than 35 feet (10 668 mm) in Seismic Zone 0, 1 or 2.

Exceptions:

1. Veneers used as interior wall finishes may be supported on wood floors which are designed to support the loads imposed.

2. Exterior masonry veneers having an installed weight of 40 pounds per square foot (195 kg/m2) or less may be supported on wood construction. When the masonry veneer is supported by wood construction that adjoins the masonry veneer supported by the foundation, there shall be a movement joint between the veneer supported by the wood construction and the foundation. The wood construction supporting the masonry veneer shall be designed to limit deflection to 1/600 of the span for the supporting members.
3. Veneer may be vertically supported on sloping surfaces as shown in Figure 703.7(a) and described in the following provision:
   a. Surface slope shall not exceed 12:12.
   b. Member supporting veneer loading shall have twice the capacity of similar beams, joist or rafters supporting the sloped surface.
   c. Minimum of 4 inches x 3-1/2 inches x 1/4 inch steel angle shall be attached to the sloping surface. Attachment shall be make by drilling 3/16 inch diameter holes in the 4 inch leg of the angle at 12 inch o.c. and using 16d nails penetrating the double members. When the slope exceeds 4:12, minimum of 3 inches x 3 inches x 1/4 inch plates shall be welded at 24 inches o.c. along the steel angle as stops to prevent the veneer from sliding down the slope. Minimum of 1 inch air space shall be maintained between the wall and veneer.
   d. Flashing shall be installed over steel angle and a minimum of 6 inches under the wall sheathing.

703.7.1 Lintels. Masonry veneer shall not support any vertical load other than the dead load of the veneer above. Veneer above openings shall be supported on lintels of noncombustible

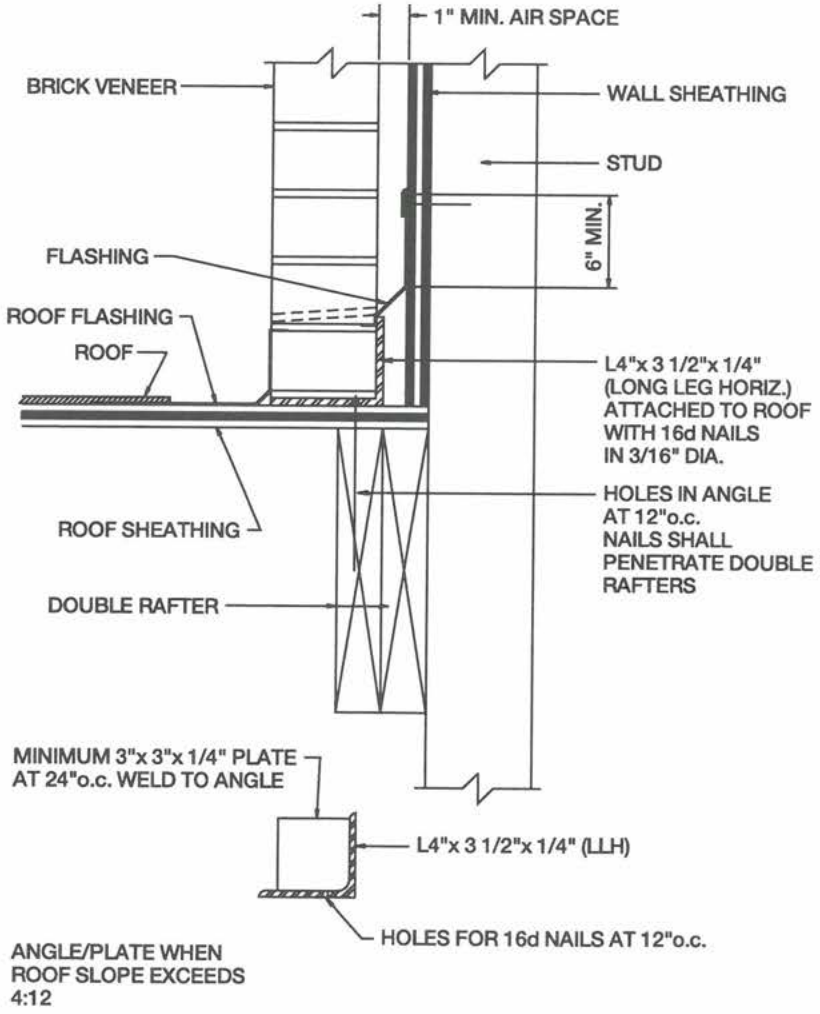


FIGURE 703.7(a)
MASONRY VENEER SUPPORTED ON WOOD DETAIL

materials and the allowable span shall not exceed the values set forth in Table 703.7.1. The lintels shall have a length of bearing of not less than 4 inches (102 mm).

TABLE 703.7.1
ALLOWABLE SPANS FOR LINTELS SUPPORTING MASONRY VENEER

Size of Angles [1,3]	Maximum Span [2,4]
3-1/2" x 3-1/2" x 1/4"	6'-0"
5" x 3-1/2" x 5/16"	10'-0"

1. Long leg of the angle shall be place in a vertical position.
2. Spans over 4' shall be shored up until cured.
3. Steel members indicated are adequate typical examples: other steel members including light gauge steel meeting structural design requirements may be used.
4. Spans over 10'-0" shall be designed in accordance with approved standard.

703.7.2 Attachment. Masonry veneer shall be attached to the supporting wall with corrosion–resistant metal ties.

703.7.2.1 Size and spacing. Veneer ties, if strand wire, shall not be less in thickness than No. 9 U.S. gage wire and shall have a hood embedded in the mortar joint, or if sheet metal, not less than No. 22 U.S. gage by 7/8 inch (22 mm) corrugated. Each tie shall be spaced not more than 24 inches (610 mm) on center horizontally and shall support not more than 3-1/4 square feet (0.302 m2) of wall area.

Exception: In Seismic Zone 3 or 4 and in wind area of more than 30 pounds per square foot (1.44 kN/m2), each tie shall support not more than 2 square feet (0.186 m2) of wall area.

TABLE 703.5.2
MAXIMUM WEATHER EXPOSURE FOR WOOD SHAKES AND SHINGLES ON EXTERIOR WALLS
(Dimensions are in inches)

LENGTH	EXPOSURE FOR SINGLE COURSE	EXPOSURE FOR DOUBLE COURSE
SHINGLES[1]		
16	7-1/2	12[2]
18	8-1/2	14[3]
24	11-1/2	16
SHAKES[1]		
18	8-1/2	14
24	11-1/2	18

For SI: 1 inch = 25.4 mm.

1. Dimensions given are for No. 1 Grade.
2. A maximum 10–inch exposure is permitted for No. 2 Grade.
3. A maximum 11–inch exposure is permitted for No. 2 Grade.

703.7.2.1.1 Seismic Zones 3 and 4. In Seismic Zones 3 and 4, veneer ties shall be mechanically attached to horizontal joint reinforcement wire a minimum of No. 9 gage. The horizontal joint reinforcement shall be continuous in the veneer bed joint with lap splices permitted between the veneer tie spacing.

703.7.2.2 Paper backing required. When applied over stud construction, the studs shall be spaced a maximum of 24 inches (610 mm) on center and approved paper shall first be applied over the sheathing or wires between the studs, except as otherwise provided in Section 703.2 and mortar shall be slushed into the 1–inch (25 mm) space between facing and paper.

Exception: As an alternate, an air space of at least 1 inch (25 mm) may be maintained between the backing and the veneer, in which case a weather–resistant membrane or felt sheathing paper or approved water–repellent sheathing shall be applied over the studs.

703.7.2.3 Veneer grouting. 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.

703.7.3 Flashing. Flashing shall be located beneath the first course of masonry above finished ground level above the foundation wall or slab, and at other points of support, including structural floors, shelf angles and lintels when masonry veneers are designed in accordance with Section 703.7. See Section 703.8 for additional requirements.

703.7.4 Weepholes. Weepholes shall be provided in the outside wythe of masonry walls at a maximum spacing of 48 inches (1219 mm) on center. Weepholes shall not be less than 3/16 inch (4.8 mm) in diameter. Weepholes shall be located immediately above the flashing.

703.8 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 (28 mm) 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.

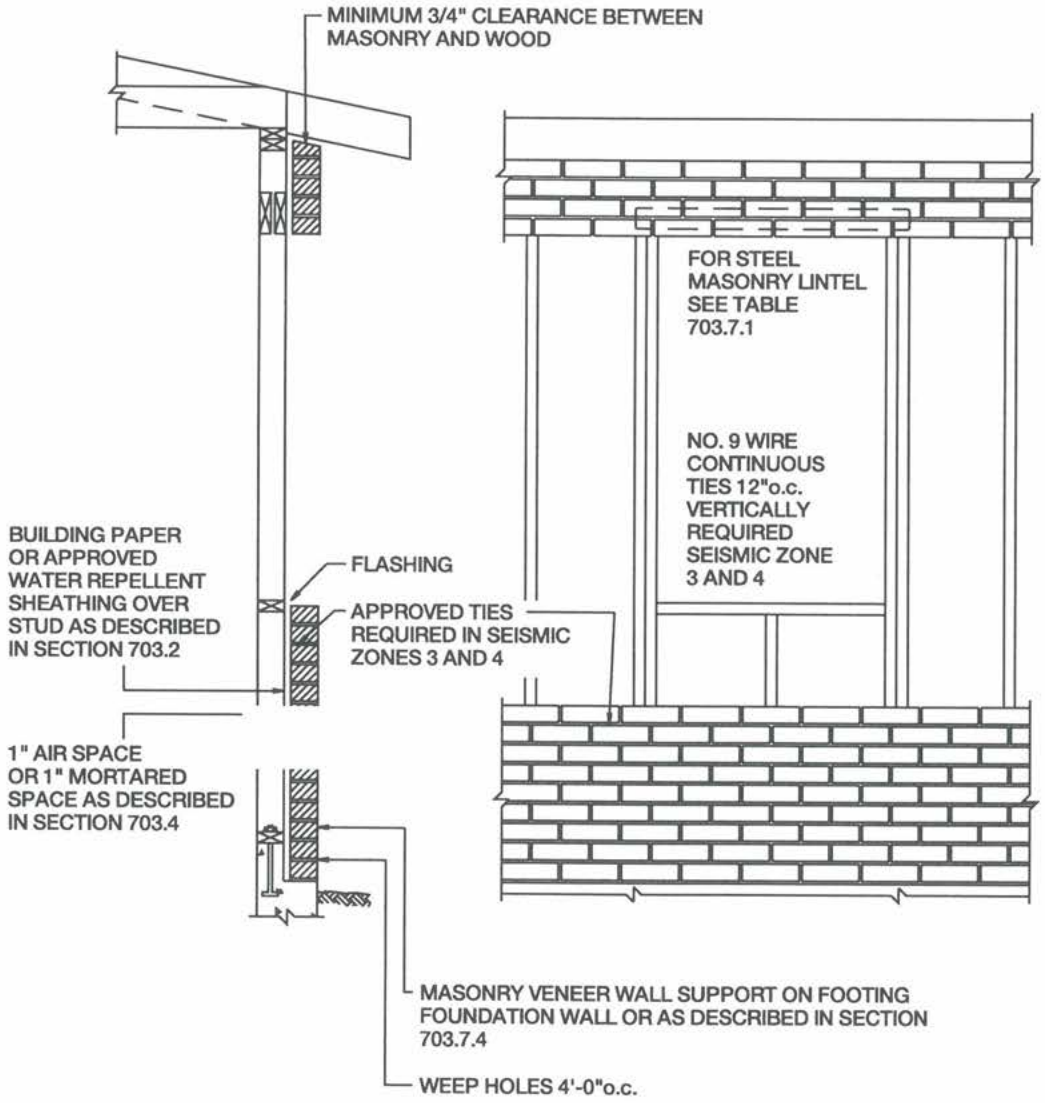
TABLE 703.4
WEATHER–RESISTANT SIDING ATTACHMENT AND TABLE 703.4
WEATHER-RESISTANT SIDING ATTACHMENT AND MINUMUM THICKNESS

SIDING MATERIAL		NOMINAL THICKNESS[1] (inches)	JOINT TREATMENT	SHEATHING PAPER REQUIRED	TYPE OF SUPPORTS FOR THE SIDING MATERIAL AND FASTENERS[2,3,4] Wood, or Wood Structural Panel Sheathing	Fiberboard Sheathing Into Stud	Gypsum Sheathing Into Stud	Direct to Studs	Number of Spacing of Fasteners
Horizontal aluminum[5]	Without insulation	0.019[6]	Lap	No	0.120 nail 1 1/2" long	0.120 nail 2" long	0.120 nail 2" long	Not allowed	Same as stud spacing
		0.024	Lap	No	0.120 nail 1 1/2" long	0.120 nail 2" long	0.120 nail 2" long	Not allowed	
	With insulation	0.019	Lap	No	0.120 nail 1 1/2" long	0.120 nail 2 1/2" long	0.120 nail 2 1/2" long	0.120 nail 1 1/2" long	
Brick Veneer Concrete Masonry veneer		2 2	Section 703	Yes (13)	See Section 703 and Figure 703.7[8]				
Hardboard[12] Board and batten-vertical		7/16	(7)	(7)	0.099 nail 2" long	0.099 nail 2 1/2" long	0.099 nail 2" long	0.099 nail 1 3/4" long	6" panel edges 8" inter. sup.
Hardboard[12] Lap-siding-horizontal		7/16	(7)	(7)	0.099 nail 2" long	0.099 nail 2 1/2" long	0.099 nail 2 1/4" long	0.099 nail 2" long	Same as stud spacing 2 per bearing
Steel[9]		29 ga.	Lap	No	0.113 nail 1 3/4" Staple-1 3/4"	0.113 nail 2 3/4" Staple-2 1/2"	0.113 nail 2 1/2" Staple-2 1/4"	Not allowed	Same as stud spacing
Stone veneer		2	Section 703	Yes	See Section 703 and Figure 703.7				
Particleboard panels		3/8 - 1/2	(7)	(7)	6d box nail	6d box nail	6d box nail	6d box nail 3/8 not allowed	6" panel edges 12" inter. sup.
		5/8	(7)	(7)	6d box nail	8d box nail	8d box nail	6d box nail	
Plywood panel[10] (exterior grade)		3/8	(7)	(7)	0.099 nail-2" Staple-1 3/8"	0.113 nail-2 1/2" Staple-2 1/4"	0.099 nail-2" Staple-2"	0.099 nail-2" Staple-1 3/8"	6" on edges 12" inter. sup.
Vinyl Siding[14]		0.035	Lap	No	0.120 nail 1 1/2" Staple 1 3/4"	0.120 nail 2" Staple 2 1/2"	0.120 nail 2" Staple 2 1/2"	Not allowed	Same as stud spacing
Wood[11] Rustic, drop Shiplap		3/8 Minimum 19/32 Average	Lap	No	Fastener penetration into stud - 1"			0.113 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 tip		3/16	Lap	No					

For SI: 1 inch = 25.4 mm.

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 gage 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 shall be used to attach aluminum siding.
6. Aluminum (0.019 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.
7. 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.
8. All attachments shall be coated with a corrosion–resistive coating.
9. Shall be of approved type.

10. 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.
11. Woodboard 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.
12. Hardboard siding shall comply with AHA A135.6.
13. For masonry veneer, a weather–resistant membrane or building paper is not required over water–repellent sheathing materials when a 1–inch air space is provided between the veneer and the sheathing. When the 1–inch space is filled with mortar, a weather–resistant membrane or building paper is required over studs or sheathing.
14. Vinyl siding shall comply with ASTM D 3679.



[1] Location of flashing and weepholes as described in Sections 703.7.3 and 703.7.4

FIGURE 703.7(b)
MASONRY VENEERED WALL DETAIL

CHAPTER 8
ROOF–CEILING CONSTRUCTION

SECTION 801
GENERAL

801.1 Application. The provisions of this chapter shall control the design and construction of the roof–ceiling system for all buildings. 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 108 shall be accepted as complying with this code.

801.2 Requirements. Roof–ceiling construction shall be capable of accommodating all loads imposed according to Section 301 and shall transmit the resulting loads to its supporting structural elements.

801.3 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 (1524 mm) from foundation walls or to an approved drainage system.

SECTION 802
ROOF FRAMING

802.1 Identification and grade. Load–bearing dimension lumber for rafters, trusses and ceiling joists shall conform to DOC PS 20–70 and to other 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 *Fb*, 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.

802.1.1 Fire–retardant–treated 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.

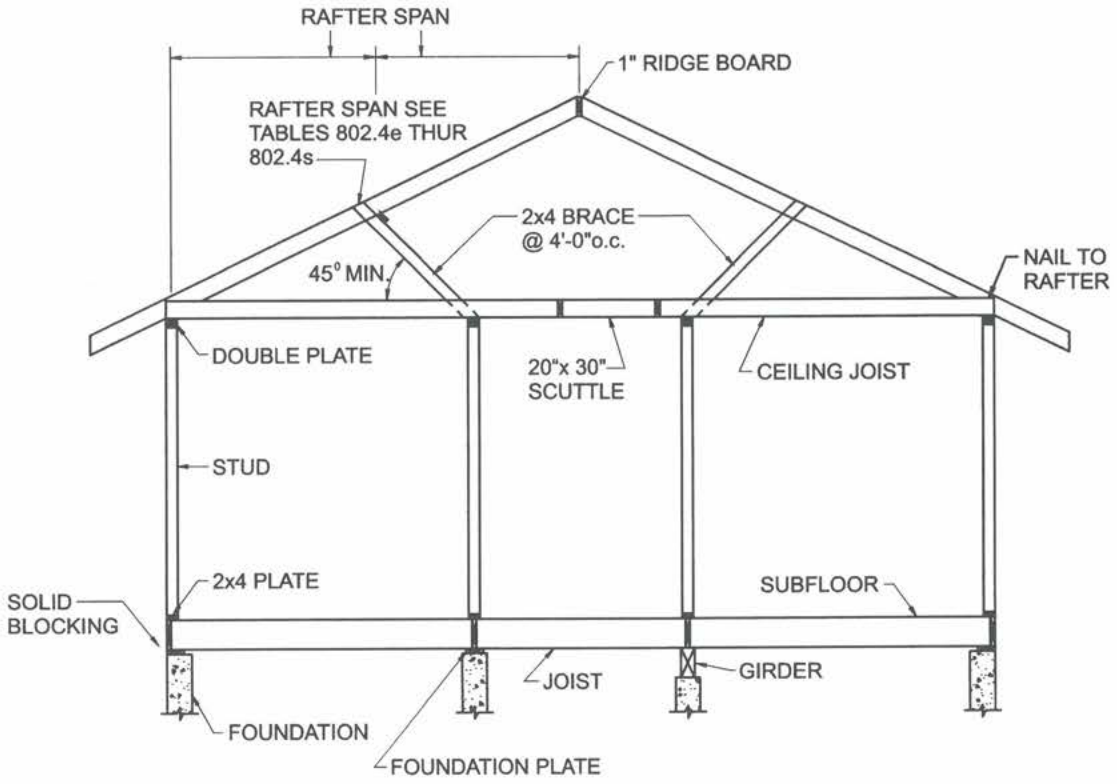
802.2 Design and construction. Roof–ceilings of wood construction shall be designed and constructed in accordance with the provisions of this chapter, or with the AFPA NDS–1991 "National Design Specification for Wood Construction," the CWC–1987 "Canadian Dimension Lumber Data Book," the WWPA–1992 "Western Lumber Span Tables for Floor and Ceiling Joists and Roof Rafters," or the "Southern Pine Maximum Spans for Joists and Rafters." Roof–ceilings shall be constructed in accordance with Figures 604.10a, 604.10b, 604.10c and 802.4.1 and nailed in accordance with Table 602.3a.

802.2.1 Cathedral ceilings. When ceiling joists and rafter ties are omitted and the rafters are used to create a cathedral ceiling, rafter ends shall be supported on bearing walls, headers or ridge beams. Rafters shall be attached to the support in accordance with Table 602.3a. Ridge beams shall be capable of carrying the imposed roof loads and shall be supported by structural elements which transmit the loads to the foundation.

802.3 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 (1219 mm) 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 (25 mm) 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 (51 mm) 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.

802.3.1 Ceiling joists lapped. Ends of ceiling joists shall be lapped a minimum of 3 inches (76 mm) 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.

802.3.2 Collar beams. A 1 x 6 or 2 x 4 collar beam shall be nailed in the upper third of the roof to every third pair of rafters not to exceed 4-feet on centers. Collar beams shall be connected to the rafters as specified in Table 602.3a for rafter ties.



Note: Where ceiling joists run perpendicular to the rafters, rafter ties shall be nailed to the rafters near the plate line and sapced not more than 4 feet on center.

FIGURE 802.4.1
BRACED RAFTER CONSTRUCTION

802.4 Allowable spans. The unsupported spans for rafters and ceiling joists shall not exceed the values set forth in Tables 802.4a through 802.4s listed at the end of this chapter. When the roof pitch is less than three units vertical in 12 units horizontal (25–percent slope), members supporting rafters and ceiling joists, such as ridge beams, hips and valleys, shall be designed as beams.

802.4.1 Purlins. Purlins may be installed to reduce the span of rafters as shown in Figure 802.4.1. Purlins shall be sized no less than the required size of the rafters that they support. Purlins shall be continuous and shall be supported by 2 by 4 (51 by 102) struts installed to bearing walls at a slope not less than 45 degrees from the horizontal. The struts shall be spaced not more than 4 feet (1219 mm) on center, and the unbraced length of struts shall not exceed 8 feet (2438 mm).

802.5 Bearing. The ends of each rafter or ceiling joist shall have not less than 1-1/2 inches (38 mm) of bearing on wood or metal and not less than 3 inches (76 mm) on masonry.

802.5.1 Finished ceiling material. 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.

802.6 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 (102 mm) wide or greater shall not be notched except at the ends of the members. Cantilevered portions less than 4 inches (102 mm) wide shall not be notched unless the reduced section properties and lumber defects are considered in the design.

802.7 Bored holes. Holes bored in rafters or ceiling joists shall not be within 2 inches (51 mm) of the top and bottom and their diameter shall not exceed one–third the depth of the member.

802.8 Lateral support. Rafters and ceiling joists having a depth–to–thickness ratio exceeding 5 to 1 based on nominal dimensions shall be provided with lateral support at points of bearing to prevent rotation.

802.8.1 Bridging. 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 continuous 1–inch–by–3–inch (25 mm by76 mm) wood strip nailed across the rafters or ceiling joists at intervals not exceeding 10 feet (3048 mm).

802.9 Framing of openings. Openings in roof and ceiling framing shall be framed with headers between ceiling joists or rafters. When the header span does not exceed 4 feet (1219 mm), the header may be a single member the same size as the ceiling joist or rafter. When the header span exceeds 4 feet (1219 mm), the header and the joists or rafters that support the header shall be doubled, and approved hangers shall be used to connect the header to the joists or rafters.

802.10 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 for in Table 602.6.2.

802.11 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 ANSI/TPI 1-1995"National Design Standard for Metal Plate Connected Wood Trusses" listed in Section 43." Trusses shall be braced according to their appropriate engineered design. In the absence of specific bracing requirements, trusses shall be braced in accordance with HIB "Commentary and Recommendation - Handling Installing & Bracing Metal Plate Connected Wood Trusses" listed in Section 43. Truss members shall not be cut or altered unless so designed.

802.12 Roof tie–down. Roof rafters and trusses shall be attached to the wall in accordance with the requirements of Table 802.12 in addition to the nailing requirements in Table No. 602.3a. For trusses, the nailing requirements in Table No. 602.3a shall include the nailing requirements for both rafters and ceiling joist. As an alternate to the anchorage requirements of Table No. 602.3a and 802.12, the anchorage for roof members may be based on a designed connection taking into account all horizontal and vertical forces. Forces for alternate anchorage design may result from wind uplift: wind lateral on roof; wind lateral on walls to be transferred to a ceiling/roof diaphragm: diaphragm shear to be transferred to shear walls: roof/ceiling diaphragm chord forces to be transferred to the top plate of the wall: roof/ceiling live loads; and other loads depending on the specific building design. If roof members align with the studs, the connection may be made from the roof member directly to the studs. If the connection is from the roof member to the top plate and then from the top plate to the stud, a double top plate is required and both connections must meet the requirements of Table 802.12. Where ceiling joist are not parallel with and connect to the roof members, the anchorage requirements for each roof member shall be increased by 110 pounds. Gable and hip ends of roofs shall be anchored in accordance with this section.

TABLE 802.12 [1,2]
ROOF TIE DOWN REQUIREMENTS

BASIC WIND VELOCITY (MPH)	MAXIMUM STRUCTURE WALL	ROOF SLOPE	ANCHORAGE EXTERIOR
70	All Widths	All	Table 602.3A
80	All Widths	All	Table 602.3A
90	See Chapter 40, Table 4008.2		

1. Alternate to the requirements of this table or roof not covered by the table, shall be designed in accordance with the North Carolina State Building Code, Volume I- General Construction or SSTD-10, "Standard For Hurricane Resistant Residential Construction."
2. See Chapter 41 for material requirements in Coastal High Hazard Areas and Ocean Hazard Areas.

SECTION 803
ROOF SHEATHING

803.1 Lumber sheathing. Allowable spans for lumber used as roof sheathing shall conform to Table 803.1. Spaced lumber sheathing for wood shingle and shake roofing shall conform to the requirements of Sections 908 and 909.

803.2 Plywood sheathing.

803.2.1 Identification and grade. Plywood and wood structural panels shall conform to DOC PS 1 or DOC PS 2, and shall be identified by grade mark or certificate of inspection issued by an approved agency. Plywood and wood structural panels shall comply with the grades specified in Table 503.2.1.1a.

803.2.1.1 Type. All plywood, when designed to be exposed in outdoor applications, shall be of an exterior type. Plywood or wood structural panel roof sheathing exposed to the underside may be of interior type bonded with exterior glue, identified as Exposure 1.

803.2.1.2 Fire–retardant–treated plywood. 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.

803.2.1.3 Wood structural panels. Wood structural–use panels conforming to DOC PS 2 includes performance–rated plywood, oriented strandboard and composite panels. Oriented strandboard structural–use panels manufactured in Canada shall conform to CSA 0437.

803.2.2 Allowable spans. The maximum allowable spans for plywood and wood structural panel roof sheathing shall not exceed the values set forth in Table 503.2.1.1a.

803.2.3 Installation. Plywood and wood structural panel roof sheathing shall be installed with joints staggered or nonstaggered in accordance with Tables 503.2.1.1a and 602.3a, or APA E30.

803.3 Particleboard sheathing.

803.3.1 Identification and grade. Particleboard roof sheathing shall conform to Type 2–M–W as set forth in ANSI A208.1 and shall be so identified by a grade mark or certificate of inspection issued by an approved agency.

803.3.2 Allowable spans. The allowable loads and spans for particleboard roof sheathing shall not exceed the values set forth in Table 803.3.2.

803.3.3 Installation. Particleboard roof sheathing shall be installed in accordance with Tables 602.3a and 803.3.2. Where walls are subject to wind pressures of 30 pounds per square foot (1.44 kN/m2) or greater, as determined in Table 301.2a, particleboard roof sheathing shall be attached to the gable end with 8d common nails spaced at no more than 4 inches (102 mm), or equivalent fasteners.

TABLE 803.1
MINIMUM THICKNESS OF LUMBER ROOF SHEATHING

RAFTER OR BEAM SPACING (inches)	MINIMUM NET THICKNESS (inches)
24	5/8
48[1]	1-1/2 T & G
60[2]	
72[3]	

For **SI:** 1 inch = 25.4 mm, 1 psi = 6.895 kPa.

1. Minimum 270 *Fb*, 340,000 *E*.
2. Minimum 420 *Fb*, 660,000 *E*.
3. Minimum 600 *Fb*, 1,150,000 *E*.

TABLE 803.3.2
ALLOWABLE LOADS FOR PARTICLEBOARD ROOF SHEATHING[1,2,3]

GRADE	THICKNESS (inches)	MAXIMUM ON–CENTER SPACING	LIVE LOAD (pounds per square foot)	TOTAL LOAD (pounds per square foot)
2-M-W	3/8[4]	16	45	65
	7/16[4]	16	105	105
	7/16[4]	24	30	40
	1/2	16	110	150
	1/2	24	40	55

For **SI:** 1 inch = 25.4 mm, 1 psi = 6.895 kPa.

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. 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.
4. Edges shall be tongue and groove or supported with blocking or edge clips.

SECTION 804
METAL

804.1 General. Elements shall be straight and free of any defects which would significantly affect their structural performance.

SECTION 805
CEILING FINISHES

805.1 Ceiling installation. Ceilings shall be installed in accordance with the requirements for interior wall finishes, as provided in Section 702.

SECTION 806
ROOF VENTILATION

806.1 Ventilation required. 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 material, with the least dimension being 1/8 inch (3.2 mm).

806.2 Minimum area. The total net free ventilating area shall not be less than 1 to 150 of the area of the space ventilated except that the total area is permitted to be reduced to 1 to 300, provided at least 50 percent and not more than 80 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 (914 mm) above eave or cornice vents with the balance of the required ventilation provided by eave or cornice vents. As an alternative, the net free cross–ventilation area may be reduced to 1 to 300 when a vapor barrier having a transmission rate not exceeding 1 perm (57.4 ng/s – m^2 – Pa) is installed on the warm side of the ceiling.

806.3 Vent clearance. Where eave or cornice vents are installed, insulation shall not block the free flow of air. A minimum of 1–inch (25 mm) space shall be provided between the insulation and the roof sheathing at the location of the vent.

SECTION 807
ATTIC ACCESS

807.1 Accessible attic access. A readily accessible attic access framed opening not less than 20 inches by 30 inches (508 mm by 762 mm) shall be provided to any attic area having a clear height of over 30 inches (762 mm).

Exception: Concealed areas not located over the main structure including porches, kneewalls less than 5 feet in height, dormers, bay windows, etc. are not required to have access.

TABLE 802.4a
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 AND SPACING		MODULUS OF ELASTICITY, "*E*," IN 1,000, 000 PSI									
(inches)	(inches)	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3
2 x 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	6-0 870	6-11 930	7-1 990	7-3 1,040
	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 1,050	6-10 1,110
	24.0	4-4 540	4-8 630	4-11 710	5-2 790	5-5 860	5-8 930	5-10 1,000	6-0 1,070	6-2 1,130	6-4 1,190
2 x 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 1,040
	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 1,050	10-9 1,110
	24.0	6-9 540	7-3 630	7-9 710	8-2 790	8-6 860	8-10 930	9-2 1,000	9-6 1,070	9-9 1,130	10-0 1,190
2 x 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 1,040
	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 1,050	14-2 1,110
	24.0	8-11 540	9-7 630	10-2 710	10-9 790	11-3 860	11-8 930	12-1 1,000	12-6 1,070	12-10 1,130	13-2 1,190
2 x 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 1,040
	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 1,050	18-1 1,110
	24.0	11-4 540	12-3 630	13-0 710	13-8 790	14-4 860	14-11 930	15-5 1,000	15-11 1,070	16-5 1,130	16-10 1,190

For **SI:** 1 inch = 25.4 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot - 0.0479 kN/m^2.

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

TABLE 802.4a—continued
ALLOWABLE SPANS FOR CEILING JOISTS

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 AND SPACING		MODULUS OF ELASTICITY, *"E,"* IN 1,000, 000 PSI								
(inches)	(inches)	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.2	2.4
2 x 4	12.0	8-3 990	8-5 1,040	8-7 1,090	8-9 1,130	8-11 1,170	9-1 1,220	9-3 1,260	9-7 1,340	9-10 1,420
	13.7	7-10 1,040	8-1 1,090	8-3 1,140	8-5 1,180	8-7 1,230	8-8 1,270	8-10 1,320	9-2 1,400	9-5 1,490
	16.0	7-6 1,090	7-8 1,140	7-10 1,200	8-0 1,240	8-1 1,290	8-3 1,340	8-5 1,390	8-8 1,480	8-11 1,570
	19-2	7-0 1.160	7-2 1,220	7-4 1,270	7-6 1,320	7-8 1,370	7-9 1,420	7-11 1,470	8-2 1,570	8-5 1,660
	24.0	6-6 1,250	6-8 1,310	6-10 1,370	7-0 1,420	7-1 1,480	7-3 1,530	7-4 1,590	7-7 1,690	7-10 1,790
2 x 6	12.0	12-11 990	13-3 1,040	13-6 1,090	13-9 1,130	14-1 1,170	14-4 1,220	14-7 1,260	15-0 1,340	15-6 1,420
	13.7	12-4 1,040	12-8 1,090	12-11 1,140	13-2 1,180	13-5 1,230	13-8 1,270	13-11 1,320	14-4 1,400	14-9 1,490
	16.0	11-9 1,090	12-0 1,140	12-3 1,200	12-6 1,240	12-9 1,290	13-0 1,340	13-3 1,390	13-8 1,480	14-1 1,570
	19.2	11-1 1,160	11-4 1,220	11-7 1,270	11-9 1,320	12-0 1,370	12-3 1,420	12-5 1,470	12-10 1,570	13-3 1,660
	24.0	10-3 1,250	10-6 1,310	10-9 1,370	10-11 1,420	11-2 1,480	11-4 1,530	11-7 1,590	11-11 1,690	12-3 1,790
2 x 8	12-0	17-0 990	17-5 1,040	17-10 1,090	18-2 1,130	18-6 1,170	18-10 1,220	19-2 1,260	19-10 1,340	20-5 1,420
	13.7	16-3 1,040	16-8 1,090	17-0 1,140	17-5 1,180	17-9 1,230	18-0 1,270	18-4 1,320	18-11 1,400	19-6 1,490
	16.0	15-6 1,090	15-10 1,140	16-2 1,200	16-6 1,240	16-10 1,290	17-2 1,340	17-5 1,390	18-0 1,480	18-6 1,570
	19.2	14-7 1,160	14-11 1,220	15-3 1,270	15-6 1,320	15-10 1,370	16-1 1,420	16-5 1,470	16-11 1,570	17-5 1,660
	24.0	13-6 1,250	13-10 1,310	14-2 1,370	14-5 1,420	14-8 1,480	15-0 1,530	15-3 1,590	15-9 1,690	16-2 1,790
2 x 10	12.0	21-9 990	22-3 1,040	22-9 1,090	23-2 1,130	23-8 1,170	24-1 1,220	24-6 1,260	25-3 1,340	26-0 1,420
	13.7	20-9 1,040	21-3 1,090	21-9 1,140	22-2 1,180	22-7 1,230	23-0 1,270	23-5 1,320	24-2 1,400	24-10 1,490
	16.0	19-9 1,090	20-2 1,140	20-8 1,200	21-1 1,240	21-6 1,290	21-10 1,340	22-3 1,390	22-11 1,480	23-8 1,570
	19.2	18-7 1,160	19-0 1,220	19-5 1,270	19-10 1,320	20-2 1,370	20-7 1,420	20-11 1,470	21-7 1,570	22-3 1,660
	24.0	17-3 1,250	17-8 1,310	18-0 1,370	18-5 1,420	18-9 1,480	19-1 1,530	19-5 1,590	20-1 1,690	20-8 1,790

For **SI:** 1 inch = 25.4 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot - 0.0479 kN/m^2.

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

TABLE 802.4b
ALLOWABLE SPANS 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 AND SPACING		MODULUS OF ELASTICITY, *"E,"* IN 1,000, 000 PSI									
(inches)	(inches)	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3
2 x 4	12.0	6-2 560	6-8 660	7-1 740	7-6 820	7-10 900	8-1 970	8-5 1,040	8-8 1,110	8-11 1,170	9-2 1,240
	13.7	5-11 590	6-5 690	6-9 770	7-2 860	7-6 940	8-1 1,090	8-4 1,160	8-7 1,230	8-9 1,300	7-8 990
	16.0	5-8 620	6-1 720	6-5 810	6-9 900	7-1 990	7-5 1,070	7-8 1,140	7-11 1,220	8-1 1,290	8-4 1,360
	19-2	5-4 660	5-9 770	6-1 870	6-5 960	6-8 1,050	6-11 1,130	7-2 1,220	7-5 1,300	7-8 1,370	7-10 1,450
	24.0	4-11 710	5-4 830	5-8 930	5-11 1,030	6-2 1,130	6-5 1,220	6-8 1,310	6-11 1,400	7-1 1,480	7-3 1,560
2 x 6	12.0	9-9 560	10-6 660	11-2 740	11-9 820	12-3 900	12-9 970	13-3 1,040	13-8 1,110	14-1 1,170	14-5 1,240
	13.7	9-4 590	10-0 690	10-8 770	11-3 860	11-9 940	12-3 1,010	12-8 1,090	13-1 1,160	13-5 1,230	13-10 1,300
	16.0	8-10 620	9-6 720	10-2 810	10-8 900	11-2 990	11-7 1,070	12-0 1,140	12-5 1,220	12-9 1,290	13-1 1,360
	19.2	8-4 660	9-0 770	9-6 870	10-0 960	10-6 1,050	10-11 1,130	11-4 1,220	11-8 1,300	12-0 1,370	12-4 1,450
	24.0	7-9 710	8-4 830	8-10 930	9-4 1,030	9-9 1,130	10-2 1,220	10-6 1,310	10-10 1,400	11-2 1,480	11-5 1,560
2 x 8	12-0	12-10 560	13-10 660	14-8 740	15-6 820	16-2 900	16-10 970	17-5 1,040	18-0 1,110	18-6 1,170	19-0 1,240
	13.7	12-3 590	13-3 690	14-1 770	14-10 860	15-6 940	16-1 1,010	16-8 1,090	17-2 1,160	17-9 1,230	18-2 1,300
	16.0	11-8 620	12-7 720	13-4 810	14-1 900	14-8 990	15-3 1,070	15-10 1,140	16-4 1,220	16-10 1,290	17-3 1,360
	19.2	11-0 660	11-10 770	12-7 870	13-3 960	13-10 1,050	14-5 1,130	14-11 1,220	15-5 1,300	15-10 1,370	16-3 1,450
	24.0	10-2 710	11-0 830	11-8 930	12-3 1,030	12-10 1,130	13-4 1,220	13-10 1,310	14-3 1,400	14-8 1,480	15-1 1,560
2 x 10	12.0	16-5 560	17-8 660	18-9 740	19-9 820	20-8 900	21-6 970	22-3 1,040	22-11 1,110	23-8 1,170	24-3 1,240
	13.7	15-8 590	16-11 690	17-11 770	18-11 860	19-9 940	20-6 1,010	21-3 1,090	21-11 1,160	22-7 1,230	23-3 1,300
	16.0	14-11 620	16-0 720	17-0 810	17-11 900	18-9 990	19-6 1,070	20-2 1,140	20-10 1,220	21-6 1,290	22-1 1,360
	19.2	14-0 660	15-1 770	16-0 870	16-11 960	17-8 1,050	18-4 1,130	19-0 1,220	19-7 1,300	20-2 1,370	20-9 1,450
	24.0	13-0 710	14-0 830	14-11 930	15-8 1,030	16-5 1,130	17-0 1,220	17-8 1,310	18-3 1,400	18-9 1,480	19-3 1,560

For **SI:** 1 inch = 25.4 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot - 0.0479 kN/m^2.

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

TABLE 802.4b—continued
ALLOWABLE SPANS FOR CEILING JOISTS

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 AND SPACING		MODULUS OF ELASTICITY, *"E,"* IN 1,000, 000 PSI								
(inches)	(inches)	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.2	2.4
2 x 4	12.0	9-5 1,300	9-8 1,360	9-10 1,420	10-0 1,480	10-3 1,540	10-5 1,600	10-7 1,650	10-11 1,760	11-3 1,860
	13.7	9-0 1,360	9-3 1,420	9-5 1,490	9-7 1,550	9-9 1,610	10-0 1,670	10-2 1,730	10-6 1,840	10-9 1,950
	16.0	8-7 1,430	8-9 1,500	8-11 1,570	9-1 1,630	9-4 1,690	9-6 1,760	9-8 1,820	9-11 1,940	10-3 2,050
	19-2	8-1 1.520	8-3 1,590	8-5 1,660	8-7 1,730	8-9 1,800	8-11 1,870	9-1 1,930	9-4 2,060	9-8 2,180
	24.0	7-6 1,640	7-8 1,720	7-10 1,790	8-0 1,870	8-1 1,940	8-3 2,010	8-5 2,080	8-8 2,220	8-11 2,350
2 x 6	12.0	14-9 1,300	15-2 1,360	15-6 1,420	15-9 1,480	16-1 1,540	16-4 1,600	16-8 1,650	17-2 1,760	17-8 1,860
	13.7	14-2 1,360	14-6 1,420	14-9 1,490	15-1 1,550	15-5 1,610	15-8 1,670	15-11 1,730	16-5 1,840	16-11 1,950
	16.0	13-5 1,430	13-9 1,500	14-1 1,570	14-4 1,630	14-7 1,690	14-11 1,760	15-2 1,820	15-7 1,940	16-1 2,050
	19.2	12-8 1,520	12-11 1,590	13-3 1,660	13-6 1,730	13-9 1,800	14-0 1,870	14-3 1,930	14-8 2,060	15-2 2,180
	24.0	11-9 1,640	12-0 1,720	12-3 1,790	12-6 1,870	12-9 1,940	13-0 2,010	13-3 2,080	13-8 2,200	14-1 2,350
2 x 8	12-0	19-6 1,300	19-11 1,360	20-5 1,420	20-10 1,480	21-2 1,540	21-7 1,600	21-11 1,650	22-8 1,760	23-4 1,860
	13.7	18-8 1,360	19-1 1,420	19-6 1,490	19-11 1,550	20-3 1,610	20-8 1,670	21-0 1,730	21-8 1,840	22-4 1,950
	16.0	17-9 1,430	18-2 1,500	18-6 1,570	18-11 1,630	19-3 1,690	19-7 1,760	19-11 1,820	20-7 1,940	21-2 2,050
	19.2	16-8 1,520	17-1 1,590	17-5 1,660	17-9 1,730	18-2 1,800	18-5 1,870	18-9 1,930	19-5 2,060	19-11 2,180
	24.0	15-6 1,640	15-10 1,720	16-2 1,790	16-6 1,870	16-10 1,940	17-2 2,010	17-5 2,080	18-0 2,220	18-6 2,350
2 x 10	12.0	24-10 1,300	25-5 1,360	26-0 1,420	26-6 1,480	27-1 1,540	27-6 1,600	28-0 1,650	28-11 1,760	29-9 1,860
	13.7	23-9 1,360	24-4 1,420	24-10 1,490	25-5 1,550	25-10 1,610	26-4 1,670	26-10 1,730	27-8 1,840	28-6 1,950
	16.0	22-7 1,430	23-2 1,500	23-8 1,570	24-1 1,630	24-7 1,690	25-0 1,760	25-5 1,820	26-3 1,940	27-1 2,050
	19.2	21-3 1,520	21-9 1,590	22-3 1,660	22-8 1,730	23-2 1,800	23-7 1,870	23-11 1,930	24-9 2,060	25-5 2,180
	24.0	19-9 1,640	20-2 1,720	20-8 1,790	21-1 1,870	21-6 1,940	21-10 2,010	22-3 2,080	22-11 2,220	23-8 2,350

For **SI:** 1 inch = 25.4 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot - 0.0479 kN/m^2.

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

TABLE 802.4c
ALLOWABLE SPANS 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 AND SPACING		MODULUS OF ELASTICITY, *"E,"* IN 1,000, 000 PSI									
(inches)	(inches)	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3
2 x 4	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
2 x 6	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	4-4 700	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
2 x 8	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
2 x 10	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	20-0 690	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

For **SI:** 1 inch = 25.4 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot - 0.0479 kN/m^2.

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

TABLE 802.4c—continued
ALLOWABLE SPANS FOR CEILING JOISTS

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 AND SPACING		MODULUS OF ELASTICITY, *"E,"* IN 1,000, 000 PSI								
(inches)	(inches)	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.2	2.4
2 x 4	12.0	10-4 790	10-7 830	10-10 860	11-1 900	11-3 930	11-6 970	11-8 1,000	12-1 1,070	12-5 1,130
	13.7	9-11 820	10-2 860	10-4 900	10-7 940	10-9 970	11-0 1,010	11-2 1,050	11-6 1,110	11-10 1,180
	16.0	9-5 870	9-8 910	9-10 950	10-0 990	10-3 1,030	10-5 1,060	10-7 1,100	10-11 1,170	11-3 1,240
	19-2	8-10 920	9-1 970	9-3 1,010	9-5 1,050	9-8 1,090	9-10 1,130	10-0 1,170	10-4 1,250	10-7 1,320
	24.0	8-3 990	8-5 1,040	8-7 1,090	8-9 1,130	8-11 1,170	9-1 1,220	9-3 1,260	9-7 1,340	9-10 1,420
2 x 6	12.0	16-3 790	16-8 830	17-0 860	17-4 900	17-8 930	18-0 970	18-4 1,000	18-11 1,070	19-6 1,130
	13.7	15-7 820	15-11 860	16-3 900	16-7 940	16-11 970	17-3 1,010	17-6 1,050	18-1 1,110	18-8 1,180
	16.0	14-9 870	15-2 910	15-6 950	15-9 990	16-1 1,030	16-4 1,060	16-8 1,100	17-2 1,170	17-8 1,240
	19.2	13-11 920	14-3 970	14-7 1,010	14-10 1,050	15-2 1,090	15-5 1,130	15-8 1,170	16-2 1,250	16-8 1,320
	24.0	12-11 990	13-3 1,040	13-6 1,090	13-9 1,130	14-1 1,170	14-4 1,220	14-7 1,260	15-0 1,340	15-6 1,420
2 x 8	12-0	21-5 790	21-11 830	22-5 860	22-11 900	23-4 930	23-9 970	24-2 1,000	24-11 1,070	25-8 1,130
	13.7	20-6 820	21-0 860	21-5 900	21-11 940	22-4 970	22-9 1,010	23-1 1,050	23-10 1,110	24-7 1,180
	16.0	19-6 870	19-11 910	20-5 950	20-10 990	21-2 1,030	21-7 1,060	21-11 1,100	22-8 1,170	23-4 1,240
	19.2	18-4 920	18-9 970	19-2 1,010	19-7 1,050	19-11 1,090	20-4 1,130	20-8 1,170	21-4 1,250	21-11 1,320
	24.0	17-0 990	17-5 1,040	17-10 1,090	18-2 1,130	18-6 1,170	18-10 1,220	19-2 1,260	19-10 1,340	20-5 1,420
2 x 10	12.0	27-5 790	28-0 830	28-7 860	29-2 900	29-9 930	30-4 970	30-10 1,000	31-10 1,070	32-9 1,130
	13.7	26-2 820	26-10 860	27-5 900	27-11 940	28-6 970	29-0 1,010	29-6 1,050	30-5 1,110	31-4 1,180
	16.0	24-10 870	25-5 910	26-0 950	26-6 990	27-1 1,030	27-6 1,060	28-0 1,100	28-11 1,170	29-9 1,240
	19.2	23-5 920	23-11 970	24-6 1,010	25-0 1,050	25-5 1,090	25-11 1,130	26-4 1,170	27-3 1,250	28-0 1,320
	24.0	21-9 990	22-3 1,040	22-9 1,090	23-2 1,130	23-8 1,170	24-1 1,220	24-6 1,260	25-3 1,340	26-0 1,420

For **SI:** 1 inch = 25.4 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot - 0.0479 kN/m^2.

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

TABLE 802.4d
ALLOWABLE SPANS 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 AND SPACING		MODULUS OF ELASTICITY, *"E,"* IN 1,000, 000 PSI									
(inches)	(inches)	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3
2 x 4	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 1,030
	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 1,030	10-6 1,080
	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 1,030	9-8 1,090	9-11 1,150
	24.0	6-2 560	6-8 660	7-1 740	7-6 820	7-10 900	8-1 970	8-5 1,040	8-8 1,110	8-11 1,170	9-2 1,240
2 x 6	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 1,030
	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 1,030	16-6 1,080
	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 1,030	15-2 1,090	15-7 1,150
	24.0	9-9 560	10-6 660	11-2 740	11-9 820	12-3 900	12-9 970	13-3 1,040	13-8 1,110	14-1 1,170	14-5 1,240
2 x 8	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 1,030
	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 1,030	21-9 1,080
	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 1,030	19-11 1,090	20-6 1,150
	24.0	12-10 560	13-10 660	14-8 740	15-6 820	16-2 900	16-10 970	17-5 1,040	18-0 1,110	18-6 1,170	19-0 1,240
2 x 10	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 1,030
	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 1,030	27-9 1,080
	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 1,030	25-5 1,090	26-2 1,150
	24.0	16-5 560	17-8 660	18-9 740	19-9 820	20-8 900	21-6 970	22-3 1,040	22-11 1,110	23-8 1,170	24-3 1,240

For **SI:** 1 inch = 25.4 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot - 0.0479 kN/m^2.

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

TABLE 802.4d—continued
ALLOWABLE SPANS FOR CEILING JOISTS

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 AND SPACING		MODULUS OF ELASTICITY, *"E,"* IN 1,000, 000 PSI								
(inches)	(inches)	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.2	2.4
2 x 4	12.0	11-10 1,030	12-2 1,080	12-5 1,130	12-8 1,180	12-11 1,220	13-2 1,270	13-4 1,310	13-9 1,400	14-2 1,480
	13.7	11-4 1,080	11-7 1,130	11-10 1,180	12-1 1,230	12-4 1,280	12-7 1,320	12-9 1,370	13-2 1,460	13-7 1,550
	16.0	10-9 1,140	11-0 1,190	11-3 1,240	11-6 1,290	11-9 1,340	11-11 1,390	12-2 1,440	12-6 1,540	12-11 1,630
	19-2	10-2 1,210	10-4 1,270	10-7 1,320	10-10 1,380	11-0 1,430	11-3 1,480	11-5 1,530	11-9 1,630	12-2 1,730
	24.0	9-5 1,300	9-8 1,360	9-10 1,420	10-0 1,480	10-3 1,540	10-5 1,600	10-7 1,650	10-11 1,760	11-3 1,860
2 x 6	12.0	18-8 1,030	19-1 1,080	19-6 1,130	19-11 1,180	20-3 1,220	20-8 1,270	21-10 1,310	21-8 1,400	22-4 1,480
	13.7	17-10 1,080	18-3 1,130	18-8 1,180	19-0 1,230	19-5 1,280	19-9 1,320	20-1 1,370	20-9 1,460	21-4 1,550
	16.0	16-11 1,140	17-4 1,190	17-8 1,240	18-1 1,290	18-5 1,340	18-9 1,390	19-1 1,440	19-8 1,540	20-3 1,630
	19.2	15-11 1,210	16-4 1,270	16-8 1,320	17-0 1,380	17-4 1,430	17-8 1,480	17-11 1,530	18-6 1,630	19-1 1,730
	24.0	14-9 1,300	15-2 1,360	15-6 1,420	15-9 1,480	16-1 1,540	16-4 1,600	16-8 1,650	17-2 1,760	17-8 1,860
2 x 8	12-0	24-7 1,030	25-2 1,080	25-8 1,130	26-2 1,180	26-9 1,220	27-2 1,270	27-8 1,310	28-7 1,400	29-5 1,480
	13.7	23-6 1,080	24-0 1,130	24-7 1,180	25-1 1,230	25-7 1,280	26-0 1,320	26-6 1,370	27-4 1,460	28-1 1,550
	16.0	22-4 1,140	22-10 1,190	23-4 1,240	23-10 1,290	24-3 1,340	24-8 1,390	25-2 1,440	25-11 1,540	26-9 1,630
	19.2	21-0 1,210	21-6 1,270	21-11 1,320	22-5 1,380	22-10 1,430	23-3 1,480	23-8 1,530	24-5 1,630	25-2 1,730
	24.0	9-6 1,300	19-11 1,360	20-5 1,420	20-1- 1,480	21-2 1,540	21-7 1,600	21-11 1,650	22-8 1,760	23-4 1,860
2 x 10	12.0	31-4 1,030	32-1 1,080	32-9 1,130	33-5 1,180	34-1 1,220	34-8 1,270	35-4 1,310	36-5 1,400	37-6 1,480
	13.7	30-0 1,080	30-8 1,130	31-4 1,180	32-0 1,230	32-7 1,280	33-2 1,320	33-9 1,370	34-10 1,460	35-10 1,550
	16.0	28-6 1,140	29-2 1,190	29-9 1,240	30-5 1,290	31-0 1,340	31-6 1,390	32-1 1,440	33-1 1,540	34-1 1,630
	19.2	26-10 1,210	27-5 1,270	28-0 1,320	28-7 1,380	29-2 1,430	29-8 1,480	30-2 1,530	31-2 1,630	32-1 1,730
	24.0	24-10 1,300	25-5 1,360	26-0 1,420	26-6 1,480	27-1 1,540	27-6 1,600	28-0 1,650	28-11 1,760	29-9 1,860

For **SI:** 1 inch = 25.4 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot - 0.0479 kN/m^2.

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

TABLE 802.4e
ALLOWABLE SPANS 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 AND SPACING		ALLOWABLE EXTREME FIBER STRESS IN BENDING, "F_b" (psi)										
(inches)	(inches)	300	400	500	600	700	800	900	1000	1100	1200	1300
2 x 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 x 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 x 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 x 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

For **SI:** 1 inch = 25.4 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot - 0.0479 kN/m^2

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

TABLE 802.4e—continued

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 AND SIZE	
1400	1500	1600	1700	1800	1900	2000	2100	2200	2400	2700	(inches)	(inches)
14-2	14-8	15-2	15-8	16-1	16-7	17-0	17-5	17-10			12.0	2 x 6
1.24	1.37	1.51	1.66	1.81	1.96	2.12	2.28	2.44				
13-3	13.9	14-2	14-8	15-1	15-6	15-11	16-3	16-8	17-5		13.7	
1.16	12.9	1.42	1.55	1.69	1.83	1.98	2.13	2.28	2.60			
12-4	12-9	13-2	13-7	13-11	14-4	14-8	15-1	15-5	16-1		16.0	
1.07	1.19	1.31	1.44	1.56	1.70	1.83	1.97	2.11	2.41			
11-3	11-7	12-0	12-4	12-9	13-1	13-5	13-9	14-1	14-8		19.2	
0.98	1.09	1.20	1.31	1.43	1.55	1.67	1.80	1.93	2.20			
10-0	10-5	10-9	11-1	11-5	11-8	12-0	12-4	12-7	13-2	13-11	24.0	
0.88	0.97	1.07	1.17	1.28	1.39	1.50	1.61	1.73	1.97	2.35		
18-9	19-5	20-0	20-8	21-3	21-10	22.4	22-11	23-6			12.0	2 x 8
1.24	1.37	1.51	1.66	1.81	1.96	2.12	2.28	2.44				
17-6	18-2	18-9	19-4	19-10	20-5	20-11	21-5	21-11	22-11		13.7	
1.16	1.29	1.42	1.55	1.69	1.83	1.98	2.13	2.28	2.60			
16-3	16-9	17-4	17-10	18-5	18-11	19-5	19-10	20-4	21-3		16-0	
1.07	1.19	1.31	1.44	1.56	1.70	1.83	1.97	2.11	2.41			
14-10	15-4	15-10	16-4	16-9	17-3	17-8	18-2	18-7	19-5		19.2	
0.98	1.09	1.20	1.31	1.43	1.55	1.67	1.80	1.93	2.20			
13-3	13-8	14-2	14-7	15-0	15-5	15-10	16-3	16-7	17-4	18-5	24.0	
0.88	0.97	1.07	1.17	1.28	1.39	1.50	1.61	1.73	1.97	2.35		
23-11	24-9	25-6	26-4	27-1	27-10	28-7	29-3	29-11			12.0	2 x 10
1.24	1.37	1.51	1.66	1.81	1.96	2.12	2.28	2.44				
22-4	23-2	23-11	24-7	25-4	26-0	26-8	27-4	28-0	29-3		13.7	
1.16	1.29	1.42	1.55	1.69	1.83	1.98	2.13	2.28	2.60			
20-8	21-5	22-1	22-10	23-5	24-1	24-9	25-4	25-11	27-1		16.0	
1.07	1.19	1.31	1.44	1.56	1.70	1.83	1.97	2.11	2.41			
18-11	19-7	20-2	20-10	21-5	22-0	22-7	23-2	23-8	24-9		19.2	
0.98	1.09	1.20	1.31	1.43	1.55	1.67	1.80	1.93	2.20			
16-11	17-6	18-1	18-7	19-2	19-8	20-2	20-8	21-2	22-1	23-5	24.0	
0.88	0.97	1.07	1.17	1.28	1.39	1.50	1.61	1.73	1.97	2.35		
29-1	30-1	31-1	32-0	32-11	33-10	34-9	35-7	36-5			12.0	2 x 12
1.24	1.37	1.51	1.66	1.81	1.96	2.12	2.28	2.44				
27-2	28-2	29-1	29-11	30-10	31-8	32-6	33-3	34-1	35-7		13.7	
1.16	1.29	1.42	1.55	1.69	1.83	1.98	2.13	2.28	2.60			
25-2	26-0	26-11	27-9	28-6	29-4	30-1	30-10	31-6	32-11		16.0	
1.07	1.19	1.31	1.44	1.56	1.70	1.83	1.97	2.11	2.41			
23-0	23-9	24-7	25-4	26-0	26-9	27-5	28-2	28-9	30-1		19.2	
0.98	1.09	1.20	1.31	1.43	1.55	1.67	1.80	1.93	2.20			
20-6	21-3	21-11	22-8	23-3	23-11	24-7	25-2	25-9	26-11	28-6	24.0	
0.88	0.97	1.07	1.17	1.28	1.39	1.50	1.61	1.73	1.97	2.35		

For **SI:** 1 inch = 25.4 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot - 0.0479 kN/m^2.

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

TABLE 802.4f
ALLOWABLE SPANS 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 AND SPACING		ALLOWABLE EXTREME FIBER STRESS IN BENDING, "F_b" (psi)										
(inches)	(inches)	300	400	500	600	700	800	900	1000	1100	1200	1300
2 x 6	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
2 x 8	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
2 x 10	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
2 x 12	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	19-5 0.90
	24.0	8-5 0.09	9-8 0.09	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

For **SI:** 1 inch = 25.4 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot - 0.0479 kN/m^2.

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

TABLE 802.4f—continued

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 AND SIZE	
1400	1500	1600	1700	1800	1900	2000	2100	2200	2400	2700	(inches)	(inches)
12-6	13-0	13-5	13-10	14-2	14-7	15-0	15-4	15-8			12.0	2 x 6
1.28	1.41	1.56	1.71	1.86	2.02	2.18	2.34	2.51				
11-9	12-2	12-6	12-11	13-3	13-8	14-0	14-4	14-8			13.7	
1.19	1.32	1.46	1.60	1.74	1.89	2.04	2.19	2.35				
10-10	11-3	11-7	11-11	12-4	12-8	13-0	13-3	13-7	14-2		16.0	
1.10	1.22	1.35	1.48	1.61	1.75	1.89	2.03	2.18	2.48			
9-11	10-3	10-7	10-11	11-3	11-6	11-10	12-2	12-5	13-0		19.2	
1.01	1.12	1.23	1.35	1.47	1.59	1.72	1.85	1.99	2.26			
8-10	9-2	9-6	9-9	10-0	10-4	10-7	10-10	11-1	11-7	12-4	24.0	
0.90	1.00	1.10	1.21	1.31	1.43	1.54	1.66	1.78	2.02	2.41		
16-6	17-1	17-8	18-2	18-9	19-3	19-9	20-3	20-8			12.0	2 x 8
1.28	1.41	1.56	1.71	1.86	2.02	2.18	2.34	2.51				
15-5	16-0	16-6	17-0	17-6	18-0	18-5	18-11	19-4			13.7	
1.19	1.32	1.46	1.60	1.74	1.89	2.04	2.19	2.35				
14-4	14-10	15-3	15-9	16-3	16-8	17-1	17-6	17-11	18-9		16-0	
1.10	1.22	1.35	1.48	1.61	1.75	1.89	2.03	2.18	2.48			
13-1	13-6	13-11	14-5	14-10	15-2	15-7	16-0	16-4	17-1		19.2	
1.01	1.12	1.23	1.35	1.47	1.59	1.72	1.85	1.99	2.26			
11-8	12-1	12-6	12-10	13-3	13-7	13-11	14-4	14-8	15-3	16-3	24.0	
0.90	1.00	1.10	1.21	1.31	1.43	1.54	1.66	1.78	2.02	2.41		
21-1	21-10	22-6	23-3	23-11	24-6	25-2	25-10	26-5			12.0	2 x 10
1.28	1.41	1.56	1.71	1.86	2.02	2.18	2.34	2.51				
19-8	20-5	21-1	21-9	22-4	22-11	23-7	24-2	24-8			13.7	
1.19	1.32	1.46	1.60	1.74	1.89	2.04	2.19	2.35				
18-3	18-11	19-6	20-1	20-8	21-3	21-10	22-4	22-10	23-11		16.0	
1.10	1.22	1.35	1.48	1.61	1.75	1.89	2.03	2.18	2.48			
16-8	17-3	17-10	18-4	18-11	19-5	19-11	20-5	20-10	21-10		19.2	
1.01	1.12	1.23	1.35	1.47	1.59	1.72	1.85	1.99	2.26			
14-11	15-5	15-11	16-5	16-11	17-4	17-10	18-3	18-8	19-6	20-8	24.0	
0.90	1.00	1.10	1.21	1.31	1.43	1.54	1.66	1.78	2.02	2.41		
25-7	26-6	27-5	28-3	29-1	29-10	30-7	31-4	32-1			12.0	2 x 12
1.28	1.41	1.56	1.71	1.86	2.02	2.18	2.34	2.51				
24-0	24-10	25-7	26-5	27-2	27-11	28-8	29-4	30-0			13.7	
1.19	1.32	1.46	1.60	1.74	1.89	2.04	2.19	2.35				
22-2	23-0	23-9	24-5	25-2	25-10	26-6	27-2	27-10	29-1		16.0	
1.10	1.22	1.35	1.48	1.61	1.75	1.89	2.03	2.18	2.48			
20-3	21-0	21-8	22-4	23-0	23-7	24-2	24-10	25-5	26-6		19.2	
1.01	1.12	1.23	1.35	1.47	1.59	1.72	1.85	1.99	2.26			
18-1	18-9	19-4	20-0	20-6	21-1	21-8	22-2	22-8	23-9	25-2	24.0	
0.90	1.00	1.10	1.21	1.31	1.43	1.54	1.66	1.78	2.02	2.41		

For **SI:** 1 inch = 25.4 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot - 0.0479 kN/m^2.

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

TABLE 802.4g
ALLOWABLE SPANS 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 AND SPACING		ALLOWABLE EXTREME FIBER STRESS IN BENDING, "F_b" (psi)										
(inches)	(inches)	300	400	500	600	700	800	900	1000	1100	1200	1300
2 x 6	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
2 x 8	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
2 x 10	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
2 x 12	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

For **SI:** 1 inch = 25.4 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot - 0.0479 kN/m^2.

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

TABLE 802.4g—continued

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 AND SIZE	
1400	1500	1600	1700	1800	1900	2000	2100	2200	2400	2700	(inches)	(inches)
11-4	11-9	12-1	12-6	12-10	13-2	13-6	13-10	14-2			12.0	2 x 6
1.26	1.40	1.54	1.68	1.83	1.99	2.15	2.31	2.48				
10-7	11-0	11-4	11-8	12-0	12-4	12-8	13-0	13-3			13.7	
1.18	1.31	1.44	1.57	1.72	1.86	2.01	2.16	2.32				
9-10	10-2	10-6	10-10	11-1	11-5	11-9	12-0	12-4	12-10		16.0	
1.09	1.21	1.33	1.46	1.59	1.72	1.86	2.00	2.15	2.45			
8-11	9-3	9-7	9-10	10-2	10-5	10-8	11-0	11-3	11-9		19.2	
0.99	1.10	1.22	1.33	1.45	1.57	1.70	1.83	1.96	2.23			
8-0	8-3	8-7	8-10	9-1	9-4	9-7	9-10	10-0	10-6	11-1	24.0	
0.89	0.99	1.09	1.19	1.30	1.41	1.52	1.63	1.75	2.00	2.38		
14-11	15-5	16-0	16-5	16-11	17-5	17-10	18-3	18-9			12.0	2 x 8
1.26	1.40	1.54	1.68	1.83	1.99	2.15	2.31	2.48				
14-0	14-6	14-11	15-5	15-10	16-3	16-8	17-1	17-6			13.7	
1.18	1.31	1.44	1.57	1.72	1.86	2.01	2.16	2.32				
12-11	13-5	13-10	14-3	14-8	15-1	15-5	15-10	16-3	16-11		16-0	
1.09	1.21	1.33	1.46	1.59	1.72	1.86	2.00	2.15	2.45			
11-10	12-3	12-7	13-0	13-5	13-9	14-1	14-6	14-10	15-5		19.2	
0.99	1.10	1.22	1.33	1.45	1.57	1.70	1.83	1.96	2.23			
10-7	10-11	11-3	11-8	12-0	12-4	12-7	12-11	13-3	13-10	14-8	24.0	
0.89	0.99	1.09	1.19	1.30	1.41	1.52	1.63	1.75	2.00	2.38		
19-1	19-9	20-4	21-0	21-7	22-2	22-9	23-4	23-11			12.0	2 x 10
1.26	1.40	1.54	1.68	1.83	1.99	2.15	2.31	2.48				
17-10	18-5	19-1	19-8	20-2	20-9	21-4	21-10	22-4			13.7	
1.18	1.31	1.44	1.57	1.72	1.86	2.01	2.16	2.32				
16-6	17-1	17-8	18-2	18-9	19-3	19-9	20-2	20-8	21-7		16.0	
1.09	1.21	1.33	1.46	1.59	1.72	1.86	2.00	2.15	2.45			
15-1	15-7	16-1	16-7	17-1	17-7	18-0	18-5	18-11	19-9		19.2	
0.99	1.10	1.22	1.33	1.45	1.57	1.70	1.83	1.96	2.23			
13-6	13-11	14-5	14-10	15-3	15-8	16-1	16-6	16-11	17-8	18-9	24.0	
0.89	0.99	1.09	1.19	1.30	1.41	1.52	1.63	1.75	2.00	2.38		
23-2	24-0	24-9	25-6	26-3	27-0	27-8	28-5	29-1			12.0	2 x 12
1.26	1.40	1.54	1.68	1.83	1.99	2.15	2.31	2.48				
21-8	22-5	23-2	23-11	24-7	25-3	25-11	26-7	27-2			13.7	
1.18	1.31	1.44	1.57	1.72	1.86	2.01	2.16	2.32				
20-1	20-9	21-5	22-1	22-9	23-5	24-0	24-7	25-2	26-3		16.0	
1.09	1.21	1.33	1.46	1.59	1.72	1.86	2.00	2.15	2.45			
18-4	19-0	19-7	20-2	20-9	21-4	21-11	22-5	23-0	24-0		19.2	
0.99	1.10	1.22	1.33	1.45	1.57	1.70	1.83	1.96	2.23			
16-5	17-0	17-6	18-1	18-7	19-1	19-7	20-1	20-6	21-5	22-9	24.0	
0.89	0.99	1.09	1.19	1.30	1.41	1.52	1.63	1.75	2.00	2.38		

For **SI:** 1 inch = 25.4 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot - 0.0479 kN/m^2

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

TABLE 802.4h
ALLOWABLE SPANS 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 AND SPACING		ALLOWABLE EXTREME FIBER STRESS IN BENDING, "F_b" (psi)									
(inches)	(inches)	300	400	500	600	700	800	900	1000	1100	1200
2 x 6	12.0	6-7	7-7	8-6	9-4	10-0	10-9	11-5	12-0	12-7	13-2
		0.18	0.28	0.40	0.52	0.66	0.80	0.96	1.12	1.29	1.48
	13.7	6-2	7-1	7-11	8-8	9-5	10-0	10-8	11-3	11-9	12-4
		0.17	0.27	0.37	0.49	0.61	0.75	0.90	1.05	1.21	1.38
	16.0	5-8	6-7	7-4	8-1	8-8	9-4	9-10	10-5	10-11	11-5
		0.16	0.25	0.34	0.45	0.57	0.70	0.83	0.97	1.12	1.28
	19-2	5-2	6-0	6-9	7-4	7-11	8-6	9-0	9-6	9-11	10-5
		0.15	0.22	0.31	0.41	0.52	0.63	0.76	0.89	1.02	1.17
	24.0	4-8	5-4	6-0	6-7	7-1	7-7	8-1	8-6	8-11	9-4
		0.13	0.20	0.28	0.37	0.46	0.57	0.68	0.79	0.92	1.04
2 x 8	12.0	8-8	10-0	11-2	12-3	13-3	14-2	15-0	15-10	16-7	17-4
		0.18	0.28	0.40	0.52	0.66	0.80	0.96	1.12	1.29	1.48
	13.7	8-1	9-4	10-6	11-6	12-5	13-3	14-0	14-10	15-6	16-3
		0.17	0.27	0.37	0.49	0.61	0.75	0.90	1.05	1-21	1.38
	16.0	7-6	8-8	9-8	10-7	11-6	12-3	13-0	13-8	14-4	15-0
		0.16	0.25	0.34	0.45	0.57	0.70	0.83	0.97	1.12	1.28
	19.2	6-10	7-11	8-10	9-8	10-6	11-2	11-10	12-6	13-1	13-8
		0.15	0.22	0.31	0.41	0.52	0.63	0.76	0.89	1.02	1.17
	24.0	6-2	7-1	7-11	8-8	9-4	10-0	10-7	11-2	11-9	12-3
		0.13	0.20	0.28	0.37	0.46	0.57	0.68	0.79	0.92	1.04
2 x 10	12-0	11-1	12-9	14-3	15-8	16-11	18-1	19-2	20-2	21-2	22-1
		0.18	0.28	0.40	0.52	0.66	0.80	0.96	1.12	1.29	1.48
	13.7	10-4	11-11	13-4	14-8	15-10	16-11	17-11	18-11	19-10	20-8
		0.17	0.27	0.37	0.49	0.61	0.75	0.90	1.05	1.21	1.38
	16.0	9-7	11-1	12-4	13-6	14-8	15-8	16-7	17-6	18-4	19-2
		0.16	0.25	0.34	0.45	0.57	0.70	0.83	0.97	1.12	1.28
	19.2	8-9	10-1	11-3	12-4	13-4	14-3	15-2	15-11	16-9	17-6
		0.15	0.22	0.31	0.41	0.52	0.63	0.76	0.89	1.02	1.17
	24.0	7-10	9-0	10-1	11-1	11-11	12-9	13-6	14-3	15-0	15-8
		0.13	0.20	0.28	0.37	0.46	0.57	0.68	0.79	0.92	1.04
2 x 12	12.0	13-5	15-6	17-4	19-0	20-6	21-11	23-3	24-7	25-9	26-11
		0.18	0.28	0.40	0.52	0.66	0.80	0.96	1.12	1.29	1.48
	13.7	12-7	14-6	16-3	17-9	19-3	20-6	21-9	23-0	24-1	25-2
		0.17	0.27	0.37	0.49	0.61	0.75	0.90	1.05	1.21	1.38
	16.0	11-8	13-5	15-0	16-6	17-9	19-0	20-2	21-3	22-4	23-3
		0.16	0.25	0.34	0.45	0.57	0.70	0.83	0.97	1.12	1.28
	19.2	10-8	12-3	13-9	15-0	16-3	17-4	18-5	19-5	20-4	21-3
		0.15	0.22	0.31	0.41	0.52	0.63	0.76	0.89	1.02	1.17
	24.0	9-6	11-0	12-3	13-5	14-6	15-6	16-6	17-4	18-2	19-0
		0.13	0.20	0.28	0.37	0.46	0.57	0.68	0.79	0.92	1.04

For **SI:** 1 inch = 25.4 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot - 0.0479 kN/m^2.

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

TABLE 802.4h—continued

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 AND SIZE	
1300	1400	1500	1600	1700	1800	1900	2000	2100	(inches)	(inches)
13-8 1.66	14-2 1.86	14-8 2.06	15-2 2.27	15-8 2.49					12.0	2 x 6
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	
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	2 x 8
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 1.97	20-4 2.35	18-11 2.55		16-0	
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	2 x 10
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	
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	2 x 12
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	
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	

For **SI:** 1 inch = 25.4 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot - 0.0479 kN/m^2.

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

TABLE 802.4i
ALLOWABLE SPANS 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 AND SPACING		ALLOWABLE EXTREME FIBER STRESS IN BENDING, "F_b" (psi)									
(inches)	(inches)	300	400	500	600	700	800	900	1000	1100	1200
2 x 6	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	10-10 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
2 x 8	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
2 x 10	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
2 x 12	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

For **SI:** 1 inch = 25.4 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot - 0.0479 kN/m^2.

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

TABLE 802.4i—continued

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 AND SIZE	
1300	1400	1500	1600	1700	1800	1900	2000	2100	(inches)	(inches)
12-1 1.71	12-6 1.91	13-0 2.12	13-5 2.34	13-10 2.56					12.0	2 x 6
11-3 1.60	11-9 1.79	12-2 1.98	12-6 2.19	12-11 2.39					13.7	
10-5 1.48	10-10 1.66	11-3 1.84	11-7 2.02	11-11 2.22	12-4 2.41				16.0	
9-6 1.35	9-11 1.51	10-3 1.68	10-7 1.85	10-11 2.02	11-3 2.20	11-6 2.39	11-10 2.58		19.2	
8-6 1.21	8-10 1.35	9-2 1.50	9-6 1.65	9-9 1.81	10-0 1.97	10-4 2.14	10-7 2.31	10-10 2.48	24.0	
15-11 1.71	16-6 1.91	17-1 2.12	17-8 2.34	18-2 2.56					12.0	2 x 8
14-11 1.60	15-5 1.79	16-0 1.98	16-6 2.19	17-0 2.39					13.7	
13-9 1.48	14-4 1.66	14-10 1.84	15-3 2.02	15-9 2.22	16-3 2.41				16-0	
12-7 1.35	13-1 1.51	13-6 1.68	13-11 1.85	14-5 2.02	14-10 2.20	15-2 2.39	15-7 2.58		19.2	
11-3 1.21	11-8 1.35	12-1 1.50	12-6 1.65	12-10 1.81	13-3 1.97	13-7 2.14	13-11 2.31	14-4 2.48	24.0	
20-4 1.71	21-1 1.91	21-10 2.12	22-6 2.34	23-3 2.56					12.0	2 x 10
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	
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	2 x 12
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	
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	

For **SI:** 1 inch = 25.4 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot - 0.0479 kN/m^2.

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

TABLE 802.4j
ALLOWABLE SPANS 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 AND SPACING		ALLOWABLE EXTREME FIBER STRESS IN BENDING, "F_b" (psi)									
(inches)	(inches)	300	400	500	600	700	800	900	1000	1100	1200
2 x 6	12.0	5-3 0.19	6-1 0.29	6-9 0.40	7-5 0.53	8-0 0.67	8-7 0.82	9-1 0.97	9-7 1.14	10-0 1.31	10-6 1.50
	13.7	4-11 0.18	5-8 0.27	6-4 0.38	6-11 0.50	7-6 0.62	8-0 0.76	8-6 0.91	8-11 1.07	9-5 1.23	9-10 1.40
	16.0	4-6 0.16	5-3 0.25	5-10 0.35	6-5 0.46	6-11 0.58	7-5 0.71	7-10 0.84	8-3 0.99	8-8 1.14	9-1 1.30
	19-2	4-2 0.15	4-9 0.23	5-4 0.32	5-10 0.42	6-4 0.53	6-9 0.64	7-2 0.77	7-7 0.90	7-11 1.04	8-3 1.18
	24.0	3-8 0.13	4-3 0.20	4-9 0.28	5-3 0.37	5-8 0.47	6-1 0.58	6-5 0.69	6-9 0.81	7-1 0.93	7-5 1.06
2 x 8	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
2 x 10	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
2 x 12	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

For **SI:** 1 inch = 25.4 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot - 0.0479 kN/m^2.

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

TABLE 802.4j—continued

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 AND SIZE	
1300	1400	1500	1600	1700	1800	1900	2000	2100	(inches)	(inches)
10-11 1.69	11-4 1.89	11-9 2.09	12-1 2.31	12-6 2.53					12.0	2 x 6
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	
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	2 x 8
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	
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	2 x 10
17-2 1.58	17-10 1.77	18-5 1.96	19-1 2.16	19-8 2.36	20-2 2.57				13.7	
15-11 1.46	16-6 1.63	17-1 1.81	17-8 2.00	18-2 2.19	18-9 2.38	19-3 2.58			16.0	
14-6 1.34	15-1 1.49	15-7 1.65	16-1 1.82	16-7 2.00	17-1 2.18	17-7 2.36	18-0 2.55		19.2	
13-0 1.19	13-6 1.33	13-11 1.48	14-5 1.63	14-10 1.79	15-3 1.95	15-8 2.11	16-1 2.28	16-6 2.45	24.0	
22-4 1.69	23-2 1.89	24-0 2.09	24-9 2.31	25-6 2.53					12.0	2 x 12
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	
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	

For **SI:** 1 inch = 25.4 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot = 0.0479 kN/m^2.

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

TABLE 802.4k
ALLOWABLE SPANS 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 AND SPACING		ALLOWABLE EXTREME FIBER STRESS IN BENDING, "F_b" (psi)										
(inches)	(inches)	300	400	500	600	700	800	900	1000	1100	1200	1300
2 x 6	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
2 x 8	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
2 x 10	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
2 x 12	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

For **SI:** 1 inch = 25.4 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot = 0.0479 kN/m^2.

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

TABLE 802.4k—continued

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 AND SIZE	
1400	1500	1600	1700	1800	1900	2000	2100	2200	2400	(inches)	(inches)
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	2 x 6
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 2.13	16-3 2.48			16.0	
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	2 x 8
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	
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	2 x 10
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	
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	2 x 12
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 2.48				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	
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	

For **SI:** 1 inch = 25.4 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot = 0.0479 kN/m^2.

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

TABLE 802.4I
ALLOWABLE SPANS 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 AND SPACING		ALLOWABLE EXTREME FIBER STRESS IN BENDING, "F_b" (psi)										
(inches)	(inches)	300	400	500	600	700	800	900	1000	1100	1200	1300
2 x 6	12.0	6-2	7-1	7-11	8-8	9-5	10-0	10-8	11-3	11-9	12-4	12-10
		0.15	0.23	0.32	0.43	0.54	0.66	0.78	0.92	1.06	1.21	1.36
	13.7	5-9	6-8	7-5	8-2	8-9	9-5	10-0	10-6	11-0	11-6	12-0
		0.14	0.22	0.30	0.40	0.50	0.61	0.73	0.86	0.99	1.13	1.27
	16.0	5-4	6-2	6-11	7-6	8-2	8-8	9-3	9-9	10-2	10-8	11-1
		0.13	0.20	0.28	0.37	0.47	0.57	0.68	0.80	0.92	1.05	1.18
	19.2	4-10	5-7	6-3	6-11	7-5	7-11	8-5	8-11	9-4	9-9	10-1
		0.12	0.18	0.26	0.34	0.43	0.52	0.62	0.73	0.84	0.95	1.08
	24.0	4-4	5-10	5-7	6-2	6-8	7-1	7-6	7-11	8-4	8-8	9-1
		0.11	0.16	0.23	0.30	0.38	0.46	0.55	0.65	0.75	0.85	0.96
2 x 8	12.0	8-1	9-4	10-6	11-6	12-5	13-3	14-0	14-10	15-6	16-3	16-10
		0.15	0.23	0.32	0.43	0.54	0.66	0.78	0.92	1.06	1.21	1.36
	13.7	7-7	8-9	9-9	10-9	11-7	12-5	13-2	13-10	14-6	15-2	15-9
		0.14	0.22	0.30	0.40	0.50	0.61	0.73	0.86	0.99	1.13	1.27
	16.0	7-0	8-1	9-1	9-11	10-9	11-6	12-2	12-10	13-5	14-0	14-7
		0.13	0.20	0.28	0.37	0.47	0.57	0.68	0.80	0.92	1.05	1.18
	19.2	6-5	7-5	8-3	9-1	9-9	10-6	11-1	11-8	12-3	12-10	13-4
		0.12	0.18	0.26	0.34	0.43	0.52	0.62	0.73	0.84	0.95	1.08
	24.0	5-9	6-7	7-5	8-1	8-9	9-4	9-11	10-6	11-0	11-6	11-11
		0.11	0.16	0.23	0.30	0.38	0.46	0.55	0.65	0.75	0.85	0.96
2 x 10	12.0	10-4	11-11	13-4	14-8	15-10	16-11	17-11	18-11	19-10	20-8	21-6
		0.15	0.23	0.32	0.43	0.54	0.66	0.78	0.92	1.06	1.21	1.36
	13.7	9-8	11-2	12-6	13-8	14-9	15-10	16-9	17-8	18-6	19-4	20-2
		0.14	0.22	0.30	0.40	0.50	0.61	0.73	0.86	0.99	1.13	1.27
	16.0	8-11	10-4	11-7	12-8	13-8	14-8	15-6	16-4	17-2	17-11	18-8
		0.13	0.20	0.28	0.37	0.47	0.57	0.68	0.80	0.92	1.05	1.18
	19.2	8-2	9-5	10-7	11-7	12-6	13-4	14-2	14-11	15-8	16-4	17-0
		0.12	0.18	0.26	0.34	0.43	0.52	0.62	0.73	0.84	0.95	1.08
	24.0	7-4	8-5	9-5	10-4	11-2	11-11	12-8	13-4	14-0	14-8	15-3
		0.11	0.16	0.23	0.30	0.38	0.46	0.55	0.65	0.75	0.85	0.96
2 x 12	12.0	12-7	14-6	16-3	17-9	19-3	20-6	21-9	23-0	24-1	25-2	26-2
		0.15	0.23	0.32	0.43	0.54	0.66	0.78	0.92	1.06	1.21	1.36
	13.7	11-9	13-7	15-2	16-8	18-0	19-3	20-5	21-6	22-6	23-6	24-6
		0.14	0.22	0.30	0.40	0.50	0.61	0.73	0.86	0.99	1.13	1.27
	16.0	10-11	12-7	14-1	15-5	16-8	17-9	18-10	19-11	20-10	21-9	22-8
		0.13	0.20	0.28	0.37	0.47	0.57	0.68	0.80	0.92	1.05	1.18
	19.2	9-11	11-6	12-10	14-1	15-2	16-3	17-3	18-2	19-0	19-11	20-8
		0.12	0.18	0.26	0.34	0.43	0.52	0.62	0.73	0.84	0.95	1.08
	24.0	8-11	10-3	11-6	12-7	13-7	14-6	15-5	16-3	17-0	17-9	18-6
		0.11	0.16	0.23	0.30	0.38	0.46	0.55	0.65	0.75	0.85	0.96

For **SI:** 1 inch = 25.4 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot = 0.0479 kN/m^2.

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

TABLE 802.4I—continued

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 AND SIZE	
1400	1500	1600	1700	1800	1900	2000	2100	2200	2400	(inches)	(inches)
13-3	13-9	14-2	14-8	15-1	15-6	15-11				12.0	2 x 6
1.52	1.69	1.86	2.04	2.22	2.41	2.60					
12-5	12-10	13-3	13-8	14-1	14-6	14-10				13.7	
1.42	1.58	1.74	1.90	2.08	2.25	2.43					
11-6	11-11	12-4	12-8	13-1	13-5	13-9	14-1	14-5		16.0	
1.32	1.46	1.61	1.76	1.92	2.08	2.25	2.42	2.60			
10-6	10-10	11-3	11-7	11-11	12-3	12-7	12-10	13-2		19.2	
1.20	1.33	1.47	1.61	1.75	1.90	2.05	2.21	2.37			
9-5	9-9	10-0	10-4	10-8	10-11	11-3	11-6	11-9	12-4	24.0	
1.08	1.19	1.31	1.44	1.57	1.70	1.84	1.98	2.12	2.41		
17-6	18-2	18-9	19-4	19-10	20-5	20-11				12.0	2 x 8
1.52	1.69	1.86	2.04	2.22	2.41	2.60					
16-5	16-11	17-6	18-1	18-7	19-1	19-7				13.7	
1.42	1.58	1.74	1.90	2.08	2.25	2.43					
15-2	15-8	16-3	16-9	17-2	17-8	18-2	18-7	19-0		16-0	
1.32	1.46	1.61	1.76	1.92	2.08	2.25	2.42	2.60			
13-10	14-4	14-10	15-3	15-8	16-2	16-7	16-11	17-4		19.2	
1.20	1.33	1.47	1.61	1.75	1.90	2.05	2.21	2.37			
12-5	12-10	13-3	13-8	14-0	14-5	14-10	15-2	15-6	16-3	24.0	
1.08	1.19	1.31	1.44	1.57	1.70	1.84	1.98	2.12	2.41		
22-4	23-2	23-11	24-7	25-4	26-0	26-8				12.0	2 x 10
1.52	1.69	1.86	2.04	2.22	2.41	2.60					
20-11	21-8	22-4	23-0	23-8	24-4	25-0				13.7	
1.42	1.58	1.74	1.90	2.08	2.25	2.43					
19-4	20-0	20-8	21-4	21-11	22-6	23-2	23-8	24-3		16.0	
1.32	1.46	1.61	1.76	1.92	2.08	2.25	2.42	2.60			
17-8	18-3	18-11	19-6	20-0	20-7	21-1	21-8	22-2		19.2	
1.20	1.33	1.47	1.61	1.75	1.90	2.05	2.21	2.37			
15-10	16-4	16-11	17-5	17-11	18-5	18-11	19-4	19-10	20-8	24.0	
1.08	1.19	1.31	1.44	1.57	1.70	1.84	1.98	2.12	2.41		
27-2	28-2	29-1	29-11	30-10	31-8	32-6				12.0	2 x 12
1.52	1.69	1.86	2.04	2.22	2.41	2.60					
25-5	26-4	27-2	28-0	28-10	29-7	30-5				13.7	
1.42	1.58	1.74	1.90	2.08	2.25	2.43					
23-6	24-4	25-2	25-11	26-8	27-5	28-2	28-10	29-6		16.0	
1.32	1.46	1.61	1.76	1.92	2.08	2.25	2.42	2.60			
21-6	22-3	23-0	23-8	24-4	25-0	25-8	26-4	26-11		19.2	
1.20	1.33	1.47	1.61	1.75	1.90	2.05	2.21	2.37			
19-3	19-11	20-6	21-2	21-9	22-5	23-0	23-6	24-1	25-2	24.0	
1.08	1.19	1.31	1.44	1.57	1.70	1.84	1.98	2.12	2.41		

For **SI:** 1 inch = 25.4 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot = 0.0479 kN/m^2.

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

TABLE 802.4m
ALLOWABLE SPANS 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 AND SPACING		ALLOWABLE EXTREME FIBER STRESS IN BENDING, "F_b" (psi)										
(inches)	(inches)	300	400	500	600	700	800	900	1000	1100	1200	1300
2 x 6	12.0	5-6	6-4	7-1	7-9	8-5	0-0	9-6	10-0	10-6	11-0	11-5
		0.14	0.22	0.31	0.41	0.51	0.63	0.75	0.88	1.01	1.15	1.30
	13.7	5-2	5-11	6-8	7-3	7-10	8-5	8-11	9-5	9-10	10-3	10-9
		0.13	0.21	0.29	0.38	0.48	0.59	0.70	0.82	0.95	1.08	1.22
	16.0	4-9	5-6	6-2	6-9	7-3	7-9	8-3	8-8	9-1	9-6	9-11
		0.12	0.19	0.27	0.35	0.44	0.54	0.65	0.76	0.88	1.00	1.12
	19.2	4-4	5-0	5-7	6-2	6-8	7-1	7-6	7-11	8-4	8-8	9-1
		0.11	0.18	0.24	0.32	0.41	0.50	0.59	0.69	0.80	0.91	1.03
	24.0	3-11	4-6	5-0	5-6	5-11	6-4	6-9	7-1	7-5	7-9	8-1
		0.10	0.16	0.22	0.29	0.36	0.44	0.53	0.62	0.71	0.81	0.92
2 x 8	12.0	7-3	8-4	9-4	10-3	11-1	11-10	12-7	13-3	13-11	14-6	15-1
		0.14	0.22	0.31	0.41	0.51	0.63	0.75	0.88	1.01	1.15	1.30
	13.7	6-9	7-10	8-9	9-7	10-4	11-1	11-9	12-5	13-0	13-7	14-1
		0.13	0.21	0.29	0.38	0.48	0.59	0.70	0.82	0.95	1.08	1.22
	16.0	6-3	7-3	8-1	8-11	9-7	10-3	10-11	11-6	12-0	12-7	13-1
		0.12	0.19	0.27	0.35	0.44	0.54	0.65	0.76	0.88	1.00	1.12
	19.2	5-9	6-7	7-5	8-1	8-9	9-4	9-11	10-6	11-0	11-6	11-11
		0.11	0.18	0.24	0.32	0.41	0.50	0.59	0.69	0.80	0.91	1.03
	24.0	5-2	5-11	6-7	7-3	7-10	8-4	8-11	9-4	9-10	10-3	10-8
		0.10	0.16	0.22	0.29	0.38	0.36	0.53	0.62	0.71	0.81	0.92
2 x 10	12.0	9-3	10-8	11-11	12-1	14-2	15-1	16-0	16-11	17-9	18-6	19-3
		0.14	0.22	0.31	0.41	0.51	0.63	0.75	0.88	1.01	1.15	1.30
	13.7	8-8	10-0	11-2	12-3	13-3	14-2	15-0	15-10	16-7	17-4	18-20
		0.13	0.21	0.29	0.38	0.48	0.59	0.70	0.82	0.95	1.08	1.22
	16.0	8-0	9-3	10-4	11-4	12-3	13-1	13-11	14-8	15-4	16-0	16-
		0.12	0.19	0.27	0.35	0.44	0.54	0.65	0.76	0.88	1.00	1.12
	19.2	7-4	8-5	9-5	10-4	11-2	11-11	12-8	13-4	14-0	14-8	15-3
		0.11	0.18	0.24	0.32	0.41	0.50	0.59	0.69	0.80	0.91	1.03
	24.0	6-6	7-7	8-5	9-3	10-0	10-8	11-4	11-11	12-6	13-1	13-7
		0.10	0.22	0.22	0.29	0.36	0.44	0.53	0.62	0.71	0.81	0.92
2 x 12	12.0	11-3	13-0	14-6	15-11	17-2	18-4	19-6	20-6	21-7	22-6	23-5
		0.14	0.22	0.31	0.41	0.51	0.63	0.75	0.88	1.01	1.15	1.30
	13.7	10-6	12-2	13-7	14-11	16-1	17-2	18-3	19-3	20-2	21-1	21-11
		0.13	0.21	0.29	0.38	0.48	0.59	0.70	0.82	0.95	1.08	1.22
	16.0	9-9	11-3	12-7	13-9	14-11	15-11	16-11	17-9	18-8	19-6	20-3
		0.12	0.19	0.27	0.35	0.44	0.54	0.65	0.76	0.88	1.00	1.12
	19.2	8-11	10-3	11-6	12-7	13-7	14-6	15-5	16-3	17-0	17-9	18-6
		0.11	0.18	0.24	0.32	0.41	0.50	0.59	0.69	0.80	0.91	1.03
	24.0	7-11	9-2	10-3	11-3	12-2	13-0	13-9	14-6	15-3	15-11	16-7
		0.10	0.16	0.22	0.29	0.36	0.44	0.53	0.62	0.71	0.81	0.92

For **SI:** 1 inch = 25.4 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot = 0.0479 kN/m^2.

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

TABLE 802.4m—continued

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 AND SIZE	
1400	1500	1600	1700	1800	1900	2000	2100	2200	2400	(inches)	(inches)
11-11	12-4	12-8	13-1	13-6	13-10	14-2				12.0	2 x 6
1.45	1.61	1.77	1.94	2.12	2.30	2.48					
11-1	11-6	11-11	12-3	12-7	12-11	13-3	13-7			13.7	
1.36	1.51	1.66	1.82	1.98	2.15	2.32	2.49				
10-3	10-8	11-0	11-4	11-8	12-0	12-4	12-7	12-11		16.0	
1.26	1.39	1.54	1.68	1.83	1.99	2.15	2.31	2.48			
9-5	9-9	10-0	10-4	10-8	10-11	11-3	11-6	11-9	12-4	19.2	
1.15	1.27	1.40	1.54	1.67	1.81	1.96	2.11	2.26	2.58		
8-5	8-8	9-0	9-3	9-6	9-9	10-0	10-3	10-6	11-0	24.0	
1.03	1.14	1.25	1.37	1.50	1.62	1.75	1.89	2.02	2.30		
15-8	16-3	16-9	17-3	17-9	18-3	18-9				12.0	2 x 8
1.45	1.61	1.77	1.94	2.12	2.30	2.48					
14-8	15-2	15-8	16-2	16-7	17-1	17-6	17-11			13.7	
1.36	1.51	1.66	1.82	1.98	2.15	2.32	2.49				
13-7	14-0	14-6	14-11	15-5	15-10	16-3	16-7	17-0		16-0	
1.26	1.39	1.54	1.68	1.83	1.99	2.15	2.31	2.48			
12-5	12-10	13-3	13-8	14-0	14-5	14-10	15-2	15-6	16-3	19.2	
1.15	1.27	1.40	1.54	1.67	1.81	1.96	2.11	2.26	2.58		
11-1	11-6	11-10	12-2	12-7	12-11	13-3	13-7	13-11	14-6	24.0	
1.03	1.14	1.25	1.37	1.50	1.62	1.75	1.89	2.02	2.30		
20-0	20-8	21-4	22-0	22-8	23-3	23-11				12.0	2 x 10
1.45	1.61	1.77	1.94	2.12	2.30	2.48					
18-8	19-4	20-0	20-7	21-2	21-9	22-4	22-11			13.7	
1.36	1.51	1.66	1.82	1.98	2.15	2.32	2.49				
17-4	17-11	18-6	19-1	19-7	20-2	20-8	21-2	21-8		16.0	
1.26	1.39	1.54	1.68	1.83	1.99	2.15	2.31	2.48			
15-10	16-4	16-11	17-5	17-11	18-5	18-11	19-4	19-10	20-8	19.2	
1.15	1.27	1.40	1.54	1.67	1.81	1.96	2.11	2.26	2.58		
14-2	14-8	15-1	15-7	16-0	16-6	16-11	17-4	17-9	18-6	24.0	
1.03	1.14	1.25	1.37	1.50	1.62	1.75	1.89	2.02	2.30		
24-4	25-2	26-0	26-9	27-7	28-4	29-1				12.0	2 x 12
1.45	1.61	1.77	1.94	2.12	2.30	2.48					
22-9	23-6	24-4	25-1	25-9	26-6	27-2	27-10			13.7	
1.36	1.51	1.66	1.81	1.98	2.15	2.32	2.49				
21-1	21-9	22-6	23-2	23-10	24-6	25-2	25-9	26-5		16.0	
1.26	1.39	1.54	1.68	1.83	1.99	2.15	2.31	2.48			
19-3	19-11	20-6	21-2	21-9	22-5	23-0	23-6	24-1	25-2	19.2	
1.15	1.27	1.40	1.54	1.67	1.81	1.96	2.11	2.26	2.58		
17-2	17-9	18-4	18-11	19-6	20-0	20-6	21-1	21-7	22-6	24.0	
1.03	1.14	1.25	1.37	1.50	1.62	1.75	1.89	2.02	2.30		

For **SI:** 1 inch = 25.4 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot = 0.0479 kN/m^2.

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

TABLE 802.4n
ALLOWABLE SPANS 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 AND SPACING		ALLOWABLE EXTREME FIBER STRESS IN BENDING, "F_b," (psi)											
(inches)	(inches)	200	300	400	500	600	700	800	900	1000	1100	1200	1300
2 x 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 x 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	10-10 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 0.29	8-1 0-34	8-6 0.40	8-11 0.46	9-4 0.52	9-8 0.59
2 x 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 0.32	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 x 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	11-11 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

(continued)

For **SI:** 1 inch = 25.4 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot - 0.0479 kN/m^2.

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

TABLE 802.4n (*continued*)

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 AND SIZE	
1400	1500	1600	1700	1800	1900	2000	2100	2200	2400	2700	3000	(inches)	(inches)
9-0	9-4	9-8	9-11	10-3	10-6	10-10	11-1	11-4	11-10	12-7		12.0	
0.93	1.03	1.14	1.24	1.36	1.47	1.59	1.71	1.83	2.09	2.49			
8-5	8-9	9-0	9-4	9-7	9-10	10-1	10-4	10-7	11-1	11-9		13.7	
0.87	0.96	1.06	1.16	1.27	1.37	1.48	1.60	1.71	1.95	2.33			
7-10	8-1	8-4	8-7	8-10	9-1	9-4	9-7	9-10	10-3	10-10	11-5	16.0	
0.80	0.98	0.98	1.08	1.17	1.27	1.37	1.48	1.59	1.81	2.16	2.53		2 x 4
7-2	7-5	7-8	7-10	8-1	8-4	8-6	8-9	8-11	9-4	9-11	10-5	19.2	
0.73	0.81	0.90	0.98	1.07	1.16	1.25	1.35	1.45	1.65	1.97	2.31		
6-5	6-7	6-10	7-0	7-3	7-5	7-8	7-10	8-0	8-4	8-10	9-4	24.0	
0.66	0.73	0.80	0.88	0.96	1.04	1.12	1.21	1.29	1.48	1.76	2.06		
14-2	14-8	15-2	15-8	16-1	16-7	17-0	17-5	17-10	18-7	19-9		12.0	
0.93	1.03	1.14	1.24	1.36	1.47	1.59	1.71	1.83	2.09	2.49			
13-3	13-9	14-2	14-8	15-1	15-6	15-11	15-11	16-8	17-5	18-5		13.7	
0.87	0.96	1.06	1.16	1.27	1.37	1.48	1.60	1.71	1.95	2.33			
12-4	12-9	13-2	13-3	13-11	14-4	14-8	15-1	15-5	16-1	17-1	18-0	16.0	
0.80	0.89	0.98	1.08	1.17	1.27	1.37	1.48	1.59	1.81	2.16	2.53		2 x 6
11-3	11-7	12-0	12-4	12-9	13-1	13-5	13-9	14-1	14-8	15-7	16-5	19.2	
0.73	0.81	0.90	0.98	1.07	1.16	1.25	1.35	1.45	1.65	1.97	2.31		
10-0	10-5	10-9	11-1	11-5	11-8	12-0	12-4	12-7	13-2	13-11	14-8	24.0	
0.66	0.73	0.80	0.88	0.96	1.04	1.12	1.21	1.29	1.48	1.76	2.06		
18-9	19-5	20-0	21-8	21-3	21-10	22-4	22-11	23-6	24-6	26-0			
0.93	1.03	1.14	1.24	1.36	1.47	1.59	1.71	1.83	2.09	2.49			
117-6	18-2	18-9	19-4	19-10	20-5	20-11	21-5	21-11	22-11	24-4		13.7	
0.87	0.96	1.06	1.16	1.27	1.37	1.48	1.60	1.71	1.95	2-33			
16-3	16-9	17-4	17-10	18-5	18-11	19-5	19-10	20-4	21-3	22-6	23-9		
0.80	0.89	0.98	1.08	1.17	1.27	1.37	1.48	1.59	1.81	2.16	2.53		2 x 8
14-10	15-4	15-10	16-4	16-9	17-3	17-8	18-2	18-7	19-5	20-7	21-8	19.2	
0.73	0.81	0.90	0.98	1.07	1.16	1.25	1.35	1.45	1.65	1.97	2.31		
13-3	13-8	14-2	14-7	15-0	15-5	15-10	16-3	16-7	17-4	18-5	19-5	24.0	
0.66	0.73	0.80	0.88	0.96	1.04	1.12	1.21	1.29	1.48	1.76	2.06		
23-11	24-9	25-6	26-4	27-1	27-10	28-7	29-3	29-11	31-3	33-2		12.0	
0.93	1.03	1.14	1.24	1.36	1.47	1.59	1.71	1.83	2.09	2.49			
22-4	23-2	23-11	24-7	25-4	26-0	26-8	27-4	28-0	29-3	31-0		13.7	
0.87	0.96	1.06	1.16	1.27	1.37	1.48	1.60	1.71	1.95	2.33			
20-8	21-5	22-1	22-10	23-5	24-1	24-9	25-4	25-11	27-1	28-9	30-3	16.0	
0.80	0.89	0.98	1.08	1.17	1.27	1.37	1.48	1.59	1.81	2.16	2.53		2 x 10
18-11	19-7	20-2	20-10	21-5	22-0	22-7	23-2	23-8	24-9	26-3	27-8	19.2	
0.73	0.81	0.90	0.98	1.07	1.16	1.25	1.35	1.45	1.65	1.97	2.31		
16-11	17-6	18-1	18-7	19-2	19-8	20-2	20-8	21-2	22-1	23-5	24-9	24.0	
0.66	0.73	0.80	0.88	0.96	1.04	1.12	1.21	1.29	1.48	1.76	2.06		

For **SI:** 1 inch = 25.4 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot = 0.0479 kN/m^2.

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

TABLE 802.4o
ALLOWABLE SPANS 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 AND SPACING		ALLOWABLE EXTREME FIBER STRESS IN BENDING, "F_b," (psi)											
(inches)	(inches)	200	300	400	500	600	700	800	900	1000	1100	1200	1300
2 x 4	12.0	3-0	3-8	4-3	4-9	5-3	5-8	6-0	6-5	6-9	7-1	7-7	7-8
		0.05	0.09	0.15	0.20	0.27	0.34	0.41	0-49	0.58	0.67	0.76	0.86
	13.7	2-10	3-5	4-0	4-5	4-11	5-3	5-8	6-0	6-4	6-7	6-11	7-2
		0.05	0.09	0.14	0.19	0.25	0.32	0.39	0-46	0.54	0.62	0.71	0.80
	16.0	2-7	3-2	3-8	4-1	4-6	4-11	5-3	5-6	5-10	6-1	6-5	6-8
		0.04	0.08	0.13	0.18	0.23	0.29	0.36	0-43	0.50	0.58	0.66	0.74
	19.2	2-5	2-11	3-4	3-9	4-1	4-5	4-9	5-1	5-4	5-7	6-10	6-1
		0.04	0.08	0.12	0.16	0.21	0.27	0.29	0-35	0.41	0.47	0.54	0.61
	24.0	2-2	2-7	3-0	3-4	3-8	4-0	4-3	4-6	4-9	5-0	5-3	5-5
		0.04	0.07	0.10	0.14	0.19	0.24	0.29	0-35	0.41	0.47	0.54	0.61
2 x 6	12.0	4-9	5-10	6-8	7-6	8-2	8-10	9-6	10-0	10-7	11-1	11-7	12-1
		0.05	0.09	0.15	0.20	0.27	0.34	0.41	0-49	0.58	0.67	0.76	0.86
	13.7	4-5	5-5	6-3	7-0	7-8	8-3	8-10	9-5	9-11	10-5	10-10	11-3
		0.05	0.09	0.14	0.19	0.25	0.32	0.39	0-46	0.54	0.62	0.71	0.80
	16.0	4-1	5-0	5-10	6-6	7-1	7-8	8-2	8-8	9-2	9-7	10-0	10-5
		0.04	0.08	0.13	0.18	0.23	0.29	0.36	0-43	0.50	0.58	0.66	0.74
	19.2	3-9	4-7	5-4	5-11	6-6	7-0	7-6	7-11	8-4	8-9	9-2	9-6
		0.04	0.08	0.12	0.16	0.21	0.27	0.33	0-39	0.46	0.53	0.60	0.68
	24.0	3-4	4-1	4-9	5-4	5-10	6-3	6-8	7-1	7-6	7-10	8-2	8-6
		0.04	0.07	0.10	0.14	0.19	0.24	0.29	0-35	0.41	0.47	0.54	0.61
2 x 8	12.0	6-3	7-8	8-10	9-10	10-10	11-8	12-6	13-3	13-11	14-8	15-3	15-11
		0.05	0.09	0.15	0.20	0.27	0.34	0.41	0-49	0.58	0.67	0.76	0.86
	13.7	5-10	7-2	8-3	9-3	10-1	10-11	11-8	12-5	13-1	13-8	14-4	14-11
		0.05	0.09	0.14	0.19	0.25	0.32	0.39	0-46	0.54	0.62	0.71	0.80
	16.0	5-5	6-7	7-8	8-7	9-4	10-1	10-10	11-6	12-1	12-8	13-3	13-9
		0.04	0.08	0.13	0.18	0.23	0.29	0.36	0-43	0.50	0.58	0.66	0.74
	19.2	4-11	6-1	7-0	7-10	8-7	9-3	9-10	10-6	11-0	11-7	12-1	12-7
		0.04	0.08	0.13	0.18	0.23	0.29	0.36	0-43	0.50	0.58	0.66	0.74
	24.0	4-5	5-5	6-3	7-0	7-8	8-3	8-10	9-4	9-10	10-4	10-10	11-3
		0.04	0.07	0.10	0.14	0.19	0.24	0.29	0-35	0.41	0.47	0.54	0.61
2 x 10	12.0	8-0	9-9	11-3	12-7	13-9	14-11	15-11	16-11	17-10	18-8	19-6	20-41
		0.05	0.09	0.15	0.20	0.27	0.34	0.41	0-49	0.58	0.67	0.76	0.86
	13.7	7-5	9-1	10-6	11-9	12-11	13-11	14-11	15-10	16-8	17-6	18-3	19-0
		0.05	0.09	0.14	0.19	0.25	0.32	0.39	0-46	0.54	0.62	0.71	0.80
	16.0	6-11	8-5	9-9	10-11	11-11	12-11	13-9	14-8	15-5	16-2	16-11	17-7
		0.04	0.08	0.13	0.18	0.23	0.29	0.36	0-43	0.50	0.58	0.66	0.74
	19.2	6-4	7-8	8-11	9-11	10-11	11-9	12-7	13-4	14-1	14-9	15-5	16-1
		0.04	0.08	0.12	0.16	0.21	0.27	0.33	0-39	0.46	0.53	0.60	0.68
	24.0	5-8	6-11	8-0	8-11	9-9	10-6	11-3	11-11	12-7	13-2	13-9	14-4
		0.04	0.07	0.10	0.14	0.19	0.24	0.29	0-35	0.41	0.47	0.54	0.61

(continued)

For **SI:** 1 inch = 25.4 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot - 0.0479 kN/m^2.

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

TABLE 802.4o—continued

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 AND SIZE	
1400	1500	1600	1700	1800	1900	2000	2100	2200	2400	2700	3000	(inches)	(inches)
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	2 x 4
7-5 0.89	7.9 0.99	8-0 1.09	8-3 1.20	8-5 1.30	8-8 1.41	8-11 1.53	9-2 1.64	9-4 1.76	9-9 2.01	10-4 2.40		13.7	
6-11 0.83	7-2 0.92	7-5 1.01	7-7 1.11	7-10 1.21	8.0 1.31	8-3 1.41	8-5 1.52	8-8 1.63	9-0 1.86	9-7 2.22	10-1 2.60	16.0	
6-4 0.76	6-6 0.84	6-9 0.92	6-11 1.01	7-2 1.10	7-4 120	7-6 1.29	7-9 1.39	7-11 1.49	8-3 1.70	8-9 2.03		19.2	
508 0.68	5-10 0.75	6-0 0.83	6-3 0.90	6-5 0.99	6-7 107	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	2 x 6
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	12-81 1.31	13-0 1.41	13-3 1.52	13-7 1.63	14-2 1.86	15-1 2.22	15-11 2.60	16.0	
9-11 0.76	10-3 0.84	10-7 0.92	10-11 1.01	11-3 1.10	11-6 1.20	11010 1.29	12-2 1.39	12-5 1.49	13-0 1.70	13-9 2.03	14-16 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	17-8 1.17	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	2-17 2.15	22-11 2.56		12.0	2 x 8
15-5 0.89	16-0 0.99	16-6 1.09	17-0 1.20	17-6 1.30	18-0 1.41	18-5 1.53	18-11 1.64	19.4 1.76	20-3 2.01	21-5 2.40		13.7	
14-4 0.83	14-10 0.92	15-3 1.01	15-9 1.11	16.3 1.21	16-8 1.31	17-1 1.41	17-6 1.52	17-11 1.63	18-9 1.86	19-10 2.22	20-11 2.60	16.0	
13-1 0.76	13-6 0.84	13-11 0.92	14-5 1.01	14-10 1.10	15-2 1.20	15-7 1.29	16-0 1.39	16-4 1.49	17-1 1.70	18-2 2.03	19-1 2.37	19.2	
11-8 0.68	12-1 0.75	12-6 0.83	12-10 0.90	13-3 0.99	13-7 107	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	2 x 10
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 1.1	21-10 1.41	22-4 1.52	22-10 1.63	23-11 1.86	25-4 2.22	26-8 2.60	16.0	
16-8 0.76	17-3 0.84	17-10 0.92	18-4 1.01	18-11 1.10	19-5 1.20	19-11 1.29	20-5 1.39	20-10 1.49	21-10 1.70	23-2 2.03	24-5 2.37	19.2	
14-11 0.68	15-5 0.75	15-11 0.83	16-5 0.90	16-11 0.99	127-4 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	

For **SI:** 1 inch = 25.4 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot = 0.0479 kN/m^2.

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

TABLE 802.4p
ALLOWABLE SPANS 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 AND SPACING		ALLOWABLE EXTREME FIBER STRESS IN BENDING, "F_b," (psi)											
(inches)	(inches)	200	300	400	500	600	700	800	900	1000	1100	1200	1300
2 x 4	12.0	2-9	3-4	3-10	4-4	4-9	5-1	5-5	5-9	6-1	6-5	6-8	6-11
		0.05	0.09	0.14	0.20	0.26	0.33	0.41	0.49	0.57	0.66	0.75	0.84
	13.7	2-7	3-1	3-7	4-0	4-5	4-9	5-1	5-5	5-8	6-0	6-3	6-6
		0.05	0.09	0.13	0.19	0.25	0.31	0.38	0.46	0.53	0.61	0.70	0.79
	16.0	2-4	2-11	3-4	3-9	4-1	4-5	4-9	5-0	5-3	5-6	5-9	6-0
		0.04	0.08	0.12	0.17	0.23	0.29	0.35	0.42	0.49	0.57	0.65	0.73
	19.2	2-2	2-8	3-1	3-5	3-9	4-0	4-4	4-7	4-10	5-1	5-3	5-6
		0.04	0.07	0.11	0.16	0.21	0.26	0.32	0.38	0.45	0.52	0.59	0.67
	24.0	1-11	2-4	2-9	3-1	3-4	3-7	3-10	4-1	4-4	4-6	4-9	4-11
		0.04	0.07	0.10	0.14	0.19	0.24	0.29	0.34	0.40	0.46	0.53	0.60
2 x 6	12.0	4-3	5-3	6-1	6-9	7-5	8-0	8-7	9-1	9-7	10-0	10-6	10-11
		0.05	0.09	0.14	0.20	0.26	0.33	0.41	0.49	0.57	0.66	0.75	0.84
	13.7	4-0	4-11	5-8	6-4	6-11	7-6	8-0	8-6	8-11	9-5	9-10	10-3
		0.05	0.09	0.13	0.19	0.25	0.31	0.38	0.46	0.53	0.61	0.70	0.79
	16.0	3-8	4-6	5-3	5-10	6-5	6-11	7-5	7-10	8-3	8-8	9-1	9-5
		0.04	0.08	0.12	0.17	0.23	0.29	0.35	0.42	0.49	0.57	0.65	0.73
	19.2	3-5	4-2	4-9	5-4	5-10	6-4	6-9	7-2	7-7	7-11	8-3	8-8
		0.04	0.07	0.11	0.16	0.21	0.26	0.32	0-38	0.45	0.52	0.59	0.67
	24.0	3-0	3-8	4-3	4-9	5-3	5-8	6-1	6-5	6-9	7-1	7-5	7-9
		0.04	0.07	0.10	0.14	0.19	0.24	0.29	0-34	0.40	0.4	0.53	0.60
2 x 8	12.0	5-8	6-11	8-10	8-11	9-9	10-7	11-3	12-0	12-7	13-8	13-10	14-5
		0.05	0.09	0.14	0.20	0.26	0.33	0.41	0.49	0.57	0.66	0.75	0.84
	13.7	5-3	6-6	7-6	8-4	9-2	9-11	10-7	11-2	11-10	12-5	12-11	13-6
		0.05	0.09	0.13	0.19	0.25	0.3	0.28	0.46	0.53	0.61	0.70	0.79
	16.0	4-11	6-0	6-11	7-9	8-6	9-2	9-9	10-4	10-11	11-6	12-0	12-6
		0.04	0.08	0.12	0.17	0.23	0.29	0.35	0.42	0.49	0.57	0.65	0.73
	19.2	4-6	5-6	6-4	7-1	7-9	8-4	8-11	9-6	10-0	10-6	10-11	11-5
		0.04	0.07	0.11	0.16	0.21	0.26	0.32	0.38	0.45	0.52	0.59	0.67
	24.0	4-0	4-11	5-8	6-4	6-11	7-6	8-0	8-6	8-11	9-4	9-9	10-2
		0.04	0.07	0.10	0.14	0.19	0.24	0.29	0.34	0.40	0.46	0.53	0.60
2 x 10	12.0	7-2	8-10	10-2	11-5	12-6	13-6	14-5	15-3	16-1	16-11	17-8	18-4
		0.05	0.09	0.14	0.20	0.26	0.33	0.41	0.49	0.57	0.66	0.75	0.84
	13.7	6-9	8-3	9-6	10-8	11-8	12-7	13-6	14-3	15-1	15-10	16-6	17-2
		0.05	0.09	0.13	0.19	0.25	0.31	0.38	0.46	0.53	0.61	0.70	0.79
	16.0	6-3	7-8	8-10	9-10	10-10	11-8	12-6	13-3	13-11	14-8	15-3	15-11
		0.04	0.08	0.12	0.17	0.23	0.29	0.35	0.42	0.49	0.57	0.65	0.73
	19.2	5-8	7-0	8-1	9-0	9-10	10-8	11-5	12-1	12-9	13-4	13-11	14-6
		0.04	0.07	0.11	0.16	0.21	0.26	0.32	0.38	0.45	0.52	0.59	0.67
	24.0	5-1	6-3	7-2	8-1	8-10	9-6	10-2	10-10	11-5	11-11	12-6	13-0
		0.04	0.07	0.10	0.14	0.19	0.24	0.29	0.34	0.40	0.46	0.53	0.60

(continued)

For **SI:** 1 inch = 25.4 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot - 0.0479 kN/m^2.

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

TABLE 802.4p (*continued*)

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 AND SIZE	
1400	1500	1600	1700	1800	1900	2000	2100	2200	2400	2700	3000	(inches)	(inches)
7-3	7-6	7-8	7-11	8-2	8-5	8-7	8-10	9-0	9.5	10-0		12.0	2 x 4
0.94	1.05	1.15	1.26	1.38	1.49	1.61	1.73	1.86	2.12	2.53			
6-9	7.0	7-3	7-5	7-8	7-10	8-1	8-3	8-5	8-10	9-4		13.7	
0.88	0.98	1.08	1.18	1.29	1.40	1.51	1.62	1.74	1.98	2.36			
6-3	6-6	6-8	6-11	7-1	7-3	7-6	7-8	7-10	8-2	8-8	9-2	16.0	
0.82	0.91	1.00	1.09	1.19	1.29	1.40	1.50	1.61	1.83	2.19	2.56		
5-8	5-11	6-1	6-3	6-6	6-8	6-10	7-0	7-2	7-6	7-11	8-4	19.2	
0.75	0.83	0.91	1.00	1.09	1.18	1.27	1.37	1.47	1.67	2.00	2.34		
5-1	5-3	5-5	5-7	5-9	5-11	6-1	6-3	6-5	6-8	7-1	7-6	24.0	
0.67	0.74	0.82	0.89	0.97	1.06	1.14	1.23	1.31	1.50	1.79	2.09		
11-4	11-9	12-1	12-6	12-10	13-2	13-6	13-10	14-2	14-10	15-9		12.0	2 x 6
0.94	1.05	1.15	1.26	1.38	1.49	1.61	1.73	1.86	2.12	2.53			
10-7	11-0	11-4	11-8	12-0	12-4	12-8	13-0	13-3	13-10	14-9		13.7	
0.88	0.98	1.08	1.18	1.29	1.40	1.51	1.62	1.74	1.98	2.36			
9-10	10-2	10-6	10-10	11-1	11-5	11-9	12-0	12-4	12-10	13-7	14-4	16.0	
0.82	0.91	1.00	1.09	1.19	1.29	1.40	1.50	1.61	1.83	2.19	2.56		
8-11	9-3	9-7	9-10	10-2	10-5	10-8	11-3	12-5	11-9	12-5	13-1	19.2	
0.75	0.83	0.91	1.00	1.09	1.18	1.37	1.39	1.47	1.67	2.00	2.34		
8-0	8-3	8-7	8-10	9-1	9-4	9-7	9-10	10-0	10-6	11-1	11-9	24.0	
0.67	0.74	0.82	0.89	0.97	1.06	1.14	1.23	1.31	1.50	1.79	2.09		
14-11	15-5	16-0	16-5	16-11	17-5	17-10	18-3	18-9	19-7	20-9		12.0	2 x 8
0.94	1.05	1.15	1.26	1.38	1.49	1.61	1.73	1.86	2.12	2.53			
14-0	14-6	14-11	15-5	15-10	16-3	16-8	17-1	17-6	18-3	19-5		13.7	
0.88	1.08	1.08	1.18	1.29	1.40	1.51	1.62	1.74	1.98	2.36			
12-11	13-5	13-10	14-3	14-8	15-1	15-5	15-10	16-3	16-11	18-0	18-11	16.0	
0.82	0.91	1.00	1.09	1.19	1.29	1.40	1.50	1.61	1.83	2.19	2.56		
11-10	12-3	12-7	13-0	13-5	13-9	14-1	14-6	14-10	15-5	16-5	17-3	19.2	
0.75	0.83	0.91	1.00	1.09	1.18	1.27	1.37	1.47	1.67	2.00	2.34		
10-7	10-11	11-3	11-8	12-0	12-4	12-7	12-11	13-3	13-10	14-8	15-5	24.0	
0.67	0.74	0.82	0.89	0.97	1.06	1.14	1.23	1.31	1.50	1.79	2.09		
19-1	19-9	20-4	21-0	21-7	22-2	22-9	23-4	23-11	24-11	26-6		12.0	2 x 10
0.94	1.05	1.15	1.26	1.38	1.49	1.61	1.73	1.86	2.12	2.53			
17-10	18-5	19-1	19-8	20-2	20-9	21-4	21-10	22-4	23-4	24-9		13.7	
0.88	0.98	1.08	1.18	1.29	1.40	1.51	1.62	1.74	1.98	2.36			
16-6	17-1	17-8	18-2	18-9	19-3	19-9	20-2	20-8	21-7	22-11	24-2	16.0	
0.82	0.91	1.00	1.09	1.19	1.29	1.40	1.50	1.61	1.83	2.19	2.56		
15-1	15-7	16-1	16-7	17-1	17-7	18-0	18-5	18-11	19-9	20-11	22-1	19.2	
0.75	0.83	0.91	1.00	1.09	1.18	1.27	1.37	1.47	1.67	2.00	2.34		
13-6	13-11	14-5	14-10	15-3	15-8	16-1	16-6	16-11	17-8	18-9	19.9	24.0	
0.67	0.74	0.82	0.89	0.97	1.06	1.14	1.23	1.31	1.50	1.79	2.09		

For **SI:** 1 inch = 25.4 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot = 0.0479 kN/m^2.

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

TABLE 802.4q
ALLOWABLE SPANS 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 AND SPACING		ALLOWABLE EXTREME FIBER STRESS IN BENDING, "F_b," (psi)											
(inches)	(inches)	200	300	400	500	600	700	800	900	1000	1100	1200	1300
2 x 4	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	3-9 011	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
2 x 6	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
2 x 8	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
2 x 10	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	19-3 0.55	20.5 0.66	21-6 0.77	22-7 0.89	23-7 1.02	24-6 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

(continued)

For **SI:** 1 inch = 25.4 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot - 0.0479 kN/m^2.

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

TABLE 802.4q *(continued)*

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 AND SIZE	
1400	1500	1600	1700	1800	1900	2000	2100	2200	2400	2700	(inches)	(inches)
10-3	10-8	11-0	11-4	11-8	12-0	12-4	12-7				12.0	2 x 4
1.37	1.52	1.68	1.84	1.82	2.17	2.34	2.52					
9-7	10.0	10-3	10-7	10-11	11-3	11-6	11-9	12-1			13.7	
1.28	1.42	1.37	1.72	1.87	2.03	2.19	2.36	2.53				
8-11	9-3	9-6	9-10	10-1	10-5	10-8	10-11	11-2			16.0	
1.19	1.32	1.45	1.59	1.73	1.88	2.03	2.18	2.34				
8-2	8-5	8-8	9-0	9-3	9-6	9-9	10-0	10-2	10-8		19.2	
1.08	1.20	1.33	1.45	1.58	1.71	1.85	1.99	2.14	2.43			
7-3	7-6	7-9	8-0	8-3	8-6	8-8	8-11	19-1	9-6	10-1	24.0	
0.97	1.08	1.19	1.30	1.41	1.53	1.56	1.78	1.91	2.18	2.60		
16-2	16-9	17-3	17-10	18-4	18-10	19-4	19-10				12.0	2 x 6
1.37	1.52	1.68	1.84	2.00	2.17	2.34	2.52					
15-1	15-8	16-2	16-8	17-2	17-7	18-1	18-6	19-0			13.7	
1.28	1.42	1.57	1.72	1.87	2.03	2.19	2.36	2.53				
14-0	14-6	15-0	15-5	15-11	16-4	16-9	17-2	17-7			16-0	
1.19	1.32	1.45	1.59	1.73	1.88	2.03	2.18	2.34				
12-9	13-3	13-8	14-1	14-6	14-11	15-3	15-8	16-0	16-9		19.2	
1.08	1.20	1.33	1.45	1.58	1.71	1.85	1.99	2.14	2.43			
11-5	11-10	12-3	12-7	13-0	13-4	13-8	14-0	14-4	15-0	15-11	24.0	
0.97	1.08	1.19	1.30	1.41	1.53	1.66	1.78	1.91	2.18	2.60		
21-4	22-1	22-9	23-3	23-6	24-2	24-10	25-6	26-1			12.0	2 x 8
1.37	1.52	1.68	1.71	1.84	2.00	2.17	2.34	2.52				
19-11	20-8	21-4	22-0	22-7	23-31	23-10	24-5	25-0			13.7	
1.28	1.42	1.57	1.72	1.87	2.03	2.19	2.36	2.53				
18-5	19-1	19-9	20-4	20-11	21-6	22-1	22-7	23-2			16.0	
1.19	1.32	1.45	1.59	1.73	1.88	2.03	2.18	2.34				
16-10	17-5	18-0	18-7	19-11	19-8	20-2	20-8	21-1	22-1		19.2	
1.08	1.20	1.33	1.45	1.58	1.71	1.85	1.99	2.14	2.43			
15-1	15-7	16-1	16-7	17-1	17-7	18-0	18-5	18-11	19-9	20-11	24.0	
0.97	1.08	1.19	1.30	1.41	1.53	1.66	1.78	1.91	2.18	2.60		
27-2	28-2	29-1	30-0	30-10	31-8	32-6	33-4				12.0	2 x 10
1.37	1.52	1.68	1.84	2.00	2.17	2.34	2.52					
25-5	26-4	27-2	28-0	28-10	29-8	30-5	31-2	31-11			13.7	
1.28	1.42	1.57	1.72	1.87	2.03	2.19	2.36	2.53				
23-7	24-5	25-2	25-11	26-8	27-5	28-2	28-10	29-6			16.0	
1.19	1.32	1.45	1.59	1.73	1.88	2.03	2.18	2.34				
21-6	22-3	23-0	23-8	24-5	25-1	25-8	26-4	26-11	28-2		19.2	
1.01	1.20	1.33	1.45	1.58	1.71	1.85	1.99	2.14	2.43			
19-3	19-11	20-7	21-2	21-10	22-5	23-0	23-7	24-1	25-2	26-8	24.0	
0.97	1.08	1.19	1.30	1.41	1.53	1.66	1.78	1.91	2.18	2.60		

For **SI:** 1 inch = 25.4 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot - 0.0479 kN/m^2.

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

TABLE 802.4r
ALLOWABLE SPANS 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 AND SPACING		ALLOWABLE EXTREME FIBER STRESS IN BENDING, "F_b," (psi)											
(inches)	(inches)	200	300	400	500	600	700	800	900	1000	1100	1200	1300
2 x 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	3-3 010	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 x 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 1.01	13-4 1.15
	13.7	4-11 0.07	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 1.95	12-5 1.07
	16.0	4-6 0.06	5-6 0.11	6-5 0.17	7-4 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 x 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 0.44	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	1-8 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	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
2 x 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 0.06	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

(continued)

For **SI:** 1 inch = 25.4 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot - 0.0479 kN/m^2.

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

TABLE 802.4r *(continued)*

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 AND SIZE	
1400	1500	1600	1700	1800	1900	2000	2100	2200	2400	2700	(inches)	(inches)
8-9	9-1	9-5	9-8	10-0	10-3	10-6	10-9	11-0			12.0	2 x 4
1.28	1.42	1.57	1.72	1.87	2.03	2.19	2.36	2.53				
8-3	8-6	8-9	9-1	9-4	9-7	9-10	10-1	10-4			13.7	
1.20	1.33	1.47	1.61	1.75	1.90	2.05	2.20	2.36				
7-7	7-11	8-2	8-45	8-8	8-10	9-1	9-4	9-17	10-0		16.0	
1.11	1.23	1.36	1.49	1.62	1.76	1.90	2.04	2.19	2.49			
6-11	7-2	7-5	7-8	7-11	8-1	8-4	8-6	8-9	9-1		19.2	
1.01	1.12	1.24	1.36	1.48	1.60	1.73	1.86	2.00	2.28			
6-3	6-5	6-8	6-10	7-1	7-3	7-5	7-7	7-9	8-2	8-8	24.0	
0.91	1.01	1.11	1.21	1.32	1.43	1.55	1.67	1.79	2.04	2.43		
13-10	14-4	14-9	15-3	15-8	16-1	16-6	16-11	17-4			12.0	2 x 6
1.28	1.42	1.57	1.72	1.87	2.03	2.19	2.36	2.53				
12-11	13-4	13-10	14-3	14-8	15-1	15-5	15-10	16-2			13.7	
1.20	1.33	1.47	1.61	1.75	1.90	2.05	2.20	2.36				
12-0	12-5	12-9	13-2	13-7	13-11	14-4	14-8	15-0	15-8		16-0	
1.11	1.23	1.36	1.49	1.62	1.76	1.90	2.04	2.19	2.49			
10-11	11-4	11-8	12-0	12-5	12-9	13-1	13-4	13-8	14-4		19.2	
1.01	1.12	1.24	1.36	1.48	1.60	1.73	1.86	2.00	2.28			
9-9	10-1	10-5	10-9	11-1	11-5	11-8	12-0	12-3	12-9	13-7	24.0	
0.91	1.01	1.11	1.21	1.32	1.43	1.55	1.67	1.79	2.04	2.43		
18-2	18-10	19-6	20-1	20-8	21-3	21-9	22-4	22-10			12.0	2 x 8
1.28	1.42	1.57	1.72	1.87	2.03	2.19	2.36	2.53				
17-0	17-8	18-2	18-9	19-4	19-10	20-4	20-10	21-4			13.7	
1.20	1.33	1.47	1.61	1.75	1.90	2.05	2.20	2.36				
15-9	16-4	16-10	7-4	17-11	18-4	18-10	19-4	19-9	20-8		16.0	
1.11	1.23	1.36	1.29	1.62	1.76	1.90	2.04	2.19	2.49			
14-5	14-11	15-5	15-10	16-4	16-9	17-2	17-8	18-1	18-10		19.2	
1.01	1.12	1.24	1.36	1.48	1.60	1.73	1.86	2.00	2.28			
12-10	13-4	13-9	14-2	14-7	15-0	15-5	15-9	16-2	16-10	17-11	24.0	
0.91	1.01	1.11	1.21	1.32	1.43	1.55	1.67	1.79	2.04	2.43		
23-3	24-1	24-10	25-7	26-4	27-1	27-9	28-5	29-1			12.0	2 x 10
1.28	1.42	1.57	1.72	1.87	2.03	2.19	2.36	2.53				
21-9	22-6	23-3	23-11	24-8	25-4	26-0	26-7	27-3			13.7	
1.20	1.33	1.47	1.61	1.75	1.90	2.05	2.20	2.36				
20-1	20-10	21-6	22-2	22-10	23-5	24-1	24-8	25-3			16.0	
1.22	1.35	1.49	1.63	1.78	1.93	2.08	2.24	2.40				
18-4	19-0	19-8	20-3	20-10	21-5	21-11	22-6	23-0	24-1		19.2	
1.01	1.12	1.24	1.36	1.48	1.60	1.73	1.86	2.00	2.28			
16-5	17-0	17-7	18-1	18-7	19-2	19-8	20-1	20-7	21-6	22-10	24.0	
0.91	1.01	1.11	1.21	1.32	1.43	1.55	1.67	1.79	2.04	2.43		

For **SI:** 1 inch = 25.4 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot - 0.0479 kN/m^2.

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

TABLE 802.4s
ALLOWABLE SPANS 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 ftlive 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 AND SPACING		ALLOWABLE EXTREME FIBER STRESS IN BENDING, "F_b," (psi)											
(inches)	(inches)	200	300	400	500	600	700	800	900	1000	1100	1200	1300
2 x 4	12.0	2-11	3-7	4-2	4-8	5-1	5-6	5-11	6-3	6-7	6-11	7-3	7-6
		0.06	0.12	0.18	0.25	0.34	0.42	0.52	0-62	0.72	0.83	0.95	1.07
	13.7	2-9	3-5	3-11	4-4	4-9	5-2	5-6	5-10	6-2	6-6	6-9	7-0
		0.06	0.11	0.17	0.24	0.31	0.40	0.48	0.58	0.67	0.78	0.89	1.00
	16.0	2-7	3-2	3-7	4-0	4-5	4-9	5-1	5-5	5-8	6-0	6-3	6-6
		0.06	0.10	0.16	0.22	0.29	0.37	0.45	0.53	0.62	0.72	0.82	0.93
	19.2	2-4	2-10	3-4	3-8	4-0	4-4	4-8	4-11	5-3	5-6	5-8	5-11
		0.05	0.09	0.14	0.20	0.26	0.33	0.41	0.49	0.57	0.66	0.75	0.85
	24.0	2-1	2-7	2-11	3-4	3-7	3-11	4-2	4-5	4-8	4-11	5-1	5-4
		0.05	0.08	0.13	0.18	0.24	0.30	0.36	0.44	0.51	0.59	0.67	0.76
2 x 6	12.0	4-8	5-8	6-7	7-4	8-0	8-8	9-3	9-10	10-4	10-10	11-4	11-10
		0.06	0.12	0.18	0.25	0.34	0.42	0.52	0.62	0.72	0.83	1.95	1.07
	13.7	4-4	5-4	6-2	6-10	7-6	8-1	8-8	9-2	9-8	10-2	10-7	11-1
		0.06	0.11	0.17	0.24	0.31	0.40	0.48	0.58	0.67	0.78	0.89	1.00
	16.0	4-0	4-11	5-8	6-4	6-11	7-6	8-0	8-6	9-0	9-5	9-10	10-3
		0.06	0.10	0.16	0.22	0.29	0.37	0.45	0.53	0.62	0.72	0.82	0.93
	19.2	3-8	4-6	5-2	5-9	6-4	6-10	7-4	7-9	8-2	8-7	9-0	9-4
		0.05	0.09	0.14	0.20	0.26	0.33	0.41	0.49	0.57	0.66	0.75	0.85
	24.0	3-3	4-0	4-8	5-2	5-8	6-2	6-7	6-11	7-4	7-8	8-0	8-4
		0.05	0.08	0.13	0.18	0.24	0.30	0.36	0.44	0.51	0.59	0.67	0.76
2 x 8	12.0	6-1	7-6	8-8	9-8	10-7	11-5	12-3	12-11	13-8	14-4	14-11	15-7
		0.06	0.12	0.18	0.25	0.34	0.42	0.52	0.62	0.72	0.83	0.95	1.07
	13.7	5-9	7-0	8-1	9-0	9-11	10-8	11-5	12-1	12-9	13-5	14-0	14-7
		0.06	0.11	0.17	0.24	0.31	0.40	0.48	0.58	0.67	0.78	0.89	1.00
	16.0	5-3	6-6	7-6	8-4	9-2	9-11	10-7	11-3	11-10	12-5	12-11	13-6
		0.06	0.10	0.16	0.22	0.29	0.37	0.45	0.53	0.62	0.72	0.72	0.93
	19.2	4-10	5-11	6-10	7-8	8-4	9-0	9-8	10-3	10-10	11-4	11-10	12-4
		0.05	0.09	0.14	0.20	0.26	0.33	0.41	0.49	0.57	0.66	0.75	0.85
	24.0	4-4	5-3	6-1	6-10	7-6	8-1	8-8	9-2	9-8	10-2	10-7	11-0
		0.05	0.08	0.13	0.18	0.24	0.30	0.36	0.44	0.51	0.59	0.67	0.76
2 x 10	12.0	7-9	9-6	11-0	12-4	13-6	14-7	15-7	16-6	17-5	18-3	19-1	19-10
		0.06	0.12	0.18	0.25	0.34	0.42	0.52	0.62	0.72	0.83	0.95	1.07
	13.7	7-3	8-11	10-4	11-6	12-7	13-8	14-7	15-5	16-4	17-1	17-10	18-7
		0.06	0.11	0.17	0.24	0.31	0.40	0.48	0.58	0.67	0.78	0.89	1.00
	16.0	6-9	8-3	9-6	10-8	11-8	12-7	13-6	14-4	15-1	15-10	16-6	17-2
		0.06	0.12	0.16	0.22	0.29	0.37	0.45	0.53	0.62	0.72	0.82	0.93
	19.2	6-2	7-7	8-9	9-9	10-8	11-6	12-4	13-1	13-9	14-5	15-1	15-8
		0.09	0.09	0.14	0.20	0.26	0.33	0.41	0.49	0.57	0.66	0.75	0.85
	24.0	5-6	6-9	7-9	8-9	9-6	10-4	11-0	11-8	12-4	12-11	13-6	14-1
		0.05	0.08	0.13	0.18	0.24	0.30	0.36	0.44	0.51	0.59	0.67	0.76

(continued)

For **SI:** 1 inch = 25.4 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot - 0.0479 kN/m^2.

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

TABLE 802.4s *(continued)*

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 AND SIZE	
1400	1500	1600	1700	1800	1900	2000	2100	2200	2400	2700	(inches)	(inches)
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	2 x 4
7-4 1.12	7-7 1.24	7-10 1.37	8-0 1.50	8-3 1.63	8-6 1.77	8-9 1.91	8-11 2.05	9-2 2.20	9-7 2.51		13.7	
6-9 1.03	7-0 1.15	7-3 1.26	7-5 1.38	7-8 1.51	7-10 1.64	8-1 1.77	8-3 1.90	8-6 2.04	8-10 2.32		16.0	
6-2 0.94	6-5 1.05	6-7 1.15	6-10 1.26	7-0 1.38	7-2 1.49	7-4 1.61	7-7 1.74	7-9 1.86	8-1 2.12	8-7 2.53	19.2	
5-6 0.84	5-8 0.94	5-11 1.03	6-1 1.13	6-3 1.23	6-5 1.34	6-7 1.44	6-9 1.55	6-11 1.66	7-3 1.90	7-8 2.26	24.0	
12-3 1.19	12-8 1.32	13-1 1.46	13-6 1.60	13-11 1.74	14-3 1.89	114-8 2.04	15-0 2.19	15-4 2.35			12.0	2 x 6
11-6 1.12	11-10 1.24	12-3 1.37	12-8 1.50	13-0 1.63	13-4 1.77	13-8 1.91	14-0 2.05	14-4 2.20	15-0 2.51		13.7	
10-7 1.03	11-0 1.15	11-4 1.26	11-8 1.38	12-0 1.51	12-4 1.64	12-8 1.77	13-0 1.90	13-4 2.04	13-11 2.32		16-0	
9-8 0.94	10-0 1.05	10-4 1.15	10-8 1.26	11-0 1.38	11-3 1.49	11-7 1.61	11-10 1.74	12-2 1.86	12-8 2.12	13-5 2.53	19.2	
8-8 0.84	9-0 0.94	9-3 1.03	9-7 1.13	9-10 1.23	10-1 1.34	10-4 1.44	10-7 1.55	10-10 1.66	11-4 1.90	12-0 2.26	24.0	
16-2 1.19	16-9 1.32	17-3 1.46	17-10 1.60	18-4 1.74	18-10 1.89	19-4 2.04	19-9 2.19	20-3 2.35			12.0	2 x 8
15-1 1.12	15-8 1.24	16-2 1.37	16-8 1.50	17-2 1.63	17-7 1.77	18-1 1.91	18-6 2.05	18-11 2.20	19-9 2.51		13.7	
14-0 1.03	14-6 1.15	14-11 1.26	15-5 1.38	15-10 1.51	16-4 1.64	16-9 1.77	17-2 1.90	17-6 2.04	18-4 2.32		16.0	
12-9 0.94	13-3 1.05	13-8 1.15	14-1 1.26	14-6 1.38	14-11 1.49	15-3 1.61	15-8 1.74	16-0 1.86	19-9 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 1.60	23-4 1.74	24-0 1.89	24-8 2.04	25-3 2.19	25-10 2.35		12.0	2 x 10
19-3 1.12	19-11 1.24	20-7 1.37	21-3 1.50	21-10 1.63	22-6 1.77	23-1 1.91	23-7 2.05	24-2 2.20	25-3 2.51		13.7	
17-10 1.03	18-6 1.15	19-1 1.26	19-8 1.38	20-3 1.51	20-10 1.64	21-4 1.77	21-10 1.90	22-4 2.04	23-4 2.32		16.0	
16-4 0.94	16-10 1.05	17-5 1.15	17-11 1.26	18-6 1.38	19-0 1.49	19-6 1.61	19-11 1.74	20-5 1.86	21-4 2.12	22-8 2.53	19.2	
14-7 0.84	15-1 0.94	15-7 1.03	16-1 1.13	16-6 1.23	17-0 1.34	17-5 1.44	17-10 1.55	18-3 1.66	19-1 1.90	20-3 2.26	24.0	

For **SI:** 1 inch = 25.4 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot - 0.0479 kN/m^2.

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

CHAPTER 9
ROOF COVERINGS

SECTION 901
GENERAL

901.1 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 108 shall be accepted as complying with this code.

901.2 Requirements. The roof covering shall be capable of accommodating the loads indicated in Section 301 and provide a barrier against the weather to protect its supporting elements and the structure beneath.

901.3 Roofing covering materials. Roofs shall be covered with materials as set forth in Sections 903 through 909. Classified roofing shall conform to UL 790 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 (914 mm) from a property line. The roofing materials set forth in Sections 904 through 906 and concrete slabs may be accepted as Class A roofing.

SECTION 902
DECK PREPARATION

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

902.2 Single layer underlayment. When a single ply of underlayment is required, it shall be laid parallel to the eaves with a 2–inch (51 mm) top lap and 4–inch (102 mm) end lap nailed sufficiently to hold in place.

902.3 Multiple layer underlayment. When two layers of underlayment are required, they shall be laid shingle fashion parallel to the eaves with 19–inch (483 mm) top lap and 12–inch (305 mm) end lap, with end laps located at least 6 feet (1829 mm) from end laps in the preceding course, and blind nailed sufficiently to hold in place.

SECTION 903
ASPHALT SHINGLES

903.1 General. Asphalt shingles shall be applied only to solidly sheathed roofs. Asphalt shingles shall be applied according to the manufacturer's printed instructions and this code.

903.2 Slopes of four units vertical in 12 units horizontal (33–percent slope) or greater. Asphalt shingle roofs shall have an underlayment of not less than one ply of No. 15 felt, applied as required in Section 902 and Table 903.4.

903.3 Slopes less than four units vertical in 12 units horizontal (33–percent slope) but not less than two units vertical in 12 units horizontal (17–percent slope). Nominally double–coverage asphalt shingles may be installed on slopes as low as two units vertical in 12 units horizontal (17–percent slope), 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 902 and Table 903.4. In areas where the January average daily temperature is 25°F. (-3.9°C.) 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 requirednailing, from the eaves up the roof to overlie a point 24 inches (610 mm) inside the interior wall line of the building. Asphalt shingles shall not be used on roofs with slopes less than two units vertical in 12 units horizontal (17–percent slope).

903.4 Fasteners. Asphalt shingles shall be fastened according to the manufacturer's printed instructions and Table 903.4.

903.5 Valley flashing. Roof valleys shall be flashed by one of the methods listed in Sections 903.5.1 through 903.5.3. Asphalt shingles shall be applied according to the manufacturer's printed instructions.

903.5.1 Sheet metal. Open roof valleys may be provided of not less than No. 28 gage galvanized corrosion–resistant sheet metal and shall extend at least 8 inches (203 mm) from the center line each way. Sections of flashing shall be jointed to provide an adequate water lock.

903.5.2 Roll roofing. Woven or closed valleys may be constructed by centering 36–inch–wide (914 mm) roll roofing material not less than Type 50 in the valley over the underlayment.

903.5.3 Multiple layer flashing. Roof valley flashing may be of laced composition shingles, applied in an approved manner, with an underlay of not less than 30–pound (14 kg) felt extending 10 inches (254 mm) from the center line each way, or shall be of two layers of 90–pound (41 kg) mineral–surfaced cap sheet cemented together with the bottom layer not less than 12 inches (305 mm) wide laid face down and the top layer not less than 24 inches (610 mm) wide laid face up.

903.6 Side wall flashing. Flashing against a vertical sidewall shall be by the step–flashing method.

Exception: Other methods shall be permitted when installed in accordance with the shingle manufacturer's printed instructions.

903.7 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.

903.8 Hips and ridges. Hip and ridge shingles shall be fastened according to the manufacturer's printed instructions and Table 903.4. Hip and ridge weather exposure shall not exceed that permitted for the field of the roof.

SECTION 904
SLATE SHINGLES

904.1 General. Slate shingles shall be applied in an approved manner and securely fastened with corrosion–resistant nails or corrosion–resistant nails and wire.

904.2 Materials. Slate roofing shall conform to ASTM C 406.

904.3 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 902. Nails for shingle tiles shall not be less than No. 14 gage copper or No. 14 gage corrosion–resistant metal and shall be long enough to penetrate into the sheathing 3/4 inch (19 mm) or through the thickness of the sheathing, whichever is less.

TABLE 903.4
ASPHALT SHINGLE APPLICATION

	NOT PERMITTED BELOW 2:12	
ROOF SLOPE	**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 Tables 503.2.1 .1a and 803.3.2
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 tapped 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-gage 3/8-inch head, or approved corrosion-resistant staples, minimum 16-gage 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 fasteners1	4 per 36-40-inch strip 2 per 9-18-inch shingle	
Exposure Field of roof	Per manufacturer's instructions included with packages of shingles.	
Hips and ridges	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 903.5 Per Sections 903.6 and 903.7	

For **SI:** 1 inch = 25.4 mm

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.

904.4 Valleys. Roof valley flashing shall be provided of not less than No. 28 gage galvanized corrosion–resistant sheet metal and shall extend at least 11 inches (279 mm) from the center line each way and shall have a splash diverter rib not less than 1-inch (25 mm) 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 (153 mm) and shall be provided with an adequate water lock.

SECTION 905
METAL

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

905.2 Materials. Metal roofing shall conform to AA ASM 35, or ASTM A 361 or B 209.

905.3 Slope. Metal shingles shall not be installed on a roof having a slope less than three units vertical in 12 units horizontal (25–percent slope) unless approved by the building official.

905.4 Underlayment. Metal shingles shall be applied over an underlayment of not less than No. 30 felt, applied as required in Section 902.

SECTION 906
TILE, CLAY OR CONCRETE SHINGLES

906.1 Attachment. All roof tile shall be securely fastened with corrosion–resistant nails or corrosion–resistant nails and wire, or other approved means.

906.2 Roof slope. Tile shall not be installed on a roof having a slope of less than three units vertical in 12 units horizontal (25–percent slope) unless approved by the building official.

906.2.1 Tile lugs. 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 (25 mm by 51 mm) stripping, treated to resist moisture deterioration, nailed to the roof sheathing over the underlayment or other approved means.

906.3 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 902.

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

SECTION 907
BUILT–UP ROOFING

907.1 Decking. Built–up roofing shall be applied only to solid surface roof decks.

907.2 Materials. Built–up roofing shall conform to UL 55A.

907.3 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 902.

907.4 Base ply. On nailable decks, a base ply is to be fastened to the deck in accordance with the manufacturer's published specifications and Table 903.4.

907.4.1 Nonnailable decks. 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 (9.1 kg) per square of hot asphalt for solid mopping, or not less than 10 pounds (4.5 kg) per square for spot mopping, or not less than 1-1/2 gallons (5.7 L) per square of cold bituminous compound, or 25 pounds (11 kg) per square of coal–tar pitch, in accordance with the 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.

907.4.2 Insulated decks. On insulated decks, a vapor retarder shall be installed between the deck and the insulation where the average January temperature is below 45°F. (7.2°C.) 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 mechanical fasteners Type II or Type III asphalt in accordance with ASTM D 312 and installed in accordance with the manufacturer's published ply specifications. The insulation may be taped if required. A base ply required by the 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.

907.5 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.

907.6 Surfacing. The built–up roofing assembly shall be surfaced by one of the methods described in Sections 907.6.1 and 907.6.2.

907.6.1 Mineral aggregate roofs. Mineral aggregate surfaced roofs shall be surfaced with not less than 60 pounds (27 kg) of hot asphalt or 75 pounds (34 kg) of coal–tar pitch in which is embedded not less than 400 pounds (181 kg) of gravel or 300 pounds (136 kg) of crushed slag per roofing square.

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

SECTION 908
WOOD SHINGLES

908.1 Sheathing requirements. Wood shingles shall be applied to roofs with solid or spaced sheathing. Spaced sheathing boards shall not be less than 1 inch by 4 inch (25 mm by 102 mm) nominal dimensions and shall be spaced on centers a distance equal to the actual weather exposure of the shingles, not to exceed the dimensions set forth in Table 908.3.3.

908.2 Materials. Wood shingle roofing shall conform to CSSB "Grading and Packing Rules for Certigrade Red Cedar Shingles."

908.3 Installation. Wood shingles shall be laid with a side lap of not less than 1-1/2 inches (38 mm). Joints in adjacent courses shall be offset a minimum of 1-1/2 inches (38 mm) and no two jointsin alternate courses shall be in direct alignment. Spacing between shingles shall not be less than 1/4 inch (6.4 mm) or more than 3/8 inch (9.5 mm). Wood shingles shall be fastened to the sheathing in accordance with Table 908.3.

908.3.1 Roof slope. Shingles shall not be installed on a roof having a slope less than three units vertical in 12 units horizontal (25–percent slope). On roofs having slopes of three units vertical in 12 units horizontal (25–percent slope) and 7 inches (178 mm) from the center line each way for slopes of 12 inches (305 mm) to less than four units vertical in 12 units horizontal (33–percent slope), 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 902.

908.3.2 Valley flashing. Roof valley flashing shall not be less than No. 28 gage corrosion–resistant sheet metal and shall extend 10 inches (254 mm) from the center line each way for roofshaving slopes less than 12 units vertical in 12 units horizontal (100–percent slope) and greater. Sections of flashing shall have an end lap of not less than 4 inches (102 mm).

908.3.3 Weather exposure. Weather exposures shall not exceed those set forth in Table 908.3.3. 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 Shake Hip and Ridge based on the Standards of the Cedar Shake and Shingle Bureau." 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 (19 mm) minimum.

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

SECTION 909
WOOD SHAKES

909.1 Sheathing requirements. Wood shakes shall be applied to roofs with solid or spaced sheathing. Spaced sheathing boards shall not be less than 1–inch–by–4–inch (25 mm by 102 mm) nominal dimensions for shakes installed at maximum 7-1/2–inch (190 mm) exposures and shall be spaced on centers a distance equal to the actual weather exposure of the shakes, not to exceed the dimensions set forth in Table 908.3.3. For 24–inch (610 mm) shakes used in 10–inch (254 mm) exposure, the spaced sheathing shall be either 1–inch–by–4–inch (25 mm by 102 mm) nominal dimension board spaced on centers a distance equal to the weather exposure with an additional 1–inch–by–4–inch (25 mm by 102 mm) board placed between these boards, or 1–inch–by–6–inch (25 mm by 153 mm) nominal dimension boards spaced on centers a distance equal to the weather exposure. In severe climate, the shakes shall be applied over an underlayment as required in Table 908.3.

TABLE 908.3
WOOD SHINGLE OR SHAKE APPLICATION

ROOF SLOPE	WOOD SHINGLES Not permitted below 3:12 See Table 908.3.3	WOOD SHAKES Not permitted below 4:12[1] See Table 908.3.3
DECK REQUIREMENT	Wood shingles shall be applied to roofs having solid or spaced sheathing in accordance with Section 908.1.	Wood shakes shall be applied to roofs having solid or spaced sheathing in accordance with Section 909.1.
UNDERLAYMENT Temperate 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 roof 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 In areas subject to wind-driven snow or roof ice buildup.	Corrosion-resistant nails, minimum No. 14-1/2-gage, 7/32-inch head, or corrosion-resistant staples when approved by the building official.	Corrosion-resistant nails, minimum No. 13-gage 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 Hip and ridges	Weather exposures shall not exceed those set forth in Table 908.3.3. Hip and ridge weather exposures shall not exceed those permitted for the field of the roof.	
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 or more than 5/8 inch except for preservative-treated wood shakes which shall have a spacing not less than 1/4 inch or 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 908.3.2 and 909.3.3 Per accepted practice	

For **SI:** 1 inch = 25.4 mm

1. When approved by the building official, wood shakes may be installed on a slope of not less than three units vertical in 12 units horizontal (25-percent slope) when an underlayment of not less than nonperforated Type 15 felt is installed.

TABLE 908.3.3
WOOD SHINGLE AND SHAKE MAXIMUM WEATHER EXPOSURES

GRADE	LENGTH (inches)	LESS THAN 4" IN 12" (inches) (Minimum 3" in 12" Permitted)	4" IN 12" AND STEEPER (inches)
WOOD SHINGLES			
No. 1	16	3 3/4	5
No. 2[1]	16	3 1/2	4
No. 3[1]	16	3	3 1/2
No. 1	18	4 1/4	5 1/2
No. 2[1]	18	4	4 1/2
No. 3[1]	18	3 1/2	4
No. 1	24	5 3/4	7 1/2
No. 2[1]	24	5 1/2	6 1/2
No. 3[1]	24	5	5 1/2
WOOD SHAKES[2]			
No. 1	18	7 1/2	7 1/2
No. 2	18[3]	Not Permitted	5 1/2
No. 1	24	10	10
No. 2	24[3]	Not Permitted	7 1/2

For **SI:** 1 inch = 25.4 mm

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.

909.2 Materials. Wood shake shall conform to CSSB "Grading and Packing Rules for Certi–Split Red Cedar Shakes" or "Grading Rules for Certi–Sawn Taper–Sawn Cedar Shakes."

909.3 Installation. 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." Wood shakes shall be fastened to the sheathing in accordance with Table 908.3.

909.3.1 Shake and shingle placement. The starter course at the eaves shall be doubled and the bottom layer shall be either 15–, 18– or 24–inch (381, 457 or 610 mm) wood shakes or wood shingles. Fifteen–inch (381 mm) or 18–inch (457 mm) wood shakes may be used for the final course at the ridge. Shakes shall be interlaid with 18–inch–wide (451 mm) 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.

909.3.2 Roof slope. Shakes shall not be installed on a roof having a slope less than four units vertical in 12 units horizontal (33–percent slope) unless they are installed over an underlayment of not less than No. 15 felt, applied as required in Section 902.

909.3.3 Valley flashing. Roof valley flashing shall not be less than No. 28 gage corrosion–resistant sheet metal and shall extend at least 11 inches (279 mm) from the center line each way. Sections of flashing shall have an end lap of not less than 4 inches (102 mm).

909.3.4 Weather exposure. Weather exposures shall not exceed those set forth in Table 908.3.3. 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." 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 (19 mm) minimum.

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

SECTION 910
REROOFING

910.1 General. Materials and methods used for repair, replacement or recovering an existing roof shall comply with Sections 117 and 901.1. When the repair replacement or recovering within any 12–month period exceeds 25 percent of the roof covering of the building, the entire roof covering shall comply with the requirements for new roofing.

910.2 Structural and construction loads. The existing roof system shall be capable of supporting all equipment loads encountered during installation as well as the loads resulting from the new roofing materials.

910.3 Recovering vs. replacement. New roof covering shall not be installed without first removing existing roof coverings when any of the following conditions occur.

1. When the existing roof or roof covering is water soaked or deteriorated to the point of being unacceptable as a base for additional roofing.

2. When the existing roof covering is wood shake, slate, clay or cement tile; except when the new roof covering is installed in accordance with approved industry standards.

3. When the existing roof has three or more layers of any type of roofing.

Exception: The removal of existing roof coverings shall not be required where complete and separate roofing systems are provided which transmit all roof loads directly to the structural system of the building and which do not bear upon the existing roof.

910.4 Reinstallation of materials. The reinstallation of existing roof covering materials which have been removed is not permitted unless the materials provide an effective barrier against the weather.

910.5 Flashings. Flashings shall be reconstructed in accordance with approved manufacturer's instruction.

CHAPTER 10
CHIMNEYS AND FIREPLACES

SECTION 1001
MASONRY CHIMNEYS

1001.1 General. Masonry chimneys shall be constructed, anchored, supported and reinforced as required in this chapter and the applicable provisions of Chapters 3, 4 and 6. In Seismic Zones 3 and 4, masonry and concrete chimneys shall be reinforced and anchored as detailed in Section 1003 for chimneys serving fireplaces. In Seismic Zone 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.

1001.1.1 Support. Masonry chimneys shall be supported on foundations of solid masonry or concrete at least 12 inches (305 mm) thick and at least 12 inches (305 mm) 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 (305 mm) below finished grade.

1001.2 Corbeling. Masonry chimneys shall not be corbeled more than 6 inches (153 mm) from a wall or foundation, or a chimney be corbeled from a wall or foundation which is less than 12 inches (305 mm) 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.

1001.3 Changes in dimension. The chimney wall or chimney flue lining shall not change in size or shape within 6 inches (153 mm) above or below where the chimney passes through floor components, ceiling components or roof components. The chimney shall be as vertical as possible with a maximum slope no greater than 30 degrees from vertical for the entire height of the chimney. All mitered joints shall be visible from either the top or bottom side of the chimney.

1001.4 Additional load. Chimneys shall not support loads other than their own weight unless they are designed and constructed to support the additional load.

1001.5 Termination. Chimneys shall extend at least 2 feet (610 mm) higher than any portion of the building within 10 feet (3048 mm), but shall not be less than 2 feet (609.6 mm) above the point where the chimney passes through the roof. Cap chimneys with brick, concrete, stone, terra cotta, or other noncombustible weather proof material. Spark arrestors shall be required on all chimneys where non-fire rated wood shingles or shakes are used as roof coverings. Such arrestors shall be constructed of 1/2 inch wire mesh.

1001.6 Wall thickness. Masonry chimney walls shall be constructed of solid masonry units with not less than 4 inches (102 mm) nominal thickness.

1001.7 Flue lining (material). Masonry chimneys shall be lined with fireclay flue liners not less than 5/8 inch (15.9 mm) in thickness or with other approved liner of material that will resist, without cracking or softening, a temperature of 1,800°F. (982°C.).

1001.8 Flue lining (installation). Flue liners shall extend from a point not less than 8 inches (203 mm) 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 (12.7 mm) air space separating the flue liners from the interior face of the chimney masonry walls. Flue lining shall be supported on all sides.

1001.9 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 (102 mm) 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 (178 mm).

1001.10 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 2104.3.2.

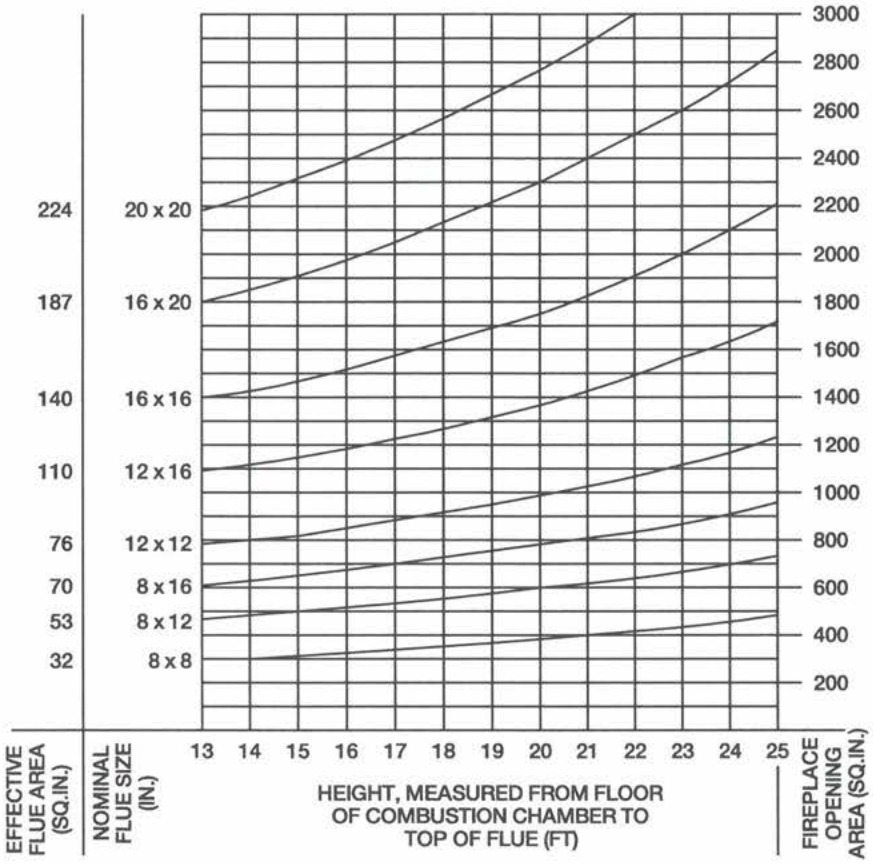
1001.11 Flue area (masonry fireplace). The cross–sectional area of the chimney flue shall be determined in accordance with Figure 1001.11. The net free area of square or rectangle flues as listed in Figure 1001.11 shall not be less than 1/10 the face area of the fireplace opening. The net free area of round flues as listed in Figure 1001.11 shall not be less than 1/12 the face area of the fireplace opening. For fireplaces with more than one opening the combined area of all faces, or damper manufacturer's recommendations shall be used. Individual flue

tiles shall not have a cross-sectional area less than 50 square inches (0.032 m2) for round flues or 64 square inches (0.041 m2) for square or rectangular flues.

1001.12 Inlet. Inlets to masonry chimneys shall enter from the side. Inlets shall have a thimble of fireclay, rigid refractory material or metal that will prevent the connector from pulling out of the inlet or from extending beyond the wall of the liner.

1001.13 Masonry chimney cleanout openings. Cleanout openings shall be provided within 6 inches (153 mm) of the base of every masonry chimney.

Exception: Chimneys serving masonry fireplaces.



For **SI:** 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 square inch = 645.16 mm^2.

1 When using Figure 1001.11, select the smaller flue size when the opening and height selected for the fireplace and chimney, respectively, intersect between standard flue sizes.

FIGURE 1001.11
FLUE SIZES FOR MASONRY CHIMNEYS

1001.14 Chimney clearances. All wood framing members shall be kept at least one (1) inch from chimney masonry and two (2) inches from fireplace masonry, excluding the fireplace facing material. Masonry chimneys which are completely on the exterior of a building against the sheathing are not required to comply with these provisions. (See Figure No. 1001.14).

Exception: Masonry chimneys equipped with a chimney lining system listed and labeled for use in chimneys in contact with combustibles in accordance with UL 1777, and installed in accordance with the manufacturer's installation instructions, are permitted to have combustible material in contact with their exterior surfaces. However, this shall not eliminate the requirement for noncombustible firestopping in accordance with Section 1001.15.

1001.15 Chimney firestopping. See Section 602.7.

1001.16 Chimney crickets. Chimney shall be provided with crickets when the dimension parallel to the ridgeline is greater than 30 inches (762 mm) 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 1001.16 and Table 1001.16.

SECTION 1002
FACTORY–BUILT CHIMNEYS

1002.1 General. Factory–built chimneys shall conform to the conditions of their listing and the manufacturer's instructions. Factory–built chimneys that are listed as part of an assembly with factory–built fireplaces shall conform to Section 1004.1.

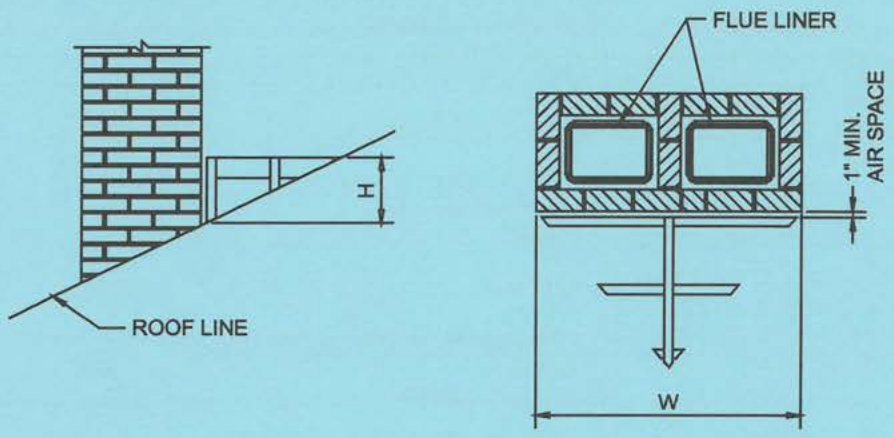


FIGURE 1001.16
CHIMNEY CRICKET

TABLE 1001.16
CRICKET DIMENSION

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

SECTION 1003
MASONRY FIREPLACES

1003.1 Fireplace support. Fireplace foundations and supporting walls shall be anchored, supported and reinforced as required in Sections 1003.1 through 1003.12, Table 1003.1, Figure 1003.1, and the applicable provisions of Chapters 3 and 4. Foundations for masonry fireplaces and their chimneys shall be constructed of concrete or solid masonry at least 12 inches (305 mm) thick and extend at least 12 inches (305 mm) beyond the face of the fireplace or supporting wall on all sides. Footings shall be founded on natural undisturbed earth or engineered fill below frost depth. In areas not subjected to freezing, footings shall be at least 12 inches (305 mm) below finished grade.

TABLE 1003.1
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" solid 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[2]	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[2]	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 or 1/2" airspace 4" min. from flue lining to outside face of chimney.
Walls with unlined flue	N	8" solid masonry.
Distances between adjacent flues	—	See Section 1001.9
Effective flue area (based on area of fireplace (opening)	P	 See Section 1001.11
Clearances Wood frame Combustible material Above roof	R	 See Sections 1001.14 and 1003.9 See Section 1003.11 2´ at 10´
Anchorage[2] Strap Number Embedment into chimney Fasten to Bolts	S	 3/16" x 1" 2 12" hooked around outer bar w/6" ext. 4 joists Two 1/2" diameter.
Footing Thickness Width	T	 12" min. 12" each side of fireplace wall.
Mortar		Type M, S, or fire clay mixture

For **SI:** 1 inch = 25.4 mm, 1 foot = 304.8 mm.

1 The letters refer to Figure 1003.1.

2 Not required in Seismic Zone 0, 1 or 2.

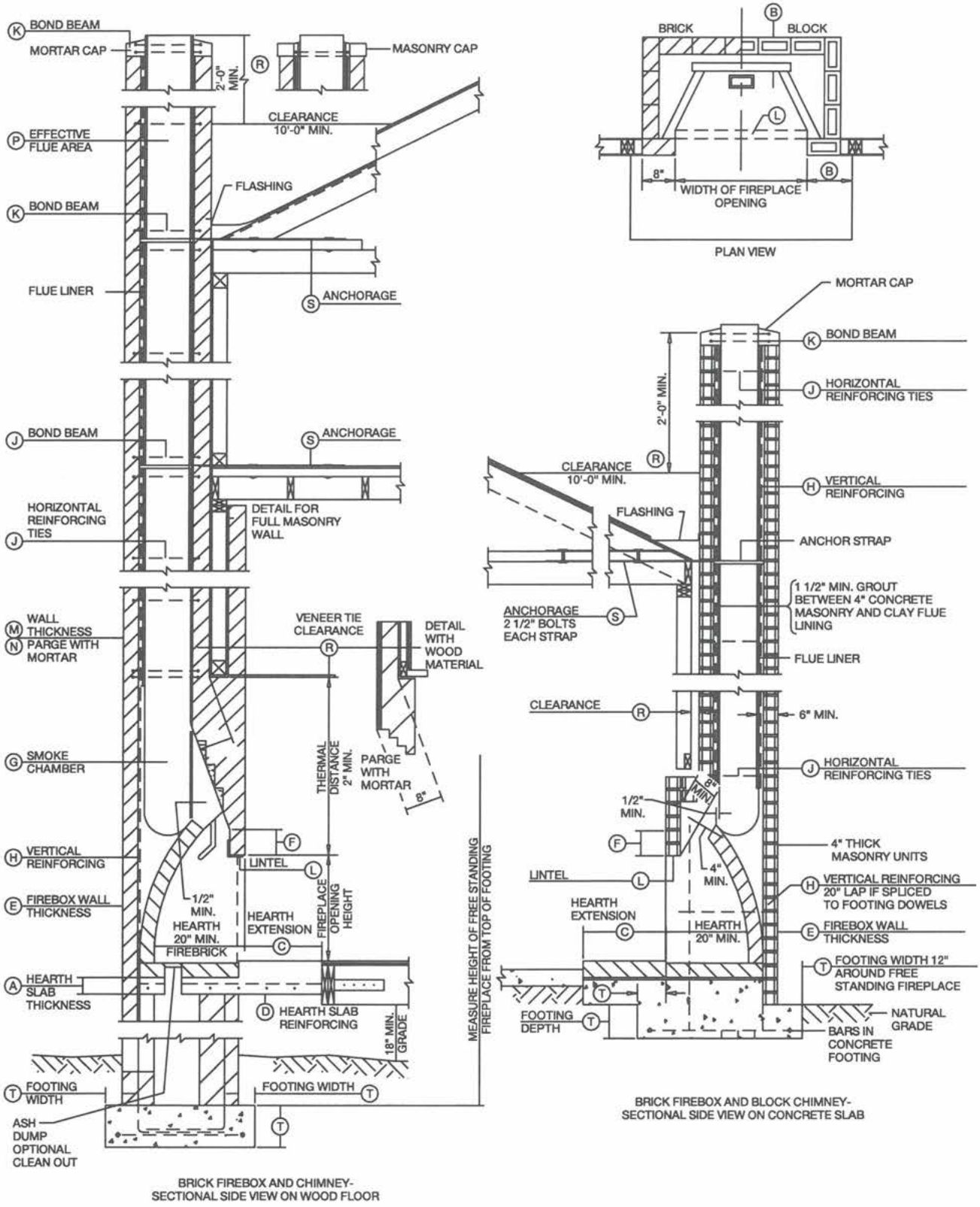


FIGURE 1003.1
FIREPLACE AND CHIMNEY DETAILS

1003.2 Seismic reinforcing. Masonry or concrete chimney in Seismic Zones 3 and 4 extending more than 7 feet (2134 mm) above the last contact with the structure shall be reinforced. Reinforcing shall conform to the requirements set forth in Table 1003.1. When the width of the chimney exceeds 40 inches (1016 mm), two additional No. 4 vertical bars shall be provided for each additional flue incorporated in the chimney or for each additional 40 inches (1016 mm) in width or fraction thereof.

1003.3 Seismic anchorage. In Seismic Zones 3 and 4, masonry and concrete chimneys shall be anchored at each floor ceiling or roof line more than 6 feet (1829 mm) above grade, except when constructed completely within the exterior walls. Anchorage shall conform to the requirements set forth in Table 1003.1.

1003.4 Fireplace walls. Masonry fireplaces shall be constructed of solid masonry units, stone or reinforced concrete in accordance with Figure 1003.1. A lining of firebrick at least 2 inches (51 mm) in thickness shall be provided. The total thickess of back and sides, including the lining, shall not be less than 8 inches (203 mm).

1003.5 Steel fireplace units. Steel fireplace units incorporating a firebox liner of not less than 1/4 inch (6.4 mm) in thickness and an air chamber may be installed with masonry to provide a total thickness at the back and sides of not less than 8 inches (203 mm), of which not less than 4 inches (102 mm) shall be of solid masonry. Warm–air ducts employed with steel fireplace units of the circulating air type shall be constructed of metal or masonry.

1003.6 Lintel. Masonry over a fireplace opening shall be supported by a lintel of noncombustible material. The minimum required bearing length on each end of the fireplace opening shall be 4 inches (102 mm).

1003.7 Hearth extension material. Hearth extensions shall be of masonry or concrete at least 2 inches (51 mm) thick and supported by noncombustible materials and reinforced to carry its own weight and all imposed loads. The hearth extension shall be readily distinguishable from the surrounding floor. Combustible forms and centers used during the construction of the hearth extension shall be removed after the construction is complete.

Exception: When the bottom of the firebox opening is raised at least 8 inches (203 mm) above the top of the hearth extension, a hearth extension of not less than 3/8–inch–thick (9.5 mm) brick, concrete, stone, tile or other approved noncombustible material may be used.

1003.8 Hearth extension. The hearth and the hearth extension shall extend a minimum of 36 inches (914 mm) from the back of the firebox to the end of the hearth extension. Hearth extensions shall extend at least 16 inches (406 mm) in front of, and at least8 inches (203 mm) beyond, each side of the fireplace opening. Where the fireplace opening is 6 square feet (0.557 m2) or larger, the hearth extension shall extend at least 20 inches (508 mm) in front of, and at least 12 inches (305 mm) beyond, each side of the fireplace opening.

1003.9 Fireplace clearance. Wood or combustible framing shall not be placed within 2 inches (51 mm) of the outside face of a masonry fireplace and not less than 6 inches (153 mm) from the inside surface of the nearest flue lining. Wood framing and other combustible material shall not be placed within 2 inches (51 mm) of the back surface of a masonry fireplace.

1003.10 Fireplace firestopping. See Section 602.7.

1003.11 Combustible materials. Woodwork or other combustible materials shall not be placed within 6 inches (153 mm) of a fireplace opening. Combustible material within 12 inches (305 mm) of the fireplace opening shall not project more than 1/8 inch (3.2 mm) for each 1–inch (25 mm) distance from such opening.

1003.12 Ash dump cleanout. 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 located so that ash removal will not create a hazard to combustible materials.

SECTION 1004
FACTORY–BUILT FIREPLACES

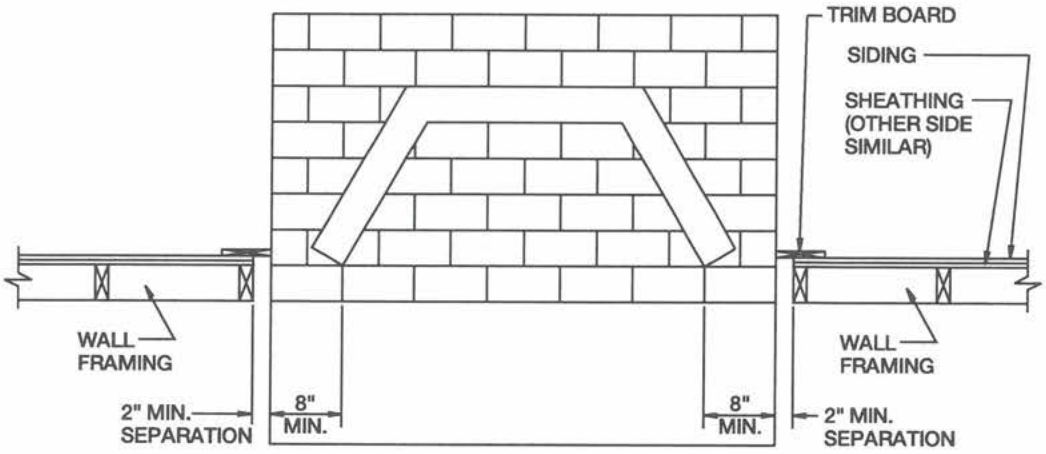
1004.1 Installation. Factory–built fireplaces that consist of a fire chamber assembly, one or more chimney sections, a roof assembly and other parts as tested and listed as an assembly by an approved agency may be installed when complying with all the following provisions:

1. The fire chamber assembly is installed to provide clearance to combustible materials not less than set forth in the listing.
2. The chimney sections are installed to provide clearance to combustible material not less than specified in the listing and if the fireplace chimney extends through floors and ceilings, factory–furnished firestops or firestop spacers shall be installed. Portions of chimneys which extend through rooms or closets are to be enclosed to avoid personal contact, contact of combustible material, and damage to the chimney.
3. Hearth extensions shall not be less than 3/8–inch–thick (9.5 mm) asbestos, hollow metal, stone, tile or other approved noncombustible material. Such hearth extensions may be placed on combustible subflooring or finish flooring. The hearth extension shall be readily distinguished from the surrounding floor.
4. Hearth extensions shall extend not less than 16 inches (406 mm) in front of and at least 8 inches (203 mm) beyond both sides of the fireplace opening.

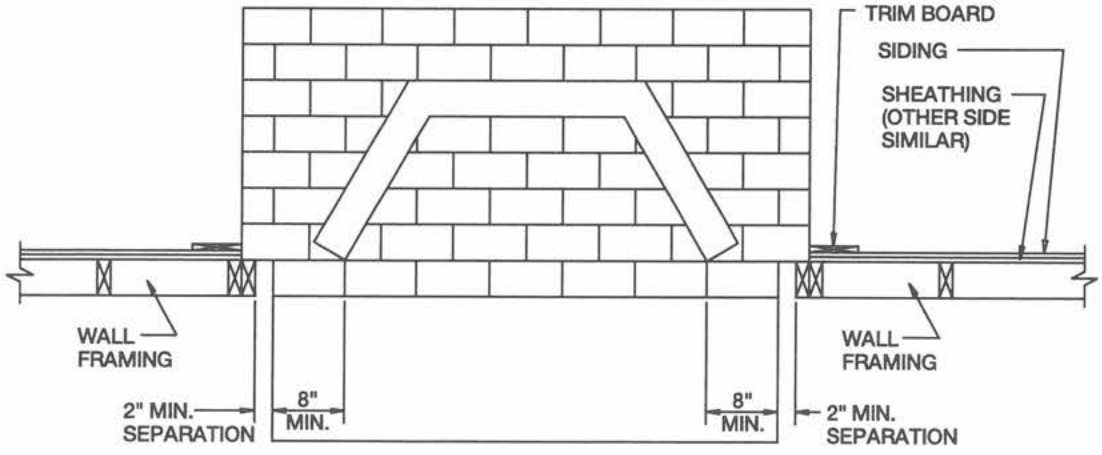
5. Factory–built fireplaces shall be installed in accordance with their listing and the manufacturer's installation instructions.
6. The supporting structure for a hearth extension shall be at the same level as the supporting structure for the fireplace unit unless otherwise authorized by the listing.

SECTION 1005
FACTORY–BUILT FIREPLACE STOVES

1005.1 General. Factory–built fireplace stoves, consisting of a freestanding fire chamber assembly, that have been tested and are listed by a nationally recognized testing laboratory, shall be installed in accordance with the requirements of said listing and the manufacturer's instructions. The supporting structure for a hearth extension shall be at the same level as the supporting structure for the fireplace unit of the firebox opening on or near the floor. The inlet shall be closable and designed to prevent burning material from dropping into concealed combustible spaces.



INTERIOR FINISHES AND INSULATION NOT SHOWN
MASONRY CHIMNEY ON EXTERIOR OF BUILDING (ALT. #1)



INTERIOR FINISHES AND INSULATION NOT SHOWN
MASONRY CHIMNEY ON EXTERIOR OF BUILDING (ALT. #2)

FIGURE 1001.14
CHIMNEY CLEARANCES

CHAPTER 11
MECHANICAL ADMINISTRATION

SECTION 1101
GENERAL

1101.1 Scope. The provisions of this chapter shall establish the general scope of the mechanical system and equipment requirements of this code and the definitions of terms related thereto.

1101.2 Application. In addition to the general administration requirements of Chapter 1, the administrative provisions of this chapter shall also apply to the mechanical requirements of Chapters 12 through 28.

1101.3 Conformity. Conformity with the standards specified in Chapter 43 shall indicate that the equipment is safe for installation under this code.

SECTION 1102
EXISTING MECHANICAL SYSTEMS

1102.1 Additions, alterations, repairs or replacement. Additions, alterations, repairs or replacement may be made to a mechanical system without requiring the existing mechanical system to comply with all the requirements of this code, provided the addition, alteration, repair or replacement conforms to that required for a new mechanical system. Additions, alterations, repairs or replacement shall not cause an existing system to become unsafe, insanitary or overloaded.

SECTION 1103
AUTHORITY TO DISCONNECT UTILITIES IN EMERGENCIES

1103.1 Authority. The building official shall have the authority to order disconnected a fuel supply or appliance that does not conform to this code; the building official shall also have the authority to order disconnected a gas utility service, or energy supplies to a building, structure, premises or equipment in case of emergency when necessary to eliminate an immediate hazard to life or property. A notice shall be attached to the energy supply or appliances stating the reason for disconnection. Such notices shall not be removed nor shall the system or appliance be reconnected until authorized by the building official.

CHAPTER 12
MECHANICAL DEFINITIONS

SECTION 1201
GENERAL

1201.1 Scope. 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 202 or Section 3002 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.

SECTION 1202
GENERAL MECHANICAL DEFINITIONS

ACCESSIBLE. Signifies access that requires the removal of an access panel or similar removable obstruction.

ACCESSIBLE, READILY. Signifies access without the necessity for removing a 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 gas appliance and decorative gas appliances for installation in vented solid–fuel–burning fireplaces. Unlisted gas–fired log lighters shall not be considered appliances.

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 pounds per square inch gage (psig) (1102 kPa gage) and at water temperatures not exceeding 250°F. (121°C.) 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 1,000oF. (538°C.) but lower than the melting temperature of the parts to be joined.

Btu/h. The listed maximum capacity of any appliance, absorption unit or burner expressed in British thermal units input per hour.

CHIMNEY. (See also "Vent") One or more passageways,vertical or nearly so, for conveying flue gases to the outside atmosphere.

CHIMNEY CONNECTOR. A pipe that connects a fuel–burning 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 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 without 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 coil 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 a building which is conditioned directly or indirectly by the operation of a heating or cooling appliance.

CONFINED SPACE. A room or space having a volume less than 50 cubic feet per 1,000 Btu/h (4.83 L/W) of the aggregate input rating of all fuel–burning appliances installed in that space.

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 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. 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. A device that will restrict, retard or direct the flow of air in any duct, or the products of combustion of heat–producing equipment, vent connector, vent or chimney.

DECORATIVE GAS APPLIANCE, VENTED. A vented appliance installed for the aesthetic effect of the flames rather than functional effects.

DECORATIVE GAS APPLIANCES FOR INSTALLATION IN VENTED SOLID–FUEL–BURNING FIREPLACES. A self–contained, freestanding, fuel–gas–burning appliance designed for installation only in a vented solid–fuel–burning fireplace and whose primary function lies in the aesthetic effect of the flame.

DILUTION AIR. Air that enters a draft hood or draft regulator and mixes with flue gases.

DIRECT–VENT APPLIANCE. A fuel–burning appliance 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, air, 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 backdraft from entering the appliance, and (3) neutralize the effect of stack action of the chimney or gas vent on 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.

FACTORY–BUILT CHIMNEY. A chimney composed of listed and labeled factory–built components assembled in accordance with the manufacturer's installation instructions to form the completed chimney.

FIREPLACE. A listed and labeled factory–built or site–built hearth and fire chamber constructed of noncombustible material for use with solid fuels and provided with a chimney.

FIREPLACE STOVE. A freestanding, chimney–connected solid–fuel–burning heater with or without doors connected to the chimney.

FLAME–SPREAD INDEX. A numerical index indicating the relative surface–burning behavior of a material tested in accordance with ASTM E 84.

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, APPLIANCE. The passages within an appliance through which combustion products pass from the combustion chamber to the flue collar.

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 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.

GAS PRESSURE REGULATOR. See "Regulator."

HEAT PUMP. An appliance having heating or heating/cooling capability and which uses refrigerants to extract heat from air, liquid or other sources.

HIGH–TEMPERATURE (H.T.) CHIMNEY. A high temperature chimney complying with the requirements of UL 103. A Type H.T. chimney is identifiable by the markings "Type H.T." on each chimney pipe section.

LABELED. Devices, equipment or materials to which have been affixed a label, seal, symbol or other identifying mark of a testing laboratory, inspection agency or other organization concerned with product evaluation that maintains periodic inspection of the production of the above labeled items which attests to compliance with a specific standard.

LISTED and **LISTING.** Terms referring to equipment whichis 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 when installed in accordance with the manufacturer's installation instructions.

LOG LIGHTER, GAS–FIRED. A manually operated gas–fired solid–fuel ignition device for installation in a vented solid–fuel–burning fireplace.
LOW–PRESSURE GAS SUPPLY SYSTEM. A gas supply system with gas pressure at or below 0.5 psig (3.44 kPa gage).
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 partof the conditions of listing and labeling.
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.
MECHANICAL EXHAUST SYSTEM. Equipment installed in a venting system to provide an induced draft.
MEDIUM–PRESSURE GAS SUPPLY SYSTEMS. A gas supply system with gas pressure exceeding 0.5 psig (3.44 kPa gage) but not exceeding 5 psig (34 kPa gage).

NONCOMBUSTIBLE MATERIAL. Materials that pass the test procedure for defining noncombustibility of elementary materials set forth in ASTM E 136.
NONCONDITIONED SPACE. A space that is isolated from 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.
REFRIGERANT COMPRESSOR. A specific machine, with or without accessories, for compressing a given refrigerant vapor.
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 an 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 an air passage.
REGULATOR. A device for reducing, controlling and maintaining the pressure in a portion of a piping system downstream of the device.
REGULATOR VENT. The opening in the atmospheric side of the regulator housing permitting the movement of air to compensate for the movement of the regulator diaphragm.
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 heating appliance installed in the space being heated and not connected to ducts.

SERVICE PIPING. The piping and equipment between the street gas main and the gas–piping system inlet, which is installed by and is under the control and maintenance of the serving gas supplier.
SMOKE–DEVELOPED RATING. A numerical index indicating the relative density of smoke produced by burning assigned to a material tested in accordance with ASTM E 84.
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 listed and labeled vent conforming to UL 441 for venting gas appliances with draft hoods and other gas appliances listed for use with Type B vents.
TYPE BW VENT. A listed and labeled vent conforming to UL 441 for venting gas–fired vented wall furnaces listed for use with Type BW vents.
TYPE L VENT. A listed and labeled vent conforming to UL 641 for venting oil–burning appliances listed for use with Type L vents or with listed gas appliances.

UNUSUALLY TIGHT CONSTRUCTION. Construction in which:

1. Walls and ceilings exposed to the outside atmosphere have a continuous water vapor retarder with a rating of 1 perm [57.4 ng/(s_m2_Pa)] or less with openings gasketed or sealed, and
2. Weatherstripping has been added on openable windows and doors, and
3. Caulking or sealants are applied to areas such as joints around window and door frames between sole plates and floors, between wall–ceiling joints, between wall panels, at penetrations for plumbing, electrical and gas lines, and at other openings.

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.
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 nonpositive vent connector pressure and with a flue gas temperature at least 140°F. (60°C.) above its dewpoint.

Category II. An appliance that operates with a nonpositive vent connector pressure and with a flue gas temperature less than 140°F. (60°C.) above its dewpoint.

Category III. An appliance that operates with a positive vent pressure and with a flue gas temperature at least 140°F. (60°C.) above its dewpoint.

Category IV. An appliance that operates with a positive vent pressure and with a flue gas temperature less than 140°F. (60°C.) 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.

WATER HEATER. A closed vessel in which water is heated by the combustion of fuels, electricity or other energy source and withdrawn for use external to the vessel at pressures not exceeding 160 psig (1102 kPa gage), including the apparatus by which heat is generated and all controls and devices necessary to prevent water temperatures from exceeding 210°F. (99°C.).

CHAPTER 13
GENERAL MECHANICAL SYSTEM REQUIREMENTS

SECTION 1301
GENERAL

1301.1 Scope. The provisions of this chapter shall govern the installation of mechanical systems not specifically covered in other chapters applicable to mechanical systems.

SECTION 1302
APPROVAL

1302.1 Heating and cooling appliances. Heating and cooling appliances shall be listed and bear the label of an approved agency or shall be approved by the building officials for safe use.

SECTION 1303
LABELING OF EQUIPMENT

1303.1 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 approved standards.
4. Clearances from combustible construction for heat–producing appliances.

1303.2 Fuel–burning appliances. The listing and 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.
3. Instructions for the lighting operation and shut off of the appliance.

1303.3 Other than fuel–burning appliances. The listing and label for other than fuel–burning appliances shall also indicate:

1. The output rating in Btu/h or kw.
2. The electrical rating in volts, amperes (or watts) and, for other than single phase, the number of phases.
3. The electrical rating in volts, amperes or watts of each field–replaceable electrical component.
4. Amount and type of refrigerant, and factory test pressures or pressures applied for heat pumps and refrigeration cooling equipment.

SECTION 1304
TYPE OF FUEL

1304.1 Appliances. Each appliance shall be designed for use with the type of fuel to which it is to be connected. Appliances shall not be converted from fuel specified on the rating plate for use with a different fuel without securing reapproval from the building official and as recommended by the manufacturer of either the original equipment or the conversion equipment. The serving gas supplier may convert appliances in accordance with procedures approved by the building official without securing reapproval of the appliance if properly relabeled. Conversion burners shall conform to ANSI Z21.17 or ANSI/UL 196. Gas conversion burners shall be installed in accordance with ANSI Z21.8.

SECTION 1305
APPLIANCE ACCESS

1305.1 Appliance access for inspection service, repair and replacement. Appliances shall be accessible for inspection, service, repair and replacement without removing permanent construction. Thirty inches (762 mm) of working space and platform shall be provided in front of the control side to service an appliance. Room heaters shall be permitted to be installed with at least an 18 inch (457 mm) working space. A platform shall not be required for room heaters.

SECTION 1306
CLEARANCES FROM COMBUSTIBLE CONSTRUCTION

1306.1 Unlisted Appliance clearance. Unlisted appliances shall have clearances from combustible materials in accordance with Figure 1306.1 and Tables 1306.1a and 1306.1b. Forms of protection with ventilated air space shall conform to the following requirements:

1. Not less than 1–inch (25 mm) air space shall be provided between the protection and combustible wall surface.
2. Air circulation shall be provided by having edges of the wall protection open at least 1 inch (25 mm).
3. If the wall protection is mounted on a single flat wall away from corners, air circulation shall be provided by having the bottom and top edges, or the side and top edges open at least 1 inch (25 mm).
4. Wall protection covering two walls in a corner shall be open at the bottom and top edges at least 1 inch (25 mm).

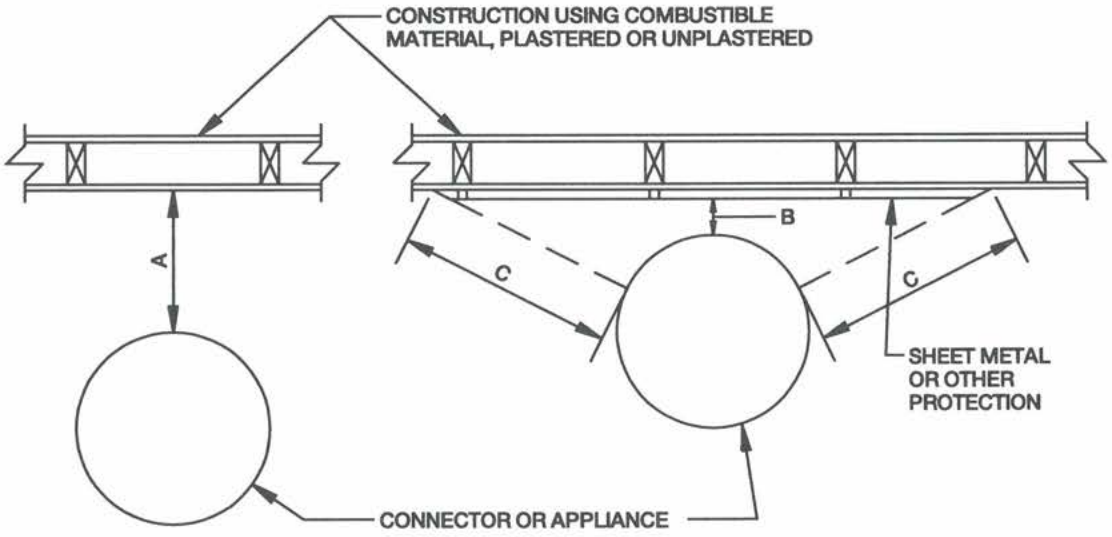


FIGURE 1306.1
REDUCED CLEARANCE DIAGRAM

Note: "A" equals the required clearance with no protection, specified in Table 1306.1a. "B" equals the reduced clearance permitted in accordance with Table 1306.1b. The protection applied to the construction using combustible material shall extend far enough in each direction to make "C" equal to "A."

TABLE 1306.1a
STANDARD INSTALLATION CLEARANCES FOR UNLISTED 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

For **SI:** 1 inch = 25.4 mm.

1 Reductions in the required clearance shall be permitted in accordance with Table 1306.1b.

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 1306.1b
REDUCED CLEARANCES FOR UNLISTED APPLIANCES 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–gage sheet metal with ventilated air space	12	18	6	9	4	6	2	3
31/2–inch thick masonry wall with air space	12	—	6	—	4	—	2	—

For **SI:** 1 inch = 25.4 mm, 1 pound per cubic foot = 0.1572 kN/m3, °F. = 1.8°C. + 32, 1 (Btu–inch)/(square foot–hour–°F.) = 1.731 W/(m_K).

NOTES:

1. Required clearances shall be measured as shown in Figure 1306.1.
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, air circulation shall be provided as described in Section 1306.1.
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 pounds per cubic foot and a minimum melting point of 1,500°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 1307
APPLIANCE INSTALLATION

1307.1 General. Installation of appliances shall conform to the conditions of their listing and label and the manufacturer's installation instructions. The manufacturer's operating and installation instructions shall remain attached to the appliance.

1307.2 Anchorage of appliances. Appliances designed to be fixed in position shall be fastened in place. In Seismic Zones 3 and 4 (see Seismic Risk Map in Figure 301.2b), water heaters having nonrigid water connections and over 4 feet (1219 mm) 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.

1307.3 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 gasoline vapors and located in a garage shall be installed with burners, burner ignition devices, or heating elements and switches at least 18 inches (457 mm) above the floor level. When such appliances are enclosed in a separate compartment having access only from outside of the garage, such appliances may be installed at floor level, provided that the required combustion air is taken from and discharged to the exterior of the garage.

1307.4 Electrical appliances. Electrical appliances shall be installed in accordance with Chapters 15 and Chapter 42.

SECTION 1308
CONTROL DEVICES

1308.1 Gas appliances. Automatic gas–burning appliances shall be equipped with a listed and 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 listed and labeled automatic device or devices that will shut off the flow of gas to the pilot in the event of ignition failure. The listed and labeled shutoff devices shall not be required on range or cooking tops, log lighters, lights or other open–burner manually operated appliances, or listed and labeled appliances not requiring such devices.

1308.2 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 listed and labeled relief valves and temperature–limiting devices whose combined Btu/h rating shall be equal to or greater than the boiler rating.

1308.3 Forced–air furnaces. Forced–air furnaces shall be equipped with a listed and labeled limit control that will prevent outlet air temperature from exceeding 250°F. (121°C.). Such controls shall be located in the bonnet or plenum.

1308.4 Electric duct heaters. Electric duct heaters shall be equipped with an automatic reset air outlet temperature–limit control that will limit the outlet air temperature to no more than 200°F. (93°C.). 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. (121°C.).

CHAPTER 14
HEATING AND COOLING EQUIPMENT

SECTION 1401
GENERAL

1401.1 Installation. Heating and cooling equipment shall be installed in accordance with the manufacturer's installation instructions and the requirements of this code.

1401.2 Access. Heating and cooling equipment shall be located with respect to building construction and other equipment to permit maintenance, servicing and replacement. 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.

1401.3 Sizing. Heating and cooling equipment shall be sized according to ACCA Manual J.

1401.4 Heating and cooling equipment 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 (508 mm) wide. An unobstructed working space not less than 30 inches (762 mm) wide and not less than 30 inches (762 mm) high shall be provided along the control side of the equipment when the door of the equipment room is open.

1401.5 Attic installations. When equipment is located in an attic, a minimum 22 inch (559 mm) wide by 30 inch (762 mm) high passageway shall be provided from the attic opening to the equipment and its controls. The access opening shall not be smaller than 20 inches (508 mm) wide by 30 inches (762 mm) long, and may be located in a 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 (559 mm) floor. Flooring shall extend a minimum of 30 inches (762 mm) in width along the control side of the equipment with a 30 inch (762 mm) high clear working space on all sides where access is necessary for servicing.

1401.6 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 36 inches (914 mm) wide by 22 inches (559 mm)high, shall be provided to the working space in front of the equipment.

1401.6.1 Ground clearance. Equipment supported from the ground shall be level and firmly supported on a concrete slab or a minimum of 4 x 8 x 16 inch masonry units extending not less than 3-inches above the adjoining ground. All stacked masonry units shall be held in place with mortar. Equipment may be supported from floor joists with steel supports or with wood supports when the equipment is labeled for zero clearance to combustibles. Equipment suspended from the floor shall have a clearance of not less than 6-inches from the ground.

1401.6.2 Excavations. 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. Below grade installations shall be provided with a natural drain or an automatic lift or sump pump

1401.7 Exterior installations. Equipment installed outdoors shall be listed and labeled for outdoor installation. Supports and foundations shall prevent excessive vibration, settlement, or movement of the equipment. Supports and foundations shall be level and conform to the manufacturer's installation instructions. For ground installations, the appliance shall be supported on pre-cast or poured concrete, masonry units, approved prefabricated inorganic materials, structural steel or pressure treated wood.

SECTION 1402
WARM–AIR FURNACES

1402.1 General. Warm–air furnaces shall conform to the applicable ANSI Z21.47, Z21.64 or ANSI/UL 727. Fuel–burning warm–air furnaces shall not be installed in a room designed to be used as a storage closet. 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.

1402.2 Clearances. Clearances shall be provided for warm–air furnaces in accordance with the listing and the manufacturer's installation instructions.

1402.3 Combustion air. Fuel–burning warm–air furnaces shall be supplied with combustion air in accordance with Chapter 20 of this code. Combustion air openings shall be unobstructed at least 6 inches (153 mm) in front of the openings.

1402.4 Electric furnaces. Electric furnaces shall be constructed in accordance with UL 1096. Electric furnaces shall be installed in compliance with their listing and the manufacturer's installation instructions.

SECTION 1403
HEAT PUMP EQUIPMENT

1403.1 Heating elements. Heat pump equipment utilizing supplemental electric heating elements shall have such elements constructed in accordance with UL 559.

1403.2 Foundations and supports. Supports and foundations for the outdoor unit of a heat pump shall be raised at least 3 inches (76 mm) above the ground to permit free drainage of defrost water, and shall conform to the manufacturer's installation instructions.

SECTION 1404
REFRIGERATION COOLING EQUIPMENT

1404.1 Compliance. Refrigeration cooling equipment shall comply with Chapter 24.

CHAPTER 15
ELECTRIC RESISTANCE HEATING

SECTION 1501
BASEBOARD CONVECTORS

1501.1 General. Electric baseboard convectors shall be listed and labeled and shall be installed in accordance with the manufacturer's installation instructions and Volume IV Electrical Code.

SECTION 1502
RADIANT HEATING SYSTEMS

1502.1 General. Radiant heating systems shall be listed and labeled and shall be installed in accordance with the manufacturer's installation instructions and Chapter 40 of this code.

1502.2 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 Chapter 42 of this code.

1502.3 Installation of radiant panels. Radiant panels installed on 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 (6.4 mm) from an element.
3. Unless listed and labeled for field cutting, heating panels shall be installed as complete units.

1502.4 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.

1502.5 Gypsum panels. When radiant heating systems are used in gypsum assemblies, operating temperatures shall not exceed 125°F. (52°C.).

1502.6 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 so that nails or other fastenings do not pierce the radiant heating elements.

SECTION 1503
DUCT HEATERS

1503.1 General. Electric duct heaters shall be listed and labeled and shall be installed in accordance with the manufacturer's installation instructions and Chapter 42 of this code.

1503.2 Installation. Electric duct heaters shall be installed so 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 listed and 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.

1503.3 Installation with heat pumps and air conditioners. Duct heaters located within 4 feet (1219 mm) of a heat pump or air conditioner shall be listed and labeled for such installations. The heat pump or air conditioner shall additionally be listed and labeled for such duct heater installations.

1503.4 Access. Duct heaters shall be accessible for servicing, and clearance shall be maintained to permit adjustment, servicing, and replacement of controls and heating elements.

CHAPTER 16
FLOOR, WALL AND ROOM HEATERS

SECTION 1601
VENTED FLOOR FURNACES

1601.1 General. Vented floor furnaces shall conform to ANSI Z21.48 or ANSI/UL 729 and shall be installed in accordance with the manufacturer's installation instructions and the requirements of this code.

1601.2 Clearances. Vented floor furnaces shall be installed in accordance with their listing and the manufacturer's installation instructions.

1601.3 Location. Location of floor furnaces shall conform to the following requirements:

1. Floor registers of floor furnaces shall be installed not less than 6 inches (153 mm) from a wall.
2. Wall registers of floor furnaces shall be installed not less than 6 inches (153 mm) from the adjoining wall at inside corners.
3. The furnace register shall be located not less than12 inches (305 mm) from doors in any position, draperies or similar combustible objects.
4. The furnace register shall be located at least 5 feet (1524 mm) below any projecting combustible materials.
5. The floor furnace burner assembly shall not project into an occupied under–floor area.

1601.4 Access. An opening in the foundation not less than18 inches by 24 inches (457 mm by 610 mm), or a trap door not less than 20 inches by 30 inches (508 mm by 762 mm) 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.

1601.5 Installation. Floor furnace installations shall conform to the following requirements:

1. Thermostats controlling floor furnaces shall be located in 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 (153 mm) to the ground. Clearance may be reduced to 2 inches (51 mm), provided that the lower 6 inches (153 mm) of the furnace is sealed to prevent water entry.
4. When excavation is required for a floor furnace installation, the excavation shall extend 30 inches (762 mm) beyond the control side of the floor furnace and 12 inches (305 mm) 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 1602
VENTED WALL FURNACES

1602.1 General. Vented wall furnace construction conforming with ANSI Z21.44, Z21.49 or ANSI/UL 730 shall be installed in accordance with the manufacturer's installation instructions and the requirements of this code.

1602.2 Location. The location of vented wall furnaces shall conform to the following requirements:

1. Vented wall furnaces shall be located not less than 6 inches (153 mm) from adjoining walls at inside corners.
2. Vented wall furnaces shall not be located where a door can swing within 12 inches (305 mm) of the furnace air inlet or outlet and shall not be installed less than18 inches (457 mm) below overhead projections.

1602.3 Installation. Vented wall furnace installations shall conform to the following requirements:

1. Required wall thicknesses shall be in accordance with the manufacturer's installation instructions.
2. Ducts shall not be attached to a wall furnace. Casing extensions or boots shall only be installed when listed as part of a listed and labeled appliance.

SECTION 1603
VENTED ROOM HEATERS

1603.1 General. Vented room heaters conforming with ANSI Z21.11.1, UL 1482 or UL 896 shall be installed in accordance with the manufacturer's installation instructions and the requirements of this code.

1603.2 Clearances. Vented room heaters shall be installed in accordance with their listing and the manufacturer's installation instructions.

1603.3 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 marked "For use in noncombustible fireplace only" shall be installed as listed and labeled.

1603.4 Installation. Room heaters shall be installed on noncombustible floors or approved assemblies constructed of noncombustible materials that extend at least 18 inches (457 mm) beyond the appliance on all sides.

1603.5 Solid–fuel–burning heaters. Solid–fuel–burning heaters installed in garages shall be installed in accordance with the manufacturer's installation instructions and the requirements of this code.

SECTION 1603
UNVENTED ROOM HEATERS

1604.1 General. Listed unvented free-standing room heaters shall be installed in accordance with their listing and the manufacturer's instructions. Unvented free-standing room heaters shall not have a normal input rating in excess of 40,000 BTU per hour and shall not be installed in bedrooms or bathrooms.

1604.2 Prohibited locations. Wall type room heaters shall not be installed in or attached to walls of combustible construction unless listed for such installation. Gas fired heaters installed in bedrooms or rooms generally kept closed shall be of the vented type and shall be connected to an effective chimney or gas vent and equipped with a safety shutoff device.

1604.3 Oxygen depletion safety shutoff systems (ODS). All unvented room heaters shall be equipped with an oxygen depletion sensitive safety shutoff system. The system shall shut off the gas supply to the main and pilot burners when the oxygen in the surrounding atmosphere is depleted to the percent concentration specified by the manufacturer, but not lower than 18%. The system shall not incorporate field adjustment means capable of changing the set point at which the system acts to shut off the gas supply to the room heater.

1604.4 Installation of Unvented Heaters in Bathrooms. Unvented room heaters suitable and listed for installation in bathrooms shall have input ratings of 6,000 BTUs per hour or less and shall be wall mounted.

1604.5 Clearances. Vented room heaters shall be installed with clearances in accordance with Table No. 1306.1a or in accordance with the manufacturer's installation instructions, as approved.

1604.6 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.

1604.7 Installation. Freestanding unvented 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.

CHAPTER 17
VENTILATION AIR SUPPLY

SECTION 1701
GENERAL

1701.1 Ventilation required. Ventilation shall be required in accordance with Section 303.

SECTION 1702
EVAPORATIVE COOLING EQUIPMENT

1702.1 General. Cooling equipment that utilizes evaporation of water for cooling shall be installed in accordance with the manufacturer's installation instructions. Evaporative coolers shall be installed on a level platform or base not less than 3 inches (76 mm) above the adjoining ground and secured to prevent displacement. Openings in exterior walls shall be flashed in accordance with Section 703.8.

CHAPTER 18
EXHAUST SYSTEMS

SECTION 1801
CLOTHES DRYERS EXHAUST

1801.1 General. Dryer vent systems shall be independent of all other systems and shall convey the moisture to the outdoors. Vents shall not be connected with sheet–metal screws or fastening means which extend into the vent. Exhaust vents shall be equipped with a backdraft damper. Vents shall be constructed of minimum 0.016–inch–thick (0.406 mm) rigid metal ducts, having smooth interior surfaces with joints running in the direction of air flow. Non-combustible flexible duct may be used when installed without dips or kinks. Approved flexible duct connectors may be used in connection with domestic dryer exhausts. Flexible duct connectors shall not be concealed within construction.

1801.2 Exhaust vent size. The minimum diameter of the exhaust vent shall be in accordance with Section 1801.3, but shall be at least the diameter of the appliance outlet.

1801.3 Length limitation. The minimum size of the exhaust duct shall be 4 inches(102 mm) ID. The maximum length of rigid metal duct shal not exceed 45 feet (13716 mm) from dryer location to wall or roof cap. There shall be a deduction of 5 ft (1524 mm) for each 45-degree (0.785 rad) bend and 10 feet (3048 mm) for each 90-degree (1.57 rad) bend. The maximum length for noncombustible flexible duct shall not exceed 25 feet (7620 mm) from the dryer location to the wall or roof cap. There shall be a deduction of 2 1/2 feet (762 mm) for each 45-degree (0.785 rad) bend and 5 feet (1524 mm) for each 90-degree (1.57 rad) bend. Åll wall or roof caps shall be nonscreened with backdraft damper and minimum size of 4 inches (102mm). The entire exhaust system shall be properly secured in place. Installations when this length is exceeded shall be installed in accordance with the manufacturer's installation instructions.

1801.4 Termination. Exhaust vent caps shall terminate as recommended by the manufacturer, but shall not be less than 12 inches above grade.

SECTION 1802
RANGE HOODS

1802.1 General. Range hoods shall be vented to the outdoors by a single–wall duct constructed of galvanized steel, stainless steel or copper. Vents serving range hoods shall not terminate in an attic or crawl space or areas inside the building. Listed and labeled unvented range hoods shall be installed in accordance with the terms of their listing.

SECTION 1803
INSTALLATION OF MICROWAVE OVENS

1803.1 Installation of microwave oven over a cooking appliance. The installation of a listed and labeled cooking appliance or microwave oven over a listed and labeled cooking appliance shall conform to the terms of the upper appliance's listing and label and the manufacturer's installation instructions.

SECTION 1804
OVERHEAD VENTILATING HOODS

1804.1 General. 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 (6.4 mm) between the hood and the underside of combustible material or cabinets. A clearance of at least 24 inches (610 mm) 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 listed and labeled for use without a ventilating hood, need not be provided with a ventilating hood.

CHAPTER 19
DUCT SYSTEMS

SECTION 1901
DUCT CONSTRUCTION

1901.1 Materials. Ducts and duct materials used for a duct serving heating and cooling equipment shall be fabricated in accordance with the provisions of this section.

1901.1.1 Above ground duct systems. Above ground duct systems shall conform to the following:

1. Equipment connected to duct systems shall have a 250°F. (121°C.) temperature limit control.
2. Factory–made air ducts shall be constructed of Class 0, Class 1, or Class 2 materials as designated in Table 1901.1.1a. Class 2 materials shall not be used for ducts located within the first 3 feet (914 mm) of the bonnet, plenum or casing of the heating unit.
3. Minimum thicknesses of metal duct material shall be listed in Table 1901.1.1b. Galvanized steel shall conform to ASTM A 525.
4. Gypsum products may be used as ducts or plenums, provided that the air temperature does not exceed 125°F. (52°C.) and exposed surfaces are not subject to condensation.
5. Return ducts, except those portions directly above the heating surface or closer than 2 feet (610 mm) to the heating unit casing, shall be constructed of materials having a flame–spread rating not greater than 200.
6. 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 (51 mm) nominal thickness.

1901.1.2 Undergound duct systems. Underground duct systems shall be constructed of approved concrete, clay, metal or plastic. The maximum duct temperature for plastic ducts shall not be greater than 150°F. (66°C.). Plastic pipe and fittings shall conform to cell classification 12454–B of ASTM D 1248 or ASTM D 1784, and external loading properties of ASTM D 2412.

1901.2 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 listing and label indicating compliance with UL 181 and UL 181A or Ul 181B.

1901.2.1 Duct installation 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. (121°C.) minimum.
3. Fiberglass or mineral wool insulation shall be a minimum 2 inch (51 mm) thick, 3/4–pound (0.340 kg) density wrap or 1 inch (25 mm) thick, 1-1/2 pound (0.680 kg) 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.

1901.2.2 Vibration isolators. Vibration isolators installed between mechanical equipment and metal ducts shall be fabricated from approved materials and shall not exceed 10 inches (254 mm) in length.

1901.3 Installation. Duct installation shall comply with Sections 1901.3.1 through 1901.3.8.

1901.3.1 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 or other approved methods.

1901.3.2 Joints and seams. Joints of duct systems shall be made substantially air tight by means of tapes, mastics, gasketing, or other approved closure systems. Tapes and mastic closure systems used with rigid fibrous glass ducts shall comply with Part I, Part II, or Part III of UL 181A. Pressure sensitive tapes and mastic closure systems used with flexible air

TABLE 1901.1.1b
GAGES OF METAL DUCTS AND PLENUMS USED FOR 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

For **SI:** 1 inch = 25.4 mm.

ducts and flexible air connectors shall comply with Part I or Part II of UL 181B. Duct connections to flanges of air distribution system equipment or sheet metal fittings shall be mechanically fastened. Crimp joints for round ducts shall have a contact lap of at least 1-1/2 inches (38 mm) and shall be mechanically fastened by means of at least three sheet metal screws equally spaced around the joint.

TABLE 1901.1.1a
CLASSIFICATION OF FACTORY–MADE AIR DUCTS

DUCT CLASS	MAXIMUM FLAME–SPREAD RATING
0	0
1	25
2	50

1901.3.3 Support. Metal ducts shall be securely supported. Where hung, or suspended, metal straps a minimum of 1 inch in width and equivalent to or heavier gauge than the duct being supported shall be used. Straps, when used shall be at maximum 64 inch intervals and shall be securely attached to the building structure. Straps shall be attached to the duct at a minimum of 2 points with screws or rivets. Hanger systems shall comply with this section or other approved means. Nonmetallic or listed duct systems shall be supported in accordance with the manufacturer's installation instructions. All equipment shall be supported independently of the duct system ecxept when the duct is used as a support base. When used as a support base, the duct shall be of sufficient strength and designed to support the weight of the unit. Listed bases shall be installed in accordance with the manufacturer's installation instructions.

1901.3.4 Firestopping. Duct installations shall be firestopped in accordance with Section 602.7.

1901.3.5 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 [(2.87 ng/(sm^2 Pa)], or aluminum foil with a minimum thickness of 2 mils (0.051 mm), shall be installed on cooling supply ducts that pass through nonconditioned spaces conducive to condensation.
3. Exterior ducts shall be protected with weatherproof covering
4. Duct coverings shall not penetrate a firestopped wall or floor.
5. Replacement or addition of cooling equipment to existing ductwork located in an attic shall require the ductwork to be insulated. Replacement of heating and/or the addition of cooling equipment in a crawl space shall not require the existing ductwork to be insulated.

1901.3.6 Ducts in slabs. Ducts shall be listed and labeled for underground installation. Metallic ducts not having an approved protective coating shall be completely encased in a minimum of 2 inches (51 mm) of concrete. Metallic ducts having an approved protective coating and nonmetallic ducts shall be installed in accordance with the manufacturer's installation instructions.

1901.3.7 Factory–made air ducts. Factory–made air ducts shall not be installed in or within 4 inches of the ground, in tile or metal pipe, or within masonry or concrete.

1901.3.8 Metal duct separation. Metal ducts shall be installed with at least 4 inches (102 mm) separation from earth.

1901.4 Under–floor plenums. An under–floor space used as a supply plenum shall conform to the requirements of this section. Fuel gas lines and plumbing waste cleanouts shall not be located within the space.

1901.4.1 General. The space shall be cleaned of 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 minimum thickness of 4 mils (0.102 mm).

1901.4.2 Materials. The under–floor space, including the sidewall insulation, shall be formed by materials having flame–spread ratings not greater than 200.

1901.4.3 Furnace connections. A duct shall extend from the furnace supply outlet to not less than 6 inches (153 mm) below the combustible framing. This duct shall comply with the provisions of Section 1602.1. 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 not be more than 18 inches (457 mm) below the floor opening.
2. The area of the receptacle shall extend 3 inches (76 mm) beyond the opening on all sides.
3. The perimeter of the receptacle shall have a vertical lip at least 1 inch (25 mm) high at the open sides.

1901.4.4 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 (457 mm by 610 mm).

1901.4.5 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. (66°C.). The furnace shall additionally be equipped with an approved automatic control that limits the outlet air temperature to 200°F. (93°C.).

SECTION 1902
RETURN AIR

1902.1 Return air. Return air shall be taken from inside the dwelling, but may be diluted with outdoor air.

1902.2 Required area. The total unobstructed area of return ducts or openings to a warm–air furnace shall be in accordance with the manufacturer's installation instructions, but not less than 2 square inches (1290 mm^2) for each 1,000 Btu/h (293 W) input rating of the furnace. The minimum unobstructed total area of the return air ducts or openings to a central air–conditioning unit and/or heat pump shall be in accordance with the manufacturer's installation instructions, but shall not be less than 6 square inches (3870 mm^2) for each 1,000 Btu/h (293 W) nominal cooling output rating.

1902.3 Prohibited sources. Return air for a warm–air furnace shall not be taken from bathrooms, garages or other dwelling units. Outdoor air shall not be taken from within 10 feet (3048 mm) of an appliance or plumbing vent outlet that is located less than 3 feet (914 mm) above the air inlet.

1902.4 Inlet opening protection. Outdoor air inlets shall be covered with screen having no less than 1/4–inch (6.4 mm) openings and no greater than 1/2–inch (12.7 mm) openings.

1902.5 Return air intake (non-engineered systems). If only one central return air grille is installed, it shall be of proper size. The size shall be sufficient to return a volume of air compatible with the CFM requirements and temperature rise limitations specified by the equipment manufacturer. The face velocity of return air grilles shall not exceed 450 fpm. At least one separate return shall be installed on each level of a multilevel structure. For split-level and split-foyer structures one return may serve more than one level if located near the levels served and the total area of the levels does not exceed 1600 sq ft. Return air grilles shall not be located in bathrooms. The return air from one residential living unit shall not be mixed with return air from other living units.

In buildings with 1600 sq. ft. or less of conditioned area, a central return is permitted. When the building contains more than 1600 sq. ft. of conditioned area, additional returns shall be provided. Each return shall not serve more than 1600 sq. ft. of area and shall be located in the area it serves. Return air may travel through the living space to the return air intake if there are no restrictions, such as solid doors, to the air movement. When panned joists are used for return air, the structural integrity shall be maintained. Air capacity for joists, 16 inches on center shall be a maximum of 375 CFM for 8 inch joists and 525 CFM or 10 inch joists. Wiring located in spaces used for return air ducts shall comply with North Carolina State Building Code, Volume IV-Electrical.

SECTION 1903
SUPPLY AIR

1903.1 General. The minimum unobstructed total area of supply ducts from a warm–air furnace shall be in accordance with the manufacturer's installation instructions, but shall not be less than 2 square inches (1290 mm^2) for each 1,000 Btu/h (293 W) input rating of the furnace. The minimum unobstructed total area of the supply air ducts from a central air–conditioning unit and/or heat pump shall be in accordance with the manufacturer's installation instructions, but shall not be less than 6 square inches (3870 mm^2) for each 1,000 Btu/h (293 W) nominal cooling output rating. Dampers, grilles or registers installed for the purpose of controlling the supply airflow shall not be considered as obstructions.

CHAPTER 20
COMBUSTION AIR

SECTION 2001
GENERAL

2001.1 Air supply. Fuel-burning equipment shall be provided with a 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, listed cooking appliances, and refrigerators.

2001.1.1 Buildings of unusually tight construction. In buildings of unusually tight construction, combustion air shall be obtained from outside the sealed thermal envelope. In buildings of ordinary tightness insofar as infiltration is concerned, all or a portion of the combustion air for fuel-burning appliances may be obtained from infiltration when the room or space has a volume of 50 cubic feet per 1,000 Btu/h (4.83 L/W) input.

2001.2 Exhaust and ventilation system. Air requirements for 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. When a clothes dryer is installed in a confined space with other vented appliances, regardless of energy source, two openings shall be required and the size of the lower opening specified shall be increase by 60 sq. in. (38,710 mm^2) of free opening to provide air for blower of clothes dryer.

2001.3 Volume dampers prohibited. Volume dampers shall not be installed in combustion air openings.

2001.4 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.

2001.5 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 2002
ALL AIR FROM INSIDE THE BUILDING

2002.1 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 (4.83 L/W) of aggregate input rating in buildings of ordinary tightness insofar as infiltration is concerned, 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.

2002.2 Confined space. Where the space in which the appliance is located does not meet the criterion specified in Section 2002. 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 (305 mm) of the top and one within 12 inches (305 mm) of the bottom of the space, as illustrated in Figure 2002.2. Each opening shall have free area equal to a minimum of 1 square inch per 1,000 Btu/h (2.20 mm^2/W) input rating of all appliances installed within the space, but not less than 100 square inches (0.064 m^2).

2002.3 Unusually tight construction. If the space is of adequate volume in accordance with Section 2002.1 or 2002.2, 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 2003 or 2004.

SECTION 2003
ALL AIR FROM OUTDOORS

2003.1 Outdoor air. When the space in which fuel-burning appliances are located does not meet the criterion for indoor air specified in Section 2002, outside combustion air shall be supplied as specified in Section 2003.2 or 2003.3.

2003.2 Two openings or ducts. Outside combustion air shall be supplied through openings or ducts as illustrated in Figures 2003.1, 2003.3, 2003.4. One opening shall be within 12 inches (305 mm) of the top of the enclosure, and one within 12 inches (305 mm) of the bottom of the enclosure. Openings are permitted to connect to spaces directly communicating with the outdoors, such as ventilated crawl spaces or ventilated attic spaces. The same duct or opening shall not serve both combustion or air openings. The duct serving the upper opening shall be level or extend upward from the appliance space.

2003.2.1 Size of openings. When communicating with the outdoors by means of vertical ducts, each opening shall have a free area of at least 1 square inch per 4,000 Btu/h (0.55 mm^2/W) 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 (0.275 mm^2/W) 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 (76 mm).

2003.3 Single opening or duct. For an appliance with a minimum clearance of 1 inch (25.4 mm)on the sides and back and 6 inches (152 mm) on the front, outside combustion air shall be supplied through one opening or duct. The opening or duct shall be within 12 inches (305 mm) of the top of the enclosure. The opening is permitted to connect to spaces directly communicating with the outdoors, such as ventilated crawl spaces or ventilated attic spaces. A duct shall be level or extend upward from the appliance space.

2003.3.1 Size of opening. When communicating with the outdoors by means of a single opening or duct. the opening or duct shall have a free area of at least 1 square inch per 3,000 Btu/h (0.413 mm^2/W) of total input rating of all appliances in the space, but no smaller than the vent flow area. A duct shall be of the same minimum cross-sectional dimension of a rectangular air duct shall be 3 inches (76 mm).

2003.4 Attic combustion air. Combustion air obtained from an attic area, as illustrated in Figure 2003.3, 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 extending from the appliance enclosure to at least 6 inches (153 mm) above the top of the ceiling joists and ceiling insulation.
3. The end of ducts that terminate in an attic shall not be screened.

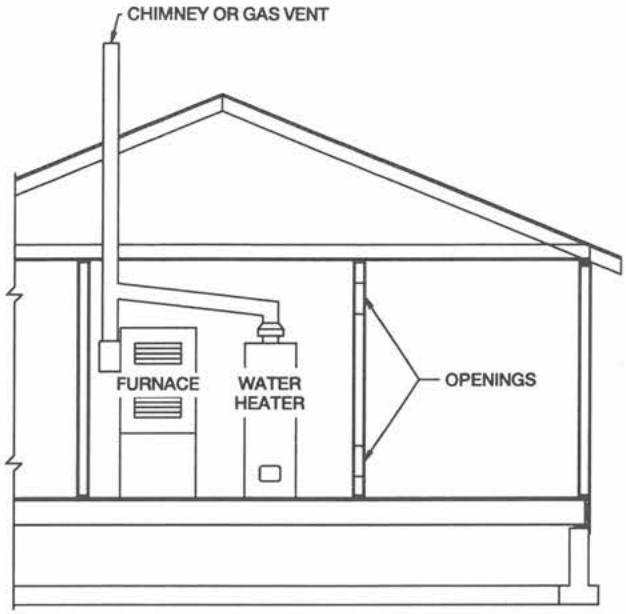
2003.5 Under-floor combustion air. Combustion air obtained from under-floor areas, shall have a free opening area to the outside equivalent to not less than twice the required combustion air opening.

2003.6 Opening requirements. Outside combustion air openings shall be covered with corrosion-resistant screen or equivalent protection having no less than 1/4-inch (6.4 mm) openings, and not greater than 1/2-inch (12.7 mm) openings.

SECTION 2004
COMBINED USE OF INDOOR AND OUTDOOR AIR

2004.1 General. When the space in which fuel-burning appliances are located does not meet the criterion for indoor air specified in Section 2002, 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.

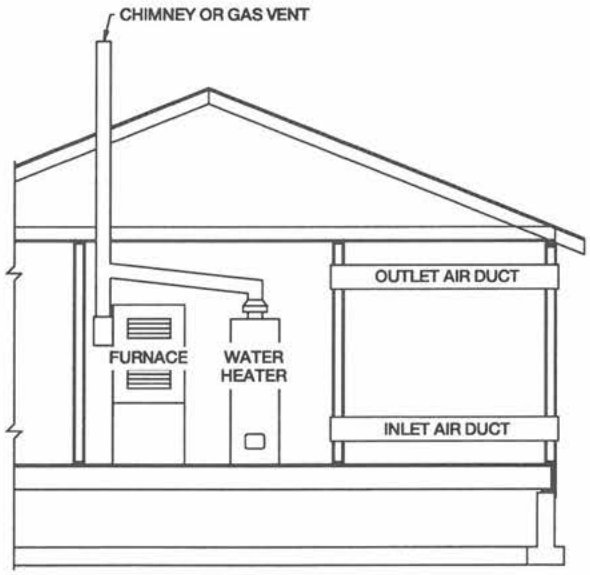
2004.2 Openings and supply ducts. Two openings for ventilation shall be located and sized in accordance with Section 2002.2. In addition, there shall be one opening directly communicating with the outdoors or to such spaces (crawl space or attic) that freely communicates with the outdoors. This opening shall have free area of at least 1 square inch per 5,000 Btu/h (0.440 mm^2/W) 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.



For: **SI:** 1 square inch = 645.16 mm^2, 1 Btu/h=0.2931 W.

NOTES: Each opening shall have a free area of not less than 1 square inch per 1,000 Btu/h of the total input rating of all equipment in the enclosure.

FIGURE 2002.2
EQUIPMENT LOCATED IN CONFINED SPACES—ALL AIR FROM ADJACENT SPACES WITHIN THE BUILDING

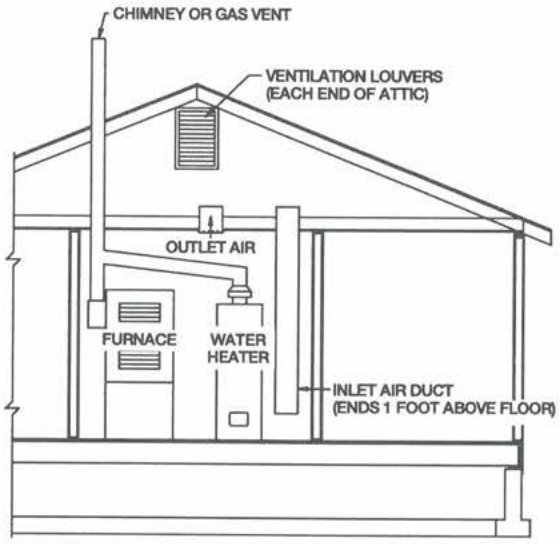


For: **SI:** 1 Btu/h=0.2931 W.

NOTES: Each air duct opening shall have a free area of not less than 1 square inch per 2,000 Btu/h of the total input 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 1 square inch per 4,000 Btu/h of the total input rating of all equipment in the enclosure.

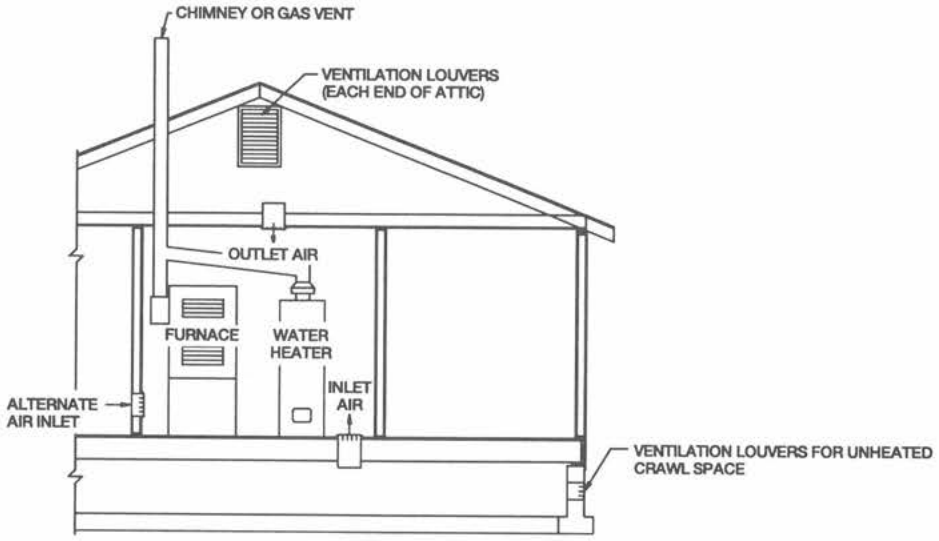
FIGURE 2003.1
EQUIPMENT LOCATED IN CONFINED SPACES—ALL AIR TAKEN FROM OUTDOORS



For **SI:** 1 inch = 25.4 mm, 1 square inch = 645.16 mm^2, 1 Btu/h = 0.2931 W.

NOTE: The inlet and outlet air openings shall each have a free area of not less than 1 square inch per 4,000 Btu/h of the total input rating of all equipment in the enclosure.

FIGURE 2003.3
EQUIPMENT LOCATED IN CONFINED SPACE-ALL AIR FROM OUTDOORS THROUGH VENTILATED ATTIC



For **SI:** 1 square inch = 645.16 mm^2, 1 Btu/h = 0.2931 W.

Note: The inlet and outlet air opening shall each have a free area of not less than 1 square inch per 4000 Btu of total input rating all equipment in the enclosure.

FIGURE 2003.4
EQUIPMENT LOCATED IN CONFINED SPACES—INLET AIR FROM VENTILATED CRAWL SPACE AND OUTLET AIR TO VENTILATED ATTIC

CHAPTER 21
CHIMNEYS AND VENTS

SECTION 2101
GENERAL

2101.1 Vent required. Fuel-burning appliances shall be vented to the outside in accordance with their listing and label and manufacturer's installation instructions except appliances listed and labeled for unvented use. Venting systems shall consist of approved chimneys or vents. or venting assemblies which are integral parts of labeled appliances.

2101.2 Draft requirements. A venting system shall satisfy the draft requirement of the equipment in accordance with the manufacturer's installation instructions and shall be constructed and installed to develop a positive flow to convey combustion products to the outside atmosphere.

2101.3 Inspection of chimneys. Before connecting a vent connector to a chimney, the chimney passageway shall be cleaned and 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 1001 and 1002, lined or relined with an approved liner, or replaced with an approved vent or chimney.

2101.4 Mechanical draft systems. A mechanical draft system shall be used only with equipment Listed and 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.

2101.5 Direct vent appliances. Direct vent appliances shall be ted and labeled and shall be installed in accordance with the manufacturer's installation instructions.

2101.6 Support. Venting systems shall be adequately supported or the weight of the material used.

2101.7 Duct penetrations. Vents or vent connectors shall not extend into or through supply and return air ducts or plenums.

2101.8 Firestopping. Vent and chimney installations shall be firestopped in accordance with Section 602.7.

2101.9 Unused openings. Unused openings in any venting system shall be closed or capped.

SECTION 2102
VENT COMPONENTS

2102.1 Draft hoods. Draft hoods shall be located in the same room or space as the combustion air openings for the appliances.

2102.2 Vent dampers. Vent dampers shall comply with Sections 2102.2.1 and 2102.2.2.

2102.2.1 Manually operated. Manually operated dampers shall not be installed except in connectors or chimneys of solid-fuel-burning appliances.

2102.2.2 Automatically operated. Automatically operated dampers shall be installed in accordance with the terms of their listing and 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 ANSI Z21.66.

2102.3 Draft regulators. Draft regulators shall be provided for oil-fired appliances required to be connected to a chimney. 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.

2102.3.1 Location. When 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 2103
CHIMNEY AND VENT CONNECTORS

2103.1 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.

2103.2 Connectors for gas appliances. Connectors for labeled gas appliances and appliances equipped with a listed and labeled gas burner and draft hood shall be of Type B or Type L vent material, or single-wall metal pipe. The minimum nominal thickness of a single-wall vent connector shall be 0.019 inch (0.483 mm) (No. 28 gage) for galvanized steel, 0.022 inch (0.559 mm) (No. 26 B.&S. gage) for copper, and 0.020 inch (0.508 mm) (No. 24 B.&S. gage) for aluminum. Connectors for Category II, III and IV equipment shall be as specified by the manufacturer's instructions.

2103.3 Connectors for oil and solid fuel appliances. Connectors for oil and solid-fuel-burning appliances shall be 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 steel as specified in Table 2103.3.

TABLE 2103.3
THICKNESS FOR SINGLE-WALL METAL PIPE CONNECTORS

DIAMETER OF CONNECTOR (inches)	SHEET METAL GAGE NUMBER
Less than 6	26
6 to 10	24

For **SI:** 1 inch = 25.4 mm

2103.4 Installation. Vent and chimney connectors shall be installed in accordance with the appliance 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 installed with a rise of not less than 1/4 inch (6.4 mm) to the foot run. Connectors shall be securely supported and joints shall be l:fastened with sheet metal screws and rivets. Devices that obstruct the flow of flue gases shall not be installed in a connector unless listed and labeled or approved for such installations.

2103.4.1 Location. When the connector serving a gas appliance with a draft hood is located in nonconditioned space, that portion of the connector shall be listed and labeled Type B or Type L vent material.

2103.4.2 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 listed and labeled for wall pass-through, or is routed through a device listed and labeled for wall pass-through and is installed in accordance with the conditions of its listing and label. Connectors for listed and labeled gas appliances with draft hoods, and oil-fired appliances listed and 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 and Type L vent material for oil appliances shall be installed with not less than listed and labeled clearances to combustible material.
2. Single-wall metal pipe shall be guarded by a ventilated metal thimble not less than 4 inches (102 mm) larger in diameter than the vent connector.

2103.4.3 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 a listed connector to a natural draft chimney shall not exceed 100 percent of the height of the vertical portion of the chimney above the connector.

2103.4.4 Size. A connector shall not be smaller than the flue collar of the appliance.

Exception: When installed in accordance with the manufacturer's installation instructions as approved by the building official .

2103.4.5 Clearance. Connectors shall be installed with clearance to combustibles as set forth in Table 2103.4.5. Reduced clearances to combustible material shall be in accordance with Table 1306.1b and Figure 1306.1.

2103.4.6 Access. The entire length of a connector shall be accessible for inspection. cleaning and replacement.

2103.4.7 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 2103.4.5
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
Unlisted Gas Appliances with Draft Hoods	9
Oil Appliances Listed for Use with Type L Vents	9
Listed Gas Appliances with Draft Hoods[2]	6
Type L Vent Piping Connectors	
Gas Appliances without Draft Hoods	9
Oil and Solid-Fuel Appliances	9
Unlisted Gas Appliances with Draft Hoods	6
Oil Appliances Listed for use with Type L Vent	__[3]
Listed Gas Appliances with Draft Hoods	__[2]
Type B Gas Vent Piping connectors	
Listed Gas Appliances with Draft Hoods	__[2]

For **SI:** 1 inch = 25.4 mm.

1 These minimum clearances apply to unlisted single-wall chimney and vent connector. Reduction of required clearances are permitted as in Table 1306.1b.

2 When listed Type B or Type L vent piping is used. The clearance shall be in accordance with the vent listing.

3 When listed Type L vent piping is used the clearance shall be in accordance with the vent listing.

SECTION 2104
VENTS

2104.1 Type of vent required. Appliances shall be provided with a listed and labeled venting system as set forth in Table 2104.1 .

2104.2 Termination. Vent termination shall comply with Sections 2104.2.1 through 2104.2.6.

2104.2.1 Through the roof. Vents passing through a roof shall extend through flashing and terminate in accordance with the manufacturer's installation requirements.

2104.2.2 Natural draft appliances. Vents for natural draft appliances shall terminate at least 5 feet (1524 mm) above the highest connected appliance outlet, and natural draft gas vents serving wall furnaces shall terminate at an elevation at least 12 feet (3658 mm) above the bottom of the furnace.

TABLE 2104.1
VENT SELECTION CHART

TYPE B GAS	TYPE BW GAS	SPECIAL GAS VENT SYSTEMS	TYPE L OIL, ETC.
All listed gas appliances with draft hoods, and other Category I gas appliance vents listed and labeled for use with Type B Gas Vents	Vented wall furnaces listed and labeled or use with Type BW vents.	Category II, III, and IV gas appliances, according to the manufacturer's recommendations and as listed and labeled.	Oil-burning appliances listed and labeled for use the Type l vents; gas appliances listed and labeled for use with Type B vents.

2104.2.3 Type B or BW vent. Type B or BW gas vents shall conform to UL 441. Such vents shall terminate in listed vent caps 12 inches (305 mm) in size or smaller in accordance with Table 2104.2.3 provided the vent is located at least 8 feet (2438 mm) from a vertical wall. If the vent is within 8 feet (2438 mm) of a wall, the vent shall be extended 2 feet (610 mm) above the wall.

2104.2.4 Type L vent. Type L venting systems shall conform to UL 641. Such vents shall terminate not less than 2 feet (610 mm) above any portion of the building within 10 feet (3048 mm).

2104.2.5 Direct vent appliances. Vent terminals for direct vent appliances shall be located in accordance with Sections 2104.2.5.1 through 2104.2.5.3. The bottom of the vent terminal and air intake shall be located not less than 12 inches (305 mm) above grade.

2104.2.5.1 Input 10,000 Btu/h (2931 W) or less. The vent terminal of a direct vent appliance with an input of 10,000 Btu/h (2931 W) or less shall be located not less than 6 inches (153 mm) from any opening through which flue gases could enter a building.

2104.2.5.2 Input greater than 10,000 Btu/h (2931 W) and not greater than 50,000 Btu/h (14 655 W). The vent terminal of a direct vent appliance with an input of greater than 10,000 Btu/h (2931 W) and not greater the 50,000 Btu/h (14 655) shall be located not less than 9 inches (229 mm) from any opening through which flue gases could enter a building.

2104.2.5.3 Input greater than 50,000 Btu/h (14 655 W). The vent terminal of a direct vent appliance with an input over 50,000 Btu/h (14655 W) shall be located not less than 12 inches (305 mm) from any opening through which flue gases could enter a building.

2104.2.6 Mechanical draft systems. Mechanical draft systems other than direct vent systems shall be installed in accordance with their listing and the manufacturer's installation instructions.

2104.3 Installation. Type B, Type BW and Type L vents shall be installed in accordance with the terms of their listing and label and the manufacturer's installation instructions. Venting systems for listed and labeled Category II, III, and IV gas appliances shall be installed in accordance with the manufacturer's installation instructions.

2104.3.1 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 (4515 mm2) except where the vent is an integral part of a listed and labeled appliance. Vents shall be sized according to Table 2104.3.1 for a single Category I gas appliance or NC Building Code Volume VI Gas.

2104.3.2 Size of multiple-appliance venting systems. Two or more listed and 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 Tables 2104.3.2a and 2104.3.2b for two or more Category I gas appliances.
2. Appliances which are connected to common venting systems shall be located on the same floor of the dwelling.

Exception: Engineered systems as provided in Section 2101.

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. 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.

2104.3.3 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 not be less than the area of the flue collar or connector but not larger than three times the area of the flue collar.

TABLE 2104.2.3
VENT TERMINATION REQUIREMENTS

ROOF SLOPE	MINIMUM HEIGHT FROM ROOF TO LOWEST DISCHARGE OPENING (feet-inches)
Flat to 6/12	1-0
Over 6/12 to 7/12	1-3
Over 7/12 to 8/12	1-6
Over 8/12 to 9/12	2-0
Over 9/12 to 10/12	2-6
Over 10/12 to 11/12	3-3
Over 11/12 to 12/12	4-0
Over 12/12 to 14/12	5-0
Over 14/12 to 16/12	6-0
Over 16/12 to 18/12	7-0
Over 18/12 to 20/12	7-6
Over 20/12 to 21/12	8-0

For **SI:** 1 inch = 25.4 mm, 1 foot = 304.8 mm.

SECTION 2105
MASONRY AND FACTORY-BUILT CHIMNEYS

2105.1 General. Masonry and factory-built chimneys shall be built and installed in accordance with Sections 1001 and 1002, respectively.

2105.2 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 listing and label. Factory-built chimneys for use with wood-burning appliances shall be Type HT.

2105.3 Masonry chimney connection. A chimney connector shall enter a masonry chimney not less than 6 inches (153 mm) above the bottom of the chimney, except that if 6 inches (153 mm) 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.

2105.4 Size of masonry chimneys. The effective area of a natural draft chimney flue for one appliance shall not be less than the area of the connector to the appliance. Chimneys connected to more than one appliance shall not be less than the area of the largest connector plus 50 percent of the areas of additional vent connectors.

2105.4.1 Size of chimney for single gas appliance. Masonry chimneys serving a single Category I gas appliance shall be sized in accordance with Table 2105.4.1.

2105.4.2 Size of chimney for multiple gas appliance. Venting of multiple gas appliances through masonry chimneys shall conform to Section 2104.3.2, except that masonry chimneys serving multiple Category I gas appliances shall be sized in accordance with Tables 2105.4.2a and 2105.4.2b.

TABLE 2104.3.1
CAPACITY OF TYPE B VENTS SERVING A SINGLE CATEGORY I GAS APPLIANCE
(Appliance Input Rating in 1,000 Btu/h)

HEIGHT (feet)	Lateral (feet)	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

For **SI:** 1 inch=25.4 mm, 1 foot=304.8 mm,1 Btu/h=0.2931 W.

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.

(Continued on next page)

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 configuration with lateral lengths are assumed to have a maximum of two 90-degree elbows.
7. The table is only applicable to vents enclosed in a chase.
8. NR indicates not recommended.

TABLE 2104.3.2a
CAPACITY OF TYPE B VENT SERVING TWO OR MORE CATEGORY I GAS APPLIANCES
(Appliance Input Rating in 1,000 Btu/h)

	COMMON VENT DIAMETER (inches)														
	4			5			6			7			8		
HEIGHT (feet)	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

For **SI:** 1 inch=25.4 mm, 1 foot=304.8 mm,1 Btu/h=0.2931 W.

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 2104.3.2b
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

For **SI:** 1 inch=25.4 mm, 1 foot=304.8 mm,1 Btu/h=0.2931 W.

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 l/2 feet for each inch of connector diameter.
3. Other notes from Table 2105.4.1 apply.
4. NR indicates not recommended.

TABLE 2105.4.1
CAPACITY OF MASONRY CHIMNEY SERVING A SINGLE CATEGORY I APPLIANCE
(Appliance Input Rating in 1,000 Btu/h)

HEIGHT (feet)	LATERAL (feet)	CHIMNEY 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	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		

For **SI:** 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 Btu/h = 0.2931 W, 1 square inch = 645.16 mm^2.

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 system.
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-degrees elbows.
7. NR indicates not recommended.

TABLE 2105.4.2a
CAPACITY OF MASONRY CHIMNEY SERVING TWO OR MORE CATEGORY I APPLIANCES
(Appliance Input Rating in 1,000 Btu/h)

HEIGHT (feet)	RISE (feet)	VENT CONNECTOR DIAMETER (inches)																	
		3			4			5			6			7			8		
		FAN		NAT	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	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

For **SI:** 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 Btu/h = 0.2931 W.

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 for each inch of connector diameter.
3. Other notes from Table 2104.3.1 apply.
4. NR indicates not recommended.

TABLE 2105.4.2b
CAPACITY OF MASONRY CHIMNEY SERVING TWO OR MORE CATEGORY I APPLIANCES
(Appliance Input Rating in 1,000 Btu/h)

HGT. (feet)	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	1,000	450
15	NR	88	36	NR	149	66	NR	230	105	NR	335	150	NR	460	210	NR	602	280	NR	772	360	NR	1,139	540
20	NR	90	40	NR	157	74	NR	247	120	NR	362	170	NR	503	240	NR	661	321	NR	849	415	NR	1,264	640
30	NR	90	NR	NR	162	NR	NR	266	135	NR	398	195	NR	558	275	NR	739	377	NR	957	490	NR	1,447	740
50	NR	83	NR	NR	160	NR	NR	280	NR	NR	429	NR	NR	612	325	NR	821	456	NR	1076	600	NR	1,672	910

For **SI:** 1 square inch = 645.16 mm2, 1 foot = 304.8 mm, 1 Btu/h = 0.2931 W.

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 22
SPECIAL FUEL-BURNING EQUIPMENT

SECTION 2201
RANGES AND OVENS

2201.1 Clearances. Freestanding or built–in ranges shall have a vertical clearance above the cooking top of not less than30 inches (762 mm) to unprotected combustible material. When the underside of such combustible material is protected with non–combustible material or a metal ventilating hood, the distance shall not be less than 24 inches (610 mm). The minimum horizontal distance from the center of the burner heads of a top (or surface) cooking unit to surrounding combustible material shall not be less than that distance specified by its listing.

2201.2 Gas ranges and ovens. Gas ranges and ovens shall be listed and labeled and shall conform to ANSI Z21.1.

2201.3 Built–in units. Built–in household cooking appliances shall be listed and 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.

SECTION 2202
OPEN–TOP GAS BROILER UNITS

2202.1 General. Open–top gas broiler units shall be listed and labeled and shall be installed in accordance with the manufacturer's installation instructions. Open–top gas broiler units shall conform to ANSI Z21.1.

SECTION 2203
OUTDOOR GAS COOKING APPLIANCES

2203.1 General. Outdoor gas cooking appliances shall be listed and 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.

SECTION 2204
CLOTHES DRYERS

2204.1 General. Clothes dryers shall be listed and labeled and shall be installed in accordance with the manufacturer's installation instructions. Gas clothes dryers shall conform to ANSI Z21.5.1.

2204.2 Closet installation. Gas clothes dryers installed in closets shall be listed and labeled for such installations and no other fuel–burning appliance shall be installed in the same closet.

SECTION 2205
VENTED DECORATIVE GAS APPLIANCES, DECORATIVE GAS APPLIANCES FOR INSTALLATION IN VENTED SOLID–FUEL–BURNING FIREPLACES AND GAS–FIRED LOG LIGHTERS

2205.1 General. Vented decorative gas appliances shall conform to ANSI Z21.50.

2205.2 Vented decorative gas appliances. Vented decorative gas appliances shall be listed and labeled and shall be installed in accordance with the manufacturer's installation instructions.

2205.2.1 Combustion air. Combustion air shall be provided in accordance with Chapter 20.

2205.3 Decorative gas appliances for installation in vented solid–fuel–burning fireplaces. Decorative gas appliances for installation in vented solid–fuel–burning fireplaces shall be listed and labeled and shall be installed in accordance with the manufacturer's installation instructions.

2205.4 Gas logs. Listed and labeled gas logs installed in vented solid–fuel–burning fireplaces shall be in accordance with the provisions of this section.

1. The gas logs are installed in accordance with their listing and label and the manufacturer's installation instructions.
2. If the fireplace is equipped with a damper, it shall be permanently blocked open to provide not less than the appliance manufacturer's required minimum vent opening at all times.
3. The minimum flue passageway shall not be less than 1 square inch per 1,000 Btu/h (2.20 mm2/W) input.
4. Gas logs equipped with a pilot shall have a listed and labeled automatic safety control valve.

2205.5 Gas–fired log lighters. Unlisted gas–fired log lighters shall be installed in accordance with the manufacturer's installation instructions.

SECTION 2206
GAS LIGHTS

2206.1 Clearances. Gas lights shall be listed and labeled and shall be installed in accordance with the manufacturer's installation instructions.

2206.2 Mounting on buildings. Gas lights for wall or ceiling mounting shall be attached to a substantial structure in such a manner that they are not dependent on the gas piping for support.

2206.3 Mounting on posts. Gas lights for post mounting shall be rigidly attached to a post. Posts shall be rigidly mounted. The strength and rigidity of posts greater than 3 feet (914 mm) in height shall be at least equivalent to that of a 2-1/2 inch–diameter (64 mm) post constructed of 14 gage steel, or 1 inch (25 mm) Schedule 40 steel pipe. Posts 3 feet (914 mm) or less in height shall not be smaller than a 3/4–inch (19 mm) Schedule 40 steel pipe. Drain openings shall be provided near the base of posts when there is a possibility of water collecting inside them.

2206.4 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 have the requisite capacity to supply all appliances simultaneously.

SECTION 2207
SAUNA HEATERS

2207.1 Locations and protection. Sauna heaters shall be protected from accidental contact by persons with a guard of material having a low thermal conductivity, such as wood. The guard shall have no effect on the transfer of heat from the heater to the room.

2207.2 Installation. Sauna heaters shall be listed and labeled and shall be installed in accordance with the manufacturer's installation instructions.

2207.3 Connection of gas–fired heaters. The provisions of Chapter 26 shall apply to gas connections. When access to controls is from an adjacent room, connections shall be made in that location.

2207.4 Combustion air. Combustion air for gas–fired sauna heaters shall not be taken from inside the sauna room. Combustion air and venting for a nondirect vent–type heater shall be provided in accordance with Chapters 20 and 21, respectively.

2207.5 Controls. Sauna heaters shall be equipped with a thermostat that will limit room temperature to no greater than 194°F. (90°C.). If the thermostat is not an integral part of the heater, the heat–sensing element shall be located within 6 inches (153 mm) of the ceiling.

CHAPTER 23
BOILERS/WATER HEATERS

SECTION 2301
BOILERS

2301.1 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 20.

2301.2 Clearance. Boilers shall be installed in accordance with their listing and label or Section 1306.

SECTION 2302
OPERATING AND SAFETY CONTROLS

2302.1 Safety controls. Electrical and mechanical operating and safety controls for boilers shall be listed and labeled.

2302.2 Boiler gages. Boilers shall be equipped with pressure and temperature gages that indicate pressure and temperature within the normal range of operation.

2302.3 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 (457 mm) of the floor or to an open receptor.

SECTION 2303
EXPANSION TANKS

2303.1 General. Boilers shall be provided with expansion tanks. Nonpressurized expansion tanks shall be securely fastened to the structure or boiler and supported to carry twice the weight of the tank filled with water. Provisions shall be made for draining nonpressurized tanks without emptying the system.

2303.1.1 Pressurized expansion tanks. 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.

2303.2 Minimum capacity. The minimum capacity of expansion tanks shall be determined from Table 2303.2.

SECTION 2304
BASEBOARD CONVECTORS

2304.1 General. Baseboard convectors shall be installed in accordance with the manufacturer's installation instructions. Convectors shall be supported independent of the hydronic piping.

TABLE 2303.2
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

For **SI:** 1 gallon = 3.785 L, 1 psig = 6.895 kPa, °F. = 1.8°C. + 32.

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 2305
FLOOR HEATING SYSTEMS

2305.1 Piping materials. Piping for embedment in concrete or gypsum materials shall be standard–weight steel pipe, copper tubing, chlorinated poly (vinyl chloride) or polybutylene with a minimum rating of 100 psi at 180°F. (68.9 kPa at 146°C.).

2305.2 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 1,000°F. (538°C.).
3. Polybutylene pipe and tubing joints shall be installed with socket–type heat fused polybutylene fittings.
4. CPVC tubing shall be joined using solvent cement joints.

2305.3 Testing. Piping or tubing to be embedded shall be tested by applying a hydrostatic pressure of not less than 100 psi (68.9 kPa). The pressure shall be maintained for 30 minutes, during which all joints shall be visually inspected for leaks.

SECTION 2306
WATER HEATERS USED FOR SPACE HEATING

2306.1 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 nonpotable water heating appliances.

2306.2 Labeling. Water heaters shall be listed and bear the label of an approved agency.

2306.3 Installation. When a combination water heating–space heating system requires water for space heating at temperatures higher than 140°F. (60°C.), a means such as a mixing valve shall be installed to temper the water for domestic uses. The input capacity of the water heater shall be 30% greater than the capacity of the heating coil or the system shall be listed, labeled, and installed in accordance with the manufacturer's installation instructions.

2306.4 Protection of potable water. Toxic chemicals used for boiler treatment shall not be introduced into a water heater for potable water heating.

SECTION 2307
WATER HEATERS

307.1 General. Water heaters shall be listed and labeled as conforming to ANSI Z21.10.1, ANSI Z21.10.3, or UL 174 and shall be installed in accordance with the manufacturer's installation instruction and Chapter 33.

2307.1.1 Vent. Water heaters designed to be vented shall be connected to a venting system and such system shall be installed in accordance with Chapter 21.

2307.1.2 Combustion air. Water heaters which depend on the combustion of fuel for the heat shall be provided with a sufficient supply of combustion air and shall be installed in accordance with Chapter 20.

2307.2 Capacity. Water heaters used for space heating shall be sized so that the input capacity of the heater is 30% greater than the capacity of the heating coil.

SECTION 2308
POOL HEATERS

2308.1 Location. Pool heaters shall be located or protected to guard against accidental contact of hot surfaces by persons.

2308.2 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.

2308.3 Temperature and pressure–limiting devices. Pool heaters shall have temperature and pressure–relief valves.

2308.4 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.

2308.5 Venting. Pool heaters shall be installed with the listed vents in accordance with the manufacturer's installation instructions. Pool heaters for indoor installations shall be vented in accordance with Chapter 21 of this code.

SECTION 2309
STEAM BOILERS

2309.1 Steam Boiler. See the North Carolina State Building Code, Volume III, Mechanical.

CHAPTER 24
REFRIGERATION

SECTION 2401
REFRIGERATION COOLING EQUIPMENT

2401.1 Approved refrigerants. Only Group I refrigerants specified in ANSI/ASHRAE 34 shall be used in direct refrigeration equipment.

2401.2 Refrigeration coils in warm–air furnaces. When 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 (124 Pa) static pressure unless the furnace is listed and labeled for use with a cooling coil. Cooling coils shall not be located upstream from heat exchangers unless listed and 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.

2401.3 Condensate disposal. An approved drain shall be provided to dispose of condensate from the cooling coil. Condensate drains shall terminate outside of the building, or to a floor drain, plumbing fixture, sump or an approved location.

2401.3.1 Cooling coil or air–conditioning unit. Where the cooling coil or air conditioning unit is located indoors above a living space, a water-tight pan of corrosion-resistant material shall be installed beneath the unit to catch overflow condensate due to a clogged condensate drain. Pans shall have a minimum depth of 1-1/2 inches and shall be not less than 0.0276-inch (24 gauge) galvanized sheet steel. Pans may be constructed of combustible materials when the casing surface of the unit is tested and approved for zero clearance to combustibles. The pan shall be provided with a separate drain pipe of minimum 3/4-inch nominal pipe size which discharges at a conspicuous location to indicate that the regular drain is clogged. A float switch to control overflow may be used in drain pan in lieu of an auxiliary drain line.

2401.4 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.

SECTION 2402
ABSORPTION COOLING EQUIPMENT

2402.1 Approval of equipment. Absorption systems shall be listed and labeled and installed in accordance with the manufacturer's installation instructions.

2402.2 Condensate disposal. Condensate from the cooling coil shall be disposed of as provided in Section 2401.3.

2402.3 Insulation of piping. Refrigerant piping, brine piping and fittings within a building shall be insulated to prevent condensation from forming on piping.

2402.4 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.

CHAPTER 25
HYDRONIC PIPING

SECTION 2501
HYDRONIC PIPING SYSTEMS INSTALLATION

2501.1 General. Hydronic piping shall conform to Table 2501.1. Approved piping, valves, fittings and connections shall be installed in accordance with the manufacturer's installation instructions. 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.

2501.2 Prohibited tees. Hot water in a system shall not enter a tee fitting through the side opening.

2501.3 System drain down. Hydronic piping systems shall be 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 Chapters 29–38 of this code.

2501.4 Protection of potable water. The potable water system shall be protected from backflow in accordance with the provisions listed in Section 3402.

2501.5 Pipe penetrations. Openings through concrete or masonry building elements shall be sleeved.

2501.6 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.

2501.7 Drilling and notching. Wood–framed structural members shall be drilled, notched or altered in accordance with the provisions of Sections 502.6, 602.5, 602.5.1, 802.6 and 802.7.

TABLE 2501.1
HYDRONIC PIPING MATERIALS

MATERIAL	USE CODE[1]	STANDARD[2]	JOINTS	NOTES
Brass Pipe	1	ASTM B 43	Brazed, welded threaded mechanical flanged fittings	
Brass Tubing	1	ASTM B 135	Brazed, soldered, mechanical fittings	
Chlorinated Poly (Vinyl Chloride) (CPVC) pipe and tubing	1,2,3	ASTM D 2846	Solvent cement joints, compression joints, threaded adapters	
Copper Pipe	1	ASTM B 42 B 302	Brazed solders mechanical fittings threaded, welded, flanged	
Copper Tubing (Type K, L or M)	1,2	ASTM B 75, B 88, B 251, B 306	Brazed, soldered, flared mechanical	Joints embedded in concrete fittings
Crosslinked Polyethylene (PEX) tubing	2,3	ASTM F 876, F 877	Mechanical compression	Install in accordance with manufacturer's instructions.
Polybutylene (PB) pipe and tubing	1,2,3	ASTM D 3309	Heat–fusion, crimp/insert, compression	Joints in concrete shall be heat–fused.
Soldering Fluxes	1	ASTM B 813	Copper tube joints	
Steel Pipe	1,2	ASTM A 53, A 106	Brazed, welded, threaded flanged mechanical fittings.	Joints in concrete shall be welded. Galvanized pipe shall not be welded or brazed.
Steel Tubing	1	ASTM A 254	Mechanical fittings welded	

For SI: °F. = 1.8°C. + 32.

1 Use Code:

1. Above ground.
2. Embedded in radiant system.
3. Temperatures below 180°F. only.

2 Standards as listed in Chapter 43.

2501.8 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.

2501.9 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 2501.9.

TABLE 2501.9
HANGER SPACING INTERVALS

PIPING MATERIAL	MAXIMUM HORIZONTAL SPACING (feet)	MAXIMUM VERTICAL SPACING (feet)
CPVC pipe or tubing	3	5
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

For SI: 1 foot = 304.8 mm.

CHAPTER 26
FUEL–GAS PIPING

SECTION 2601
GENERAL

2601.1 Scope. The requirements of this chapter shall govern the installation of fuel–gas piping in or in connection with a building or structure or within the property lines of premises, other than service piping.

2601.2 Point of delivery. 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 2602
AUTHORITY TO RENDER GAS SERVICE

2602.1 Rough inspection required. A serving gas supplier, or person furnishing gas shall not turn on, or cause to be turned on, fuel gas or gas meters, until approval of rough piping inspection, in compliance with Section 2603.3.1.

2602.2 Final inspection. Temporary gas service shall be permitted on approval of rough inspection of the equipment to be served.

SECTION 2603
INSPECTIONS

2603.1 General. On completion of installation, alteration, repair or replacement of gas piping, and prior to the use thereof, the building official shall be notified that gas piping is ready for inspection.

2603.2 Accessibility for inspection. Excavations required for the installation of underground piping shall be kept open until such time as the piping has been inspected and approved. If piping is covered or concealed before approval, it shall be exposed on the direction of the building official.

2603.3 Required inspections. The building official shall make the following inspections and shall either approve that portion of the work as completed, or shall notify the permit holder wherein the same fails to comply with this chapter.

2603.3.1 Rough inspection. This inspection shall be made after gas piping authorized by the permit has been installed and before such piping has been covered or concealed or a fixture or appliance has been attached thereto. This inspection shall include a determination that the gas piping size, material and installation meet the requirements of this chapter.

2603.3.2 Final inspection. This inspection shall be made after piping authorized by the permit has been installed and after all portions thereof which are to be covered or concealed are so concealed and after all fixtures, appliances and shutoff valves have been attached thereto.

2603.4 Other inspections. In cases where the work authorized by the permit consists of a minor installation of additional piping to piping already connected to a gas meter, the foregoing inspection may be waived at the discretion of the building official. The building official shall make such inspections as deemed advisable in order to assure that the work has been performed in accordance with the intent of this chapter.

SECTION 2604
GAS METERS

2604.1 Location. A meter location when required, shall be provided for the building or premises to be served. The location shall be such that the meter and connections are accessible in order that the meter may be read or changed. Location, space requirements, dimensions, and type of installation shall be acceptable to the gas company.

2604.2 Support. Gas meters shall be securely supported or connected to rigid piping.

SECTION 2605
GAS PIPING MATERIALS

2605.1 Approved types. Pipe and tubing materials shall conform to Table 2605.1 or other approved materials.

2605.2 Used materials. Gas pipe, tubing, fittings, valves, etc., shall have been used previously for no purpose other than conveying gas; it shall be in good condition, clean and free from internal obstructions. Burred ends shall be reamed to the full bore of the pipe.

SECTION 2606
GAS VALVES

2606.1 Approved type. Gas valves shall be listed and labeled or approved for fuel gas service and compatible with the gas piping served. Manually operated gas valves shall conform to ANSI Z21.15.

2606.2 Size. Gas valves shall be equivalent in nominal size to the piping served.

TABLE 2605.1
GAS SUPPLY PIPING MATERIALS

MATERIAL	STANDARD	APPROVED JOINTS	NOTES
Black Steel	ASTM A 53, A 106	Welded, Threaded, Flanged	Schedule 40 pipe, malleable black or galvanized fittings only. Protect in accordance with Section 2608.1.2.
Galvanized Steel Pipe	ASTM A 53	Thread or Flanged only. Protect in accordance with	Schedule 40 pipe, malleable black or galvanized fittings Section 2608.1.2.
Corrugated Stainless Steel Tubing	ANSI/AGA LC 1	Proprietary Mechanical Fitting	Listed and labeled system. Install per manufacturer's installation instructions. Above grade use only.
Soft Copper, Type K or L Tubing[2]	ASTM B 75, B 88, B 280, B 68	Flared or Brazed	Mark as per Section 2608.8 when used above grade.
Copper or Brass Pipe	ASTM B 42, B 43, B 302	Threaded or Flared	
Plastic Pipe[1]	ASTM D 2513	Solvent Cement, Adhesive, Heat Fusion, Compression Couplings, Flanged	Use only underground, outside of building.

For SI: 1 grain/ft.3 = 0.0229 kg/m^3.

[1] Plastic pipe and fittings shall not be used within or beneath a building.

[2] 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 grain of hydrogen sulfide per 100 standard cubic feet of gas.

2606.3 Shutoff valves. 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 valve located adjacent to, inside or under an appliance shall be accessible. This section shall not prohibit of use or the installation of gas shut off valves in the firebox of fireplaces serving listed gas decorative appliances.

2606.3.1 Appliance removal. Shutoff valves may be accessibly located inside or under an appliance when such appliance can be removed without removal of the shutoff valve.

2606.3.2 Wall appliance. Shutoff valves may be accessibly located inside wall heaters and wall furnaces listed for recessed installations where necessary maintenance can be performed without removal of the shutoff valve.

2606.4 Log Lighters. Gas outlets located in fireplaces shall be controlled by a listed and labeled shutoff valves located in the same room outside the hearth and not more than 4 feet (1219 mm) from the outlets. When gas piping on the discharge side of the valve penetrates the masonry hearth or walls, it shall be embedded in or surrounded by not less than 1-1/2 inches (38 mm) of concrete or masonry or 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. This does not apply to gas logs.

2606.5 Quick–disconnect devices. Gas utilization equipment may be connected to the building piping by means of a listed and 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 shall not require a manual valve upstream of the device.

SECTION 2607
PIPING JOINTS AND CONNECTIONS

2607.1 General. The type of piping joint used shall be suitable for the pressure–temperature conditions and compatible with the piping material.

2607.2 Pipe joints. Pipe joint compound or tape shall be used on male threads only.

2607.3 Tubing joints. Tubing joints shall be made with listed and labeled gas tubing fittings or be brazed with a material having a melting point exceeding 1,000°F. (538°C.). Brazing alloys shall not contain phosphorus. Flared joints shall be made with a proper flaring tool that will produce a flare compatible with the fittings. Other joints shall be installed in accordance with the manufacturer's installation instructions as approved by the building official.

2607.4 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.

2607.5 Plastic joints and fittings. Plastic pipe, tubing and fittings shall be joined by solvent–cement or heat–fusion methods, or by means of compression couplings or flanges in accordance with the manufacturer's installation instructions.

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 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 installation 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.

2607.6 Appliance connection. Gas appliances and equipment shall be connected to the building piping by rigid metallic pipes, semi–rigid metallic tubing, or a listed and labeled gas appliance connector having a diameter not less than the nominal inlet connection to the appliance in accordance with their listing and label. Labeled metal appliance connectors shall have an overall length not to exceed 3 feet (914 mm), except range and domestic clothes dryer connection, which may not exceed 6 feet (1829 mm) in length. Connectors shall not be concealed within or extended through walls, floors or partitions. The connection of an indoor appliance with any type of gas hose is prohibited. Outdoor portable appliances may be connected with an approved outdoor hose connector not to exceed 15 feet (4572 mm) in length, provided it connects outdoors to approved gas piping including an approved valve at the inlet of the hose connector. Appliances may be connected to fuel gas piping with an listed quick–disconnect device.

SECTION 2608
GAS PIPING INSTALLATION

2608.1 Underground piping. Underground gas piping shall be installed to protect it from settlement, shifting, contact or damage resulting from proximity to structures.

2608.1.1 Minimum depth. Underground metallic piping systems shall be installed at a minimum of 10 inches (254 mm) below grade. Plastic piping systems shall be installed at a minimum of 10 inches (254 mm) below grade. If minimum depths cannot be maintained, the piping system shall be installed in conduit or shielded in an approved manner.

2608.1.2 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.

2608.1.3 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.

2608.1.4 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.

2608.1.5 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 entrance of gas leakage. The conduit shall extend at least 4 inches (102 mm) outside the building and be vented above grade to the outside. This section shall not apply to piping in ventilated crawl spaces.

2608.1.6 Tracer for nonmetallic buried piping. A minimum No. 18 AWG insulated copper tracer wire conductor shall be installed adjacent to underground nonmetallic gas piping and shall be accessible or terminate above grade at each end.

2608.2 Piping in buildings. Piping within buildings shall comply with Sections 2608.2.1 through 2608.2.6.

2608.2.1 Drilling and notching. When necessary, wood–framed structural members shall be drilled or notched as provided in Sections 502.6, 602.5, 602.5.1, 802.6 and 802.7.

2608.2.2 Sediment trap. If a sediment trap is not incorporated as a part of the gas utilization equipment, a sediment trap shall be installed in accordance with the manufacturer's installation instructions. 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.

2608.2.3 Prohibited locations. Gas piping shall not be run in or through supply and return air ducts, clothes chutes, chimneys, vents, dumbwaiters or elevator shafts. This provision shall not apply to ducts used to provide combustion air in accordancewith Chapter 20. Valves and unions shall not be located in any air plenum.

2608.2.4 Piping in concealed locations. Portions of gas piping systems installed in concealed locations shall not have unions or running threads. Concealed tubing joints are prohibited unless the fittings are listed for use in concealed spaces.

2608.2.5 Piping in concrete slabs. Gas piping embedded in concrete slabs shall be surrounded with a minimum of 1-1/2 inches (38 mm) 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 2608.1.2.

2608.2.6 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 2608.2.6.

TABLE 2608.2.6
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, 11/2–inch diameter and under	6

For **SI**: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

2608.3 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 by coating or wrapping with an inert material. Where piping is encased in a protective sleeve, the annular space between the pipe and sleeve shall be sealed.

2608.4 Gas tubing. Gas tubing shall comply with Sections 2608.4.1 and 2608.4.2.

2608.4.1 Metallic tubing bends. Metallic tubing shall conform with the following:

1. Bends shall be made 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 not be less than six times the outside diameter of the tubing.
4. Corrugated stainless steel tubing bends shall be in compliance with the manufacturer's installation instructions.

2608.4.2 Plastic pipe bends. Plastic pipe bends shall conform with the following:

1. Plastic pipe shall not be damaged and the internal diameter of the pipe shall not be reduced.
2. The inside radius of a bend shall not be 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.

2608.5 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 (127 mm) of each side of the penetration, as appropriate. Concealed tubing at support points and points of penetration 2 to 3 inches (51 to 76 mm) 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. Unsupported sections within a wall or ceiling cavity need not be shielded.

2608.6 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.

2608.7 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 listed and labeled quick–disconnect devices or gas convenience outlets as provided in Section 2606.5.

2608.8 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 (1524 mm) 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. CSST gas piping systems shall be marked and labeled in accordance with ASNI/AGA LC-1.

2608.9 Electrical bonding and grounding. Each aboveground 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 the Electrical Code. Gas piping shall not be used as a grounding electrode.

2608.9.1 Electrical circuits prohibited. 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 2609
GAS PIPE SIZING

2609.1 Required gas supply. All fuel–gas pipe shall be sized to supply the required demand of the attached appliances. The cubic feet per hour (mL/s) of gas required shall be obtained by dividing the specified Btu/h (W) of an appliance by the average Btu heating value for each 1 cubic foot (kj/L) of gas being supplied. When the rating of the gas appliance to be installed

has not been specified, other approved sources shall be permitted to estimate the requirement in Btu/h (W).

2609.2 Required size. Fuel–gas pipe operating under low pressure [0.5 psig (3.44 kPa gage)] or less shall be sized using the following procedure or the listed capacity tables in accordance with ANSI/AGA LC-1.:

1. Measure the length of pipe from the point of delivery to the most remote outlet or appliance connection.
2. From Table 2609.2, 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.

SECTION 2610
MEDIUM-PRESSURE PIPING SYSTEM

2610.1 Medium–pressure piping size. Two psig (13.8 kPa gage) medium–pressure systems shall be sized according to Table 2610.5a and 2610.5b or listed capacity tables in accordance with ANSI/AGA LC-1.

2610.2 Gas pressure regulators. Pounds–to–inches (kg to mm) regulators installed between the medium–pressure and low–pressure 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.

2610.3 Regulator vent. Pounds to inches (kg to mm) 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 upward. 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.

2610.4 Shutoff valve. An approved gas valve shall be installed immediately upstream from each pounds–to–inches (kg to mm) regulator.

2610.5 Required Size For 2-PSI Piping. To determine the size of consumer's gas piping from point of delivery to consumer's MP (medium pressure) regulators when the gas is 2 psi, proceed as follows:

1. Measure the length of piping from the point where the building piping begins to the most remote consumer's MP regulator.
2. In the first vertical column in Table 2610.5a, select the horizontal line showing that distance or the next longer distance if the table does not give the exact length.
3. Use this horizontal line to locate all gas demand figures for the particular system of gas piping.
4. Starting at the most remote consumer's MP regulator, find in the horizontal line just selected, the gas demand for that regulator. If the text figure of demand is not shown, choose the next larger figure to the right on the same line.
5. Above this demand figure in the top horizontal line in Table 2610.5a will be found the nominal size of piping required.
6. For each succeeding section of pipe, determine the total gas demand supplied by such section and then proceed in the manner outlined above to determine the size of each section of piping.
7. For iron pipe, follow foregoing procedure using Table 2610.5b.

SECTION 2611
LIQUEFIED PETROLEUM GAS SYSTEMS

2611.1 Pressure regulating valves. Pressure regulating valves for LPG systems shall be listed and labeled in accordance with UL 144, as listed in Chapter 43.

2611.2 Location of containers. Location of undiluted liquefied petroleum gas continers shall be the responsibility of the North Carolina Department of Agriculture.

2611.3 LP Pipe Sizing. Pipe and tubing shall be sized in accordance with Section 2609.2 and using Tables Nos. 2611.3a and 2611.3b.

SECTION 2612
TESTING

2612.1 General. Before any gas piping system is finally put in service it shall be carefully tested to assure that it is gas tight. Where any part of the sytem is to be enclosed or concealed, this test should precede the work of closing in. To test for tightness, the piping shall be filled with air or inert gas, but not with any other gas or liquid. In no case shall oxygen ever be used. In cases where the work authorized by the permit consist of additional piping to an existing piping system, a shut-off valve shall be installed and the additional piping shall be tested in accordance with Section 2612.2. Any new fittings installed before the new shut-off valve shall be soap tested at the operating pressure of the existing piping system.

2612.2 Method of test: Low pressure gas piping shall withstand a pressure of at least 10 psi for a period of not less than 10 minutes without showing any drop in pressure. High pressure piping (5 psi or greater) must withstand a pressure of at least 50 psi for a period of not less than 10 minutes without showing any drop in pressure.

2612.3 Test Instruments: For these tests, pressure shall be measured with a manometer or slope gage or other accurate and sensitive pressure indicating device, the scale of which is so graduated that variations in pressure may be accurately read. All necessary apparatus for conducting the pressure test shall be furnished by the installer

TABLE 2609.2
MAXIMUM CAPACITY OF PIPE AND SMOOTH WALLED 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

For **SI:** 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 inch water column = 249 Pa.

TABLE No. 2610.5a
SIZE OF GAS TUBING
Maximum Capacity of tubing in Cubic Feet of Gas Per Hour
For a Gas Pressure of 2 psig; Based on a Pressure Drop of 1.5 psi,
0.6 Specific Gravity Gas and Tubing

Length	OD of Tubing (in)			
(ft)	3/8	1/2	5/8	7/8
5	501	1062	2222	5706
10	336	713	1491	3831
15	266	565	1181	3034
20	226	479	1001	2571
30	179	379	793	2037
40	151	321	672	1726
50	133	283	591	1518
60	120	255	532	1367
70	110	233	487	1251
80	102	216	451	1159
90	95	202	422	1083
100	89	190	397	1019
125	79	167	349	897
150	71	150	314	807
200	60	127	266	684

TABLE No. 2610.5b
SIZE OF GAS PIPE
Maximum Capacity of Pipe in Cubic Feet of Gas Per Hour
For a Gas Pressure of 2 psig; Based on a Pressure Drop of 1.5 psi,
0.6 Specific Gravity Gas and Schedule 40 Pipe

Length	Nominal Diamerter (in)	
(ft)	1/2	3/4
10	1990	4170
20	1370	2860
30	1100	2300
40	940	1970
50	830	1740
60	760	1580
70	700	1450
80	650	1350
90	610	1270
100	570	1200
125	510	1060
150	460	960
175	425	890
200	395	820

TABLE 2611.3a
PIPE & TUBING SIZING
SINGLE STAGE REGULATION
OR
BETWEEN SECOND STAGE REGULATOR AND APPLIANCE

Maximum propane capacities listed are based on 1/2" W.C. pressure drop at 11" W.C. setting – Capacities in 1,000 BTU/HR

• Tubing may be:
Steel (ANSI/ASTM 539).
Brass (ANSI/ASTM 135).
Copper, Type K or L (ANSI/ASTM B88).
Copper, refrigeration (ANSI/ASTM B280).

PIPE OR TUBING LENGTH, FEET	•TUBING SIZE				NOMINAL PIPE SIZE								
	3/8"	1/2"	5/8"	3/4"	1/2"	3/4"	1"	1-1/4"	1-1/2"	2"	2-1/4"	3"	4"
10	39	92	199	329	275	567	1,071	2,205	3,307	6,221	10,110	17,290	32,710
20	26	62	131	216	189	393	732	1,496	2,299	4,331	7,046	12,510	25,520
30	21	50	107	181	152	315	590	1,212	1,858	3,465	3,695	10,110	20,620
40	19	41	90	145	129	267	504	1,039	1,559	2,992	4,778	8,481	17,300
50	18	37	79	131	114	237	448	913	1,417	2,646	4,343	7,708	15,730
60	16	35	72	121	103	217	409	834	1,275	2,394	3,908	6,936	14,150
80	13	29	62	104	89	185	346	724	1,086	2,047	3,329	5,908	12,050
100	11	26	55	90	78	162	307	630	976	1,811	2,901	5,309	10,830
125	10	24	48	81	69	146	275	567	866	1,606	2,654	4,711	9,613
150	9	21	43	72	63	132	252	511	787	1,496	2,412	4,281	8,736
200	8	19	39	66	54	112	209	439	665	1,282	2,038	3,618	7,382
250	8	17	36	60	48	100	185	390	590	1,138	1,808	3,210	6,549
300	–	–	–	–	43	90	168	353	534	1,030	1,637	4,966	5,927
350	–	–	–	–	40	83	155	325	491	947	1,505	2,671	5,450
400	–	–	–	–	37	77	144	303	458	883	1,404	2,492	5,084

NOTE: Determine distance from regulator to the furthermost appliance. Use this distance in selecting each section of pipe or tubing according to the gas load to be carried by that section.

TABLE 2611.3b
PIPE & TUBING SIZING
BETWEEN FIRST AND SECOND STAGE REGULATORS

Maximum propane capacities listed are based on 2 psig pressure drop at 10 psig setting – Capacities in 1,000 BTU/HR

• Tubing may be:
Steel (ANSI/ASTM 539).
Brass (ANSI/ASTM 135).
Copper, Type K or L (ANSI/ASTM B88), or
Copper, refrigeration (ANSI/ASTM B280).

PIPE OR TUBING LENGTH, FEET	•TUBING SIZE				NOMINAL PIPE SIZE								
	3/8"	1/2"	5/8"	3/4"	1/2"	3/4"	1"	1 1/4"	1 1/2"	2"	2 1/4"	3"	4"
10	730	1,700	3,200	5,300	3,200	7,500	12,800	24,000	40,000	88,000	133,000	237,500	489,000
20	500	1,100	2,200	3,700	2,200	4,200	8,800	18,000	33,000	61,000	93,500	165,500	341,000
30	400	920	2,000	2,900	1,800	4,000	7,200	14,000	26,000	49,000	76,500	136,500	281,000
40	370	850	1,700	2,700	1,600	3,700	6,800	13,500	24,000	46,000	71,000	127,000	262,000
50	330	770	1,500	2,400	1,500	3,400	6,300	12,600	22,500	43,000	65,000	116,000	240,000
60	300	700	1,300	2,200	1,300	3,100	5,600	12,000	21,700	40,000	61,000	109,000	224,000
80	260	610	1,200	1,900	1,200	2,600	4,900	10,000	18,000	34,000	52,000	93,000	192,000
100	220	540	1,000	1,700	1,000	2,300	4,300	9,000	15,000	31,000	45,500	81,500	168,000
125	200	490	900	1,400	900	2,100	4,000	7,900	13,500	28,000	41,500	74,000	152,500
150	190	430	830	1,300	830	1,900	3,600	7,200	12,600	25,000	37,000	66,600	137,000
175	170	400	780	1,200	770	1,700	3,300	6,700	11,400	23,500	34,500	61,500	127,000
200	160	380	730	1,100	720	1,500	3,100	6,200	10,600	22,000	32,000	57,500	119,000
250	–	–	–	–	643	1,341	2,772	5,545	9,480	19,677	28,621	51,429	106,436
300	–	–	–	–	587	1,224	2,531	5,062	8,654	17,942	26,127	46,948	97,168
350	–	–	–	–	544	1,133	2,343	4,686	8,012	16,630	24,189	43,466	89,955
400	–	–	–	–	509	1,060	2,192	4,384	7,496	15,556	22,627	40,658	84,145
450	–	–	–	–	480	1,000	2,066	4,133	7,066	14,466	21,333	38,383	79,333
500	–	–	–	–	455	948	1,960	3,921	6,704	13,914	20,238	34,366	76,262

To convert to capacities at 5 psig settings - X by 0.879
To convert to capacities at 15 psig settings - X by 1.130
To convert to capacities at 20 psig settings - X by 1. 185
To convert to capacities at 30 psig settings - X by 1.345
To convert to capacities at 40 psig settings - X by 1.488
To convert to capacities at 50 psig settings - X by 1.618

CHAPTER 27
SPECIAL PIPING AND STORAGE SYSTEMS

SECTION 2701
OIL TANKS

2701.1 Materials. Fuel oil supply tanks shall be fabricated from steel. Steel tanks shall conform to UL 80, UL 142 or UL 443. All shop–fabricated supply tanks shall be listed and bear the label of an approved agency.

2701.2 Aboveground tanks. The maximum amount of fuel oil stored aboveground or inside of a building shall be 660 gallons (2498 L). The supply tank shall be supported on rigid noncombustible supports to prevent settling or shifting.

2701.2.1 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 (38 L) shall be placed not less than 5 feet (1524 mm) to an adjoining property line. Such tanks shall be protected from the weather and from physical damage.

2701.2.2 Outside aboveground tanks. Tanks installed outside aboveground shall be a minimum of 5 feet (1524 mm) from an adjoining property line. Such tanks shall be suitably protected from the weather and from physical damage.

2701.3 Underground tanks. Excavations for underground tanks shall not undermine the foundations of existing structures. The clearance from the tank to the nearest wall of basement, pit or property line shall not be less than 1 foot (305 mm). 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 (305 mm) of earth. Corrosion protection shall be provided in accordance with Section 2703.7.

2701.4 Multiple tanks. Cross connection of two supply tanks shall be permitted in accordance with Section 2703.6.

2701.5 Oil gages. Inside tanks shall be provided with a device to indicate when the oil in the tank has reached a predetermined safe level. Glass gages or a gage subject to breakage that could result in the escape of oil from the tank shall not be used.

SECTION 2702
OIL PIPING, FITTING AND CONNECTIONS

2702.1 Materials. Piping shall consist of steel pipe, copper tubing or steel tubing conforming to ASTM A 539. Aluminum tubing shall not be used between the fuel–oil tank and the burner units.

2702.2 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 1,000°F. (538°C.) shall not be used for oil piping. Threaded joints and connections shall be made tight with a lubricant or pipe thread compound.

2702.3 Flexible connectors. Flexible metal hose used when rigid connections are impractical or to reduce the effect of jarring and vibration shall be listed and 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 aboveground outside of buildings.

SECTION 2703
INSTALLATION

2703.1 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.

2703.2 Supply piping. Supply piping used in the installation of oil burners and appliances shall not be smaller than 3/8–inch (9.5 mm) pipe or 3/8–inch (9.5 mm) OD tubing. Copper tubing and fittings shall be minimum Type L.

2703.3 Fill piping. Fill piping shall terminate outside of dwellings at a point at least 2 feet (610 mm) from a dwelling opening at the same or lower level. Fill openings shall be equipped with a tight metal cover.

2703.4 Vent piping. Vent piping shall be no smaller than 1-1/4–inch (32 mm) pipe. Vent piping shall be laid to drain toward 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 (25 mm).

2703.5 Vent termination. Vent piping shall terminate outside of buildings at a point not less than 2 feet (610 mm), 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.

2703.6 Cross connection of tanks. Cross connection of two supply tanks, not exceeding 660 gallons (2498 L) aggregate capacity, with gravity flow from one tank to another, shall be acceptable providing that the two tanks are on the same horizontal plane.

2703.7 Corrosion protection. Underground tanks and buried piping shall be protected by corrosion–resistant coatings or special alloys or fiberglass reinforced plastic.

SECTION 2704
OIL PUMPS AND VALVES

2704.1 Pumps. Oil pumps shall be positive displacement types that automatically shut off the oil supply when stopped. Automatic pumps shall be listed and labeled and shall be installed in compliance with their listing and label.

2704.2 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.

2704.3 Maximum pressure. Pressure at the oil supply inlet to an appliance shall not be greater than 3 psi (20.7 kPa).

2704.4 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 28
SOLAR SYSTEMS

SECTION 2801
SOLAR ENERGY SYSTEMS

2801.1 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.

2801.2 Installation. Installation of solar energy systems shall comply with Sections 2801.2.1 through 2801.2.7.

2801.2.1 Access. Solar energy collectors, controls, dampers, fans, blowers, and pumps shall be accessible for inspection, maintenance, repair, and replacement.

2801.2.2 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 9 of this code. When mounted on or above the roof coverings, the collectors and supporting structure shall be constructed of noncombustible materials or fire–retardant–treated wood equivalent to that required for the roof construction.

2801.2.3 Pressure and temperature relief. System components containing fluids shall be protected with pressure– and temperature–relief valves. Relief devices shall be installed in sections of the system such that a section cannot be valved off or isolated from a relief device.

2801.2.4 Vacuum relief. System components that may be subjected to pressure drops below atmospheric pressure during operation or shutdown shall be protected by a vacuum–relief valve.

2801.2.5 Protection from freezing. System components shall be protected from damage by freezing of heat–transfer liquids at the lowest ambient temperatures during operation.

2801.2.6 Expansion tanks. Expansion tanks in solar energy systems shall be installed in accordance with Section 2303.

2801.2.7 Roof penetrations. Roof penetrations shall be flashed and waterproofed in accordance with Chapter 9 of this code.

2801.3 Labeling. Labeling shall comply with Sections 2801.3.1 and 2801.3.2.

2801.3.1 Collectors. Collectors shall be listed and 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.

2801.3.2 Thermal storage units. Pressurized thermal storage units shall be listed and 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.

2801.4 Prohibited heat transfer fluids. Flammable gases and liquids shall not be used as heat transfer fluids.

CHAPTER 29
PLUMBING ADMINISTRATION

SECTION 2901
GENERAL

2901.1 Scope. The provisions of this chapter shall establish the general administrative requirements applicable to plumbing systems and inspection requirements of this code.

2901.2 Application. In addition to the general administration requirements of Chapter 1, the administrative provisions of this chapter shall also apply to the plumbing requirements of Chapters 30 through 38.

SECTION 2902
EXISTING PLUMBING SYSTEMS

2902.1 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.

2902.2 Alterations or repairs. 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 2903
INSPECTION AND TESTS

2903.1 Inspection required. New plumbing work and parts of existing systems affected by new work or alterations shall be inspected by the building official to ensure compliance with the requirements of this code.

2903.2 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 building official.

2903.3 Responsibility of permittee. Test equipment, materials and labor shall be furnished by the permittee.

2903.4 Building sewer testing. DELETED

2903.5 DWV systems testing. Rough and finished plumbing installations shall be tested in accordance with Sections 2903.5.1 and 2903.5.2.

2903.5.1 Rough plumbing. DWV systems shall be tested on 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 (3048 mm) 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 15 minutes before inspection. The system shall prove leak free by visual inspection.

EXCEPTION: Rough plumbing testing shall be as per Item 1 except water level shall be a minimum of 3' above the highest drainage fitting.

2. Air Test—The portion under test shall be maintained at a gage pressure of 5 psi (34 kPa) or 10 inches mercury column (2488 Pa). This pressure shall be held without introduction of additional air for a period of 15 minutes.

2903.5.2 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—When 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:
   2.1 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 (249 Pa) shall be applied and maintained for the period of inspection.

   2.2 Peppermint Test—Introduce 2 ounces (59 mL) of oil of peppermint into the system. Add 10 quarts (9464 mL) 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.

CHAPTER 30
PLUMBING DEFINITIONS

SECTION 3001
GENERAL

3001.1 Scope. For the purpose of the plumbing requirements, the following terms shall be defined as follows and as set forth in Section 202 or 1202.

SECTION 3002
GENERAL PLUMBING DEFINITIONS

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.

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. Backsiphonage is one type of backflow.

BACKSIPHONAGE. 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 (2438 mm), 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 10 feet (3047 mm) outside the building wall.

BUILDING OFFICIAL. 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.

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 (610 mm) 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 tapered threaded 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 Tables C101a and C101b, Appendix C.

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 3504.1.

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 3409.2.

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°F. (49°C.) and 140°F. (60°C.).

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 Chapters 29 through 38.
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 buildup of pressure.
RELIEF VALVE, VACUUM. A device to prevent excessive buildup 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 discharge automatically 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 backsiphonage 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 (1102 kPa gage), including the apparatus by which heat is generated, and all controls and devices necessary to prevent water temperatures from exceeding 210°F. (98°C.). Note that Section 3403.2.2 limits the maximum average static pressure of the water distribution system to 80 psig (551 kPa gage).

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 pipe from the water main, water meter, water supply system or other approved source of water supply, to a point two feet from the building or structure served.

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 31
GENERAL PLUMBING REQUIREMENTS

SECTION 3101
GENERAL

3101.1 Scope. The provisions of this chapter shall govern the installation of plumbing not specifically covered in other chapters applicable to plumbing systems.

3101.2 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.

SECTION 3102
INDIVIDUAL WATER SUPPLY AND SEWAGE DISPOSAL

3102.1 General. 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. When 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 3103
STRUCTURAL AND PIPING PROTECTION

3103.1 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.

3103.2 Drilling and notching. Wood-framed structural members shall not be drilled, notched or altered in any manner except as provided in Sections 502.6, 602.5, 602.5.1, 802.6 and 802.7.

3103.3 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.

3103.4 Sleeves. Annular spaces between sleeves and pipes shall be filled or tightly caulked as approved by the building official. 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.

3103.5 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 a pipe sleeve two pipe sizes greater than the pipe passing through as may be approved by the building official.

3103.6 Freezing. The top of water pipes, installed below grade outside the building, shall be below the frost line or a minimum of 12 inches below finished grade whichever is greater. Water pipes installed in a wall exposed to the exterior shall be located on the heated side of the wall insulation. Water piping installed in an unconditioned attic or unconditioned utility room shall be insulated with an insulation having a minimum R factor of 6.5 determined at 75 degrees farenheit in accordance with ASTM C-77. Note: These provisions are minimum requirements which have been found suitable for normal weather conditions. Abnormally low temperatures for extended periods may require additional provisions to prevent freezing.

3103.7 Depth. Piping installed deeper than and parallel to footings or bearing walls shall be 45 degrees therefrom (see Figure 3103.7).

3103.8 Waterproofing of openings. Joints at the roof, around vent pipes, shall be made water tight by the use of lead. copper or galvanized iron flashings or an approved elastomeric material. Exterior wall openings shall be made water tight.

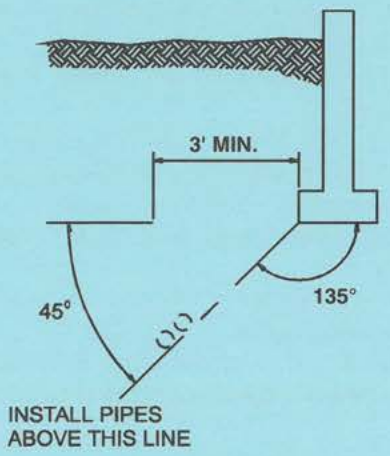


FIGURE 3103.7
PIPE LOCATION WITH RESPECT TO FOOTINGS

SECTION 3104
TRENCHING AND BACKFILLING

3104.1 Trenching and bedding. Piping shall be installed in trenches so that it rests on solid and continuous bearing. When 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.

3104.2 Common trench. See Section 3403.5.1.

3104.3 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 (305 mm) 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 (153 mm) 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 (153 mm) above the pipe.

3104.4 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.

3104.5 Inspection. 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 3105
SUPPORT

3105.1 General. 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 3105.1.
5. Hangers shall be of a material which is compatible with the pipe it supports and will not promote galvanic action.

TABLE 3105.1
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	3/4" diameter and under—10' 0" 1" diameter and over—12'0"	15' 0"
Copper tube and Copper pipe	1 1/4" diameter and under—6'0" 1 1/2" 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.

For **SI:** 1 inch = 25.4 mm, 1 foot = 304.8 mm.

SECTION 3106
JOINTS AND CONNECTIONS

3106.1 Pipe-joint compound. Pipe-joint compound used on threads shall be insoluble materials compatible with the type of service.

3106.2 Mortar. Rigid mortar or similar joints shall not be used with concrete or clay building sewers.

3106.3 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.

3106.4 Ground, flared or ferrule connections. 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.

3106.5 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.

3106.6 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 3107
WATERPROOFING OF OPENINGS

3107.1 General. Roof and exterior wall penetrations shall be made water tight. Counterflashing shall not restrict the required internal cross-sectional area of any vent.

SECTION 3108
WORKMANSHIP

3108.1 General. 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 3109
MATERIALS EVALUATION AND LISTING

3109.1 General. Plastic pipes, plastic plumbing pipe components and related plastic materials shall be evaluated and listed as conforming to ANSI/NSF 14 by an approved agency. The approved agency shall maintain periodic evaluations of production of listed products or materials, and their listing shall state that the products or materials meet ANSI/NSF 14.

CHAPTER 32
PLUMBING FIXTURES

SECTION 3201
FIXTURES, FITTINGS AND APPURTENANCES

3201.1 General. 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 3201.1 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.

SECTION 3202
FIXTURE ACCESSORIES

3202.1 Plumbing fixtures. Plumbing fixtures, other than water closets, shall be provided with approved strainers.

3202.2 Material for tail pieces and traps. Accessible continuous wastes, waste and overflow fittings, and tail pieces maybe seamless drawn brass of No. 20 gage (0.8 mm) minimum thickness.

3202.3 Plastic tubular fittings. Plastic tubular fittings shall conform to ASTM F 409 listed in Table 3201.1.

SECTION 3203
TAIL PIECES

3203.1 Minimum size. Fixture tail pieces shall not be less than 1-1/2 inches (38 mm) O.D. for sinks, dishwashers, laundry tubs, bathtubs and similar fixtures, and not less than 1-1/4 inches (32 mm) for bidets lavatories and similar fixtures.

SECTION 3204
PROVISION FOR FUTURE FIXTURES

3204.1 General. 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.

SECTION 3205
ACCESS TO CONNECTIONS

3205.1 General. Fixtures having concealed tubular traps shall be provided with an access panel or unobstructed utility space 12 inches (305 mm) in least dimension. Joints that are soldered, screwed, fused or solvent–cemented to form a solid connection or those designs which withstand 25 psi (172 kPa) unrestrained need not be accessible.

TABLE 3201.1
PLUMBING FIXTURES

MATERIAL	STANDARD
Diverters for Faucets with Hose Spray Anti–Syphon Type, Residential Application	ASSE/ANSI 1025
Enameled Cast Iron Plumbing Fixtures	ASME/ANSIA112.19.1
Floor Drains	ASME/ANSI A112.21.1
Handheld Showers	ASSE/ANSI 1014
Home Laundry Equipment	ASSE/ANSI 1007
Hose Connection Vacuum Breakers	ASSE/ANSI 1011
Hotwater Dispensers, Household Storage Type, Electrical	ASSE/ANSI 1023
Household Dishwashing Machines	ASSE/ANSI 1006
Household Disposers	ASSE/ANSI 1008
Hydraulic Performance for Water Closets and Urinals	ASME/ANSI A112.19.6
Individual Shower Control Valves Anti–Scald	ASSE/ANSI 1016
Nonvitreous Ceramic Plumbing Fixtures	ANSI A112.19.9
Pipe Applied Vacuum Breakers	ASSE/ANSI 1001
Plastic Bathtub Units	ANSI Z124.1
Plastic Lavatories	ANSI Z124.3
Plastic Shower Receptors and Shower Stall	ANSI Z124.2
Plastic Sinks	ANSI Z124.6
Plastic Water Closet Bowls and Tanks	ANSI Z124.4
Porcelain Enameled Formed Steel Plumbing Fixtures	ASME/ANSI A112.19.4M
Pressurized Flushing Devices for Plumbing Fixtures	ASSE/ANSI 1037
Specification for Copper Sheet and Strip for Building Construction	ASTM B 370
Suction Fittings for Use in Swimming Pools, Wading Pools, Spas, Hot Tubs and Whirlpool Bathtub Appliances	ASME/ANSI A112.19.8M
Stainless Steel Plumbing Fixtures (Residential)	ASME/ANSI A112.19.3M
Thermoplastic Accessible and Replaceable Plastic Tube and Tubular Fittings	ASTM F 409
Trim for Water Closet Bowls, Tank and Urinals	ASME/ANSI A112.19.5
Vitreous China Fixtures	ASME/ANSI A112.19.2M
Wall Hydrants, Freezeless, Automatic Draining Anti–Backflow Types	ASSE/ANSI 1019
Water Closet Flush Tank Ball Cocks	ASSE/ANSI 1002
Water Hammer Arrestors	ASSE/ANSI 1010
Water Pressure Reducing Valves for Domestic Water Supply Systems	ASSE/ANSI 1003
Whirlpool Bathtub Appliances	ASME/ANSIA112.19.7M

SECTION 3206
INSTALLATION

3206.1 General. 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 not be less than 15 inches (381 mm) from adjacent walls or partitions or not less than 30 inches (762 mm) 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.

SECTION 3207
RECEPTORS

3207.1 General. 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 3208
PROHIBITED RECEPTORS

3208.1 Indirect waste. No plumbing fixture which is used for domestic or culinary purposes shall be used to receive the discharge of an indirect waste.

Exceptions:

1. In a kitchen sink trap is acceptable for use as a receptor for a dishwasher.
2. A laundry tray is acceptable for use as a receptor for a clothes–washing machine.

SECTION 3209
DIRECTIONAL FITTINGS

3209.1 Wye required. 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 3210
SHOWERS

3210.1 General. 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 702.4. Such walls shall form a water–tight joint with each other and with either the tub, receptor or shower floor.

3210.2 Water–supply riser. The water–supply riser from the shower valve to the shower head outlet shall be secured to the permanent structure.

3210.3 Shower heads. Shower heads shall be of the water–conserving type, which will deliver a maximum flow rate of 2-1/2 gpm at 80 psi (9.5 L/m at 551 kPa).

SECTION 3211
SHOWER RECEPTORS

3211.1 Construction. Shower receptors shall have a finished curb threshold not less than 1 inch (25 mm) below the sides and back of the receptor. The curb shall not be less than 2 inches (51 mm) or more than 9 inches (229 mm) 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 one–fourth unit vertical in 12 units horizontal (2–percent slope) nor more than 1/2 inch (12.7 mm), and floor drains shall be flanged to provide a water–tight joint in the floor.

3211.2 Lining required. The adjoining walls and floor framing, enclosing on–site built–up shower receptors shall be lined with sheet lead, copper or a plastic liner material that complies with ASTM D 4068. The lining material shall extend not less than 3 inches (76 mm) beyond or around the rough jambs and not less than 3 inches (76 mm) above finished thresholds. Hot–mopping shall be permitted in accordance with Section 3211.2.1.

3211.2.1 Hot–mopping. Shower receptors lined by hot–mopping shall be built–up with not less than three layers of standard grade Type 15 asphalt impregnated roofing felt. The bottom layer shall be fitted to the formed subbase and each succeeding layer thoroughly hot–mopped to that below. All corners shall be carefully fitted and shall be made strong and water tight by folding or lapping, and each corner shall be reinforced with suitable webbing hot–mopped in place. All folds, laps, and reinforcing webbing shall extend at least 4 inches (102 mm) in directions from the corner and all webbing shall be of approved type and mesh, producing a tensile strength of not less than 50 pounds per inch (893 kg/m) in either direction.

3211.3 Installation. Lining materials shall be laid on 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 cpooer pans or liners shall be burned or silver brazed, respectively. Joints in plastic liner materials shall be jointed per manufacturer's recommendations.

3211.3.1 Materials. Lead and copper linings shall be insulated from conducting substances other than the connecting drain by 15–pound (6.80 kg) 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 the manufacturer's recommendations.

3211.4 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 3212
SHOWER WALLS

3212.1 Finished. Shower walls shall be finished in accordance with Section 702.4.

SECTION 3213
LAVATORIES

3213.1 Lavatory waste outlets. Lavatories shall have waste outlets not less than 1-1/4 inch (32 mm) in diameter. A strainer, pop–up stopper, crossbar or other device shall be provided to restrict the clear opening of the waste outlet.

3213.2 Lavatory faucets. Faucets on lavatories shall be of the water–conserving type, which deliver a maximum flow rate of 2.2 gpm at 60 psi (8.32 L/m at 413 kPa).

SECTION 3214
WATER CLOSETS

3214.1 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.

3214.2 Flushing devices required. Water closets shall be of the water conserving low consumption 1.6 gallons per flush (gpf) (6.1 Lpf) type and 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.

3214.3 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.

3214.4 Flush valves in flush tanks. Flush valve seats in tanks for flushing water closets shall be at least 1 inch (25 mm) 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.

3214.5 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.

3214.6 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 3215
BATHTUBS

3215.1 Bathtub waste outlets and overflows. Bathtubs shall have outlets and overflows at least 1-1/2 inches (38 mm) in diameter, and the waste outlet shall be equipped with an approved stopper.

SECTION 3216
SINKS

3216.1 Sink waste outlets. Sinks shall be provided with waste outlets not less than 1-1/2 inches (38 mm) 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 (89 mm) in diameter.

3216.2 Sink faucets. Sink faucets shall be of the water–conserving type, which deliver a maximum flow rate of 2.2 gpm at 60 psi (8.32 L/m at 413 kPa).

SECTION 3217
LAUNDRY TUBS

3217.1 Laundry tub waste outlet. Each compartment of a laundry tub shall be provided with a waste outlet not less than 1-1/2 inches (38 mm) in diameter and a strainer or crossbar to restrict the clear opening of the waste outlet.

SECTION 3218
FOOD–WASTE GRINDER

3218.1 Food–waste grinder waste outlets. Food–waste grinders shall be connected to a drain of not less than 1-1/2 inches (38 mm) in diameter.

3218.2 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 3219
DISHWASHING MACHINES

3219.1 Protection of water supply. Each unit shall have integral backflow protection of the water supply to the appliance.

3219.2 Sink and dishwasher. A sink and dishwasher may discharge through a single 1-1/2 inch (38 mm) trap. The discharge from the dishwasher shall be increased to a minimum of 5/8 inch (15.8 mm) and be connected with a wye fitting between the sink outlet and the trap inlet.

3219.3 Sink, dishwasher and food grinder. The discharge from a sink, dishwasher, and waste grinder may discharge through a single 1-1/2 inch (38 mm) trap. The discharge from the dishwasher shall be increased to a minimum of 5/8 inch (15.8 mm) 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 3220
CLOTHES WASHER

3220.1 Backflow protection. 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 3221
FLOOR DRAINS

3221.1 Minimum size. Floor drains shall have waste outlets not less than 2 inches (51 mm) 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 3222
WHIRLPOOL BATHTUBS

3222.1 Access panel. A door or panel of sufficient size shall be installed to provide access to the pump for repair and/or replacement.

3222.2 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 ensure minimum water retention in the volute after fixture use.

3222.3 Leak testing. Leak testing and pump operation shall be performed in accordance with the manufacturer's installation instructions.

3222.4 Manufacturer's instructions. The product shall be installed in accordance with the manufacturer's installation instructions.

3222.5 Piping. Whirlpool bathtub circulation piping shall be installed to be self–draining.

SECTION 3223
BIDET INSTALLATIONS

3223.1 Water supply. The bidet shall be equipped with either an air–gap–type or vacuum–breaker–type fixture supply fitting.

SECTION 3224
FIXTURE–FITTING INSTALLATION

3224.1 Hot water. 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 33
WATER HEATERS

SECTION 3301
GENERAL

3301.1 Required. Each 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. When installed in a crawl space, the provisions of Section 1401.6.1 must be met.

3301.2 Tank sizing. Table 3301.2 may be used as a guide in determining minimum water heater tank size.

3301.3 Prohibited locations. Water heaters, which depend on the combustion of fuel with the exception of those gaving direct systems, shall not be installed in sleeping rooms, bathrooms, clothes closets, or in closets or confined spaces opening into bathrooms or bedrooms.

Exception: When a closet, having a weather-stripped solid door with an approved door closing device (spring load hinges or pneumatic closure), has been designed exclusively for the water heater and where all air for combustion and ventilation is supplied from outdoors.

3301.4 Relief valves. Relief valves shall have a minimum–rated capacity for the equipment served and shall conform to ANSI Z21.22.

TABLE 3301.2
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 (Btu/h 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 Bath	Storage (gal)	30	40	30	40	50	30	40	50	30	50	66	30
	Input (Btu/h 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 (Btu/h or kw)	38K	5.5	70K	38K	5.5	70K	47K	5.5	70K	50K	5.5	7K
	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

For **SI**: 1 gallon = 3.785 L, 1 gallon per hour = 1.05 mL/s, 1 Btu/h = 0.2931 W, °F. = 1.8°C. + 32.

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.

SECTION 3302
SAFETY DEVICES

3302.1 Hot Water Heaters or Tanks of 120 Gallons or Less

3302.1.1 Installation by Manufacturer. All automatic hot water heaters or tanks (120 gallons or less) which utilize nonmetallic dip tubes, supply and hot water nipples, supply baffles or heat traps shall be tested and so labeled by the manufacturer to withstand a temperature of 400°F without deteriorating in any manner. All such heaters or tanks shall have installed thereon by the manufacturer an American Society of Mechanical Engineers and National Board of Boiler and Pressure Vessel Inspectors Approved Type Pressure-Temperature Relief Valve set at or below the safe working pressure of the tank as indicated and labeled upon the tank or heater or upon a plate secured to it.

3302.1.2 Replacement Components. All replacement components for an automatic hot water heater or tank (120 gallons or less) shall meet the provisions of 3302.2.

3302.2 Energy Shutoff Devices. All automatically controlled water heaters shall be equipped with an energy cutoff device which will cut off the supply of heat energy to the water tank before the temperature of the water in the tank exceeds 210°F. This cutoff device is in addition to the temperature and pressure relief valves.

3302.3 Approvals. Temperature and pressure relief valves, or combinations thereof, or energy shutoff devices, shall bear the label of the AGA or ASTM; with thermosetting of not more than 210°F and pressure setting not to exceed the tank or heater manufacturer's rated working pressure. The relieving capacity of these two devices shall each equal or exceed the heat input to the water heater or storage tank.

3302.4 Relief Outlet Wastes. The outlet of a pressure, temperature, or other relief valve shall not be connected to the drainage system as a direct waste.

3302.5 Pressure Marking of Storage Tank. Any storage tank installed for domestic hot water shall have clearly and indelibly stamped in the metal, or so marked upon a plate welded thereto or otherwise permanently attached, the maximum allowable working pressure. Such markings shall be in an accessible position outside of the tank so as to make inspection or re-inspection readily possible. All storage tanks for domestic hot water shall meet the applicable ASME standards.

3302.6 Safety Pans and Relief Valve Waste.

3302.6.1 When water heaters or hot water storage tanks are installed immediately and directly above a ceiling or above equipment that will be damaged by water and create a hazard, they shall be installed in a galvanized steel or other metal pan of equal corrosive resistance having a thickness at least equal to 0.0276-inch (24 ga) galvanized sheet steel.

Exception: Electric water heaters may rest in a high impact plastic pan of at least 1/16 inch thickness.

3302.6.2 Safety pans shall be no less than 1-1/2 inches deep and shall be of sufficient size and shape to receive all drippings or condensate from the tank or heater and the discharge from the relief valve or valves. The pan shall be drained by an indirect waste pipe no less than 1-inch diameter or the diameter of the outlet of the required relief valve, whichever is larger.

3302.6.3 The pan drain shall extend full-size and terminate over a suitably located indirect waste receptor or floor drain or extend to the crawlspace or exterior of the building and terminate no less than 6 inches or more than 24 inches above grade.

3302.6.4 When the discharge from the relief valve is to be discharged into the safety pan, it shall be piped full-size of the valve outlet pipe size to a point not more than 2 inches and not less than 1 inch above the pan flood level rim.

3302.6.5 The discharge from the relief valve shall be piped full-size separately to the crawlspace, 6 inches above the floor, outside of the building, or to another approved terminal as provided for safety pan drain terminals but in no case shall the discharge from a relief valve be trapped.

3302.6.6 Relief valve discharge piping shall be of those materials listed in Section 3409.

3302.6.7 Sediment Drains. A suitable water valve or cock, through which sediment may be drawn off or the heater or tank emptied, shall be installed at the bottom of the heater or tank.

3302.6.8 AntiSiphon Devices. Means acceptable to the Plumbing Official shall be provided to prevent siphoning of any water heater or tank to which any water heater or tank is connected. A cold water "dip" tube with a hole at the top or a vacuum relief valve installed in the cold water supply line above the top of the heater or tank may be accepted for this purpose. Bottom fed heaters or bottom fed tanks connected to water heaters shall have a vacuum relief valve installed. The vacuum relief valve shall be in compliance with the appropriate requirements of ANSI Z21.22.

CHAPTER 34
WATER SUPPLY AND DISTRIBUTION

SECTION 3401
GENERAL

3401.1 Potable water required. Dwelling units 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 3402
PROTECTION OF POTABLE WATER SUPPLY

3402.1 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 be prohibited.

3402.2 Backflow–prevention devices. Backflow–prevention devices shall comply with Section 3402.2.1 or 3402.2.2.

3402.2.1 Air gaps. When specified, a 1–inch–minimum (25 mm) 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.

3402.2.2 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 in accordance with the manufacturer's installation instructions.

3402.3 Heat exchangers. Heat exchanges shall comply with Section 3402.3.1 or 3402.3.2.

3402.3.1 Double wall. When 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.

3402.3.2 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 3403
WATER–SERVICE PIPING

3403.1 Materials. Materials for underground water–supply systems, water–service pipe and lawn sprinkler systems shall be as shown in Table 3403.1. 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.

3403.1.1 Underground 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 or copper water tube Type L conforming to the standards specified in Table 3403.1.

3403.1.2 Minimum pressure rating. Minimum working pressure rating for piping shall be 160 psi at 73°F. (1102 kPa at 23°C.) or 100 psi @ 180° F (689 kPa at 82° C) where the water supply pressure does not exceed 100 psi.. Fittings shall be approved and compatible with the type of piping used.

3403.2 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 (276 kPa).

3403.2.1 Outlet discharge. The minimum pressure at the point of outlet discharge shall not be less than a flow pressure of 8 psi (55 kPa) 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.

3403.2.2 Pressure–reducing valve. Maximum average static pressure shall be 80 psi (551 kPa). When main pressure exceeds 80 psi (551 kPa), an approved pressure–reducing valve shall be installed on the domestic water branch main or riser at the connection to the water–service pipe.

3403.3 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.

TABLE 3403.1
WATER SERVICE, SUPPLY AND DISTRIBUTION PIPING

MATERIAL	STANDARD
ABS Plastic Fittings, Sch. 40	ASTM D 2468
ABS Plastic Pipe (SDR–PR)	ASTM D 2282
ABS Plastic Pipe Sch. 40 and 80	ASTM D 1527
Butt Heat Fusion P.E. Fittings for P.E. Plastic Pipe and Tubing	ASTM D 3261
Cast Copper Alloy Solder–Joint Pressure Fittings	ASME B 16.18
CPVC Plastic Hot and Cold Water Distribution Systems	ASTM D 2846
CPVC Plastic Pipe Sch. 40 and 80	ASTM F 441
CPVC Plastic Pipe Sch. (SDR–PR)	ASTM F 442
Crosslinked P.E. Plastic Hot and Cold Water Distribution	ASTM F 877
Crosslinked Polyethylene (PEX) Tubing	ASTM F 876
Ductile Iron Pressure Pipe	ASTM A 377
Metal Insert Fittings for PB Tubing	ASTM F 1380
P.B. Plastic Hot Water Distribution Systems	ASTM D 3309
Plastic Insert Fittings for P.B. Tubing	ASTM F 845
Plastic Insert Fittings for P.E. Plastic Pipe	ASTM D 2609
Polybutylene (PB) Plastic Pipe (SDR–PR) Based on Outside Diameter	ASTM D 3000
Polybutylene (PB) Plastic Tubing	ASTM D 2666
Polybutylene (PE) Plastic Tubing	ASTM D 2737
Polyethylene (PE) Plastic Pipe (SDR–PR)	ASTM D 3000
Polyethylene (PE) Plastic Pipe Controlled OD	ASTM D 2447
Polyethylene Plastic Pipe, Sch. 40	ASTM D 2104
Polyethylene Plastic Pipe (SDR–PR) Controlled ID	ASTM D 2239
Primers for Solvent Cemented PVC Plastic Pip	ASTM F 656
PVC Plastic Pipe Fittings, Sch. 40	ASTM D 2466
PVC Plastic Pipe Sch. 40, 80 and 120	ASTM D 1785
PVC Pressure Rated Pipe (SDR Series)	ASTM D 2241
Seamless Brass Type	ASTM B 135
Seamless Copper Tube	ASTM B 75
Seamless Copper Watertube Type K, L and M	ASTM B 88
Seamless Red Brass Pipe, Standard Size	ASTM B 43
Socket Type PVC Plastic Pipe Fittings Sch. 80	ASTM D 2467
Solvent Cement for ABS Plastic Pipe	ASTM D 2235
Solvent Cement for CPVC Plastic Hot and Cold Water Distribution Systems	ASTM F 493
Solvent Cement for PVC Plastic Pipe	ASTM D 2564
Socket Bell for PVC Plastic Pipe	ASTM D 2672
Socket Type CPVC Plastic Pipe Fittings, Sch. 4	ASTM F 438
Socket Type CPVC Plastic Pipe Fittings, Sch. 8	ASTM F 439
Steel Pipe, Black and Hot Dipped, Zinc Coated Welded and Seamless	ASTM A 53
Welded Copper Water Tube (WK, WL, WM)	ASTM B 447

3403.4 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 (19 mm) nominal diameter. Exact sizing to account for total demand and for pressure drop due to friction loss shall be determined in accordance with the procedure outlined in Appendix C or in accordance with the tables in Section 3409.6. Total demand in water–supply fixture units shall be determined from Tables 3409.2 and 3409.3.

3403.5 Installation. Installation shall comply with Section 3403.5.1 or 3403.5.2.

3403.5.1 Trench installation. Trenching, pipe installation and backfilling shall be in conformance with Section 3104. Water–service pipes may be laid in the same trench with a building sewer constructed of materials listed in Section 3502.1. If the building sewer is constructed of material not approved for use within the building as listed in Section 3502.1, the water–service pipe shall be placed on a solid ledge at least 12 inches (305 mm) above and to one side of the highest point in the sewer line.

3403.5.2 Polyethylene plastic piping installation. Polyethylene pipe shall be cut square, using a cutter designed for plastic pipe. Except when joined by heat fusion, pipe ends shall be chamfered to remove sharp edges. Pipe that has been kinked shall not be installed. For bends, the installed radius of pipe curvature shall be greater 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. Stiffener inserts used with compression–type fittings shall not extend beyond the clamp or nut of the fitting. Flared joints shall be permitted where recommended by the manufacturer and made by the use of a tool designed for that operation.

3403.6 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.

3403.6.1 Investigation required. When 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.

3403.6.1.1 Detrimental condition. When a detrimental condition exists, approved alternate materials or alternate routing shall be required.

SECTION 3404
JOINTS AND CONNECTIONS

3404.1 Tightness. Joints and connections in the plumbing system shall be gas tight and water tight for the intended use or required test pressure.

3404.2 Joint requirements.

3404.2.1 Threaded pipe joints. Threaded joints shall conform to American National Taper Pipe Thread specifications. Pipe ends shall be deburred and chips removed. Pipe joint compound shall be used only on male threads.

3404.2.2 Soldered joints. Soldered joints in tubing shall be made with fittings approved for water piping and shall conform to ASTM B 828. 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. Fluxes shall conform to ASTM B 813.

3404.2.3 Flared joints. Flared joints in water tubing shall be made with approved fittings. The tubing shall be reamed and then expanded with a flaring tool.

3404.2.4 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 or compression connections.

3404.2.5 Pressure–lock fittings. Joints within the building between copper pipe, polybutylene tubing or CPVC tubing, in any combination with compatible outside diameters, may be made with the use of approved push–in mechanical fittings of a pressure–lock design.

3404.2.6 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 3405
UNDER CONCRETE SLABS

3405.1 Material. Inaccessible water–distribution piping under slabs shall be copper water tube minimum Type L, 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°F. (689 kPa at 82°C.).

SECTION 3406
CHANGES IN DIRECTION

3406.1 Bends. 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 3407
UNDERGROUND JOINTS

3407.1 Installation. Joints in polybutylene (PB) plastic pipe or tubing under a concrete floor slab shall be installed using heat fusion, in accordance with the manufacturer's recommendations and Appendix X2.2.1.9 of ASTM D3309 listed in Chapter 43. Joints in underground polybutylene (BP) water service tubing shall be installed using compression type fittings of materials approved for such use. 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 3408
VALVES

3408.1 Service valve. Each dwelling unit shall be provided with an accessible main shutoff valve on the water supply system prior to any branch lines to fixtures or hose bibbs. When a drain valve or stop and waste valve is provided, it shall be located above grade. A drain valve or hose bibb on the outside of the foundation wall shall be provided to drain the water distribution system when the shutoff valve is closed. The main shutoff valve shall be located:

1. in the interior of the building; or
2. in the crawl space within 3 feet of the access door; or
3. in a readily accessible valve box within 2 feet of the outside foundation wall.

The valve shall be of a fullway type having 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 requirements.

3408.2 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.

3408.3 Individual fixture, riser and branch valves. Valves or stops to individual fixtures, appliances, risers and branches may be installed, but shall not be required. When installed, such valves or stops shall be accessible.

3408.4 Hose bibb. Deleted.

3408.5 Relief valves. Relief valves shall have a minimum–rated capacity for the equipment served and shall conform to ANSI Z21.22.

3408.5.1 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 (172 kPa) above the system pressure but not over 150 psi (1034 kPa). The relief–valve setting shall not exceed the tank's rated working pressure.

3408.5.2 Temperature–relief valves. Temperature–relief valves shall have a relief rating compatible with the temperature conditions of the equipment protected. The valves shall be installed such that the temperature–sensing element monitors the water within the top 6 inches (153 mm) of the tank. The valve shall be set to open at a maximum temperature of 210°F. (99°C.).

3408.5.3 Combination pressure/temperature–relief valves. Combination pressure/temperature–relief valves shall comply with all the requirements of separate pressure– and temperature–relief valves.

3408.5.4 Installation of relief valves. A check or shutoff valve shall not be installed in the following locations:

1. Between a relief valve and the termination point of the relief valve discharge pipe;
2. Between a relief valve and a tank; or
3. Between a relief valve and heating equipment.

3408.5.4.1 Requirements of discharge pipe. The diameter of the discharge pipe shall not be smaller than the relief valve outlet. The discharge from the relief valve shall be piped full-size separately to the crawlspace, 6 inches above the floor, outside of the building, or to another approved terminal as provided for safety pan drain terminals, but in no case shall the discharge from a relief valve be trapped.

3408.5.5 Relief valves required on water heaters. Equipment used for heating water or storing hot water shall be protected by:

1. A separate pressure–relief valve and a separate temperature–relief valve; or
2. A combination pressure– and temperature–relief valve.

3408.5.6 Relief valves required on pressure tanks. Water–pressure tanks shall be provided with 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.

3408.5.7 Relief valve drains. Relief valve drains shall comply with Section 3409.1 or ASME/ANSI A112.4.1.

SECTION 3409
WATER–DISTRIBUTION SYSTEM

3409.1 Materials. Material for water-distribution pipes and tubing shall be brass, copper water tube minimum type M, stainless steel water tube minimum Grade H, cast iron pressure pipe, galvanized steel, chlorinated polyvinyl chloride (CPVC) or polybutylene (PB) plastic pipe, or cross-linked polyethylene (PEX) plastic pipe, or tubing, all to be installed with approved fittings; except that changes in direction in copper tube (ASTM B88) may be made with bends having a radius of not less than four diameters of the tube, providing that such bends are made by use of forming equipment which does not deform or create a loss in cross-sectional area of the tube.

3409.1.2 Under Ground. Inaccessible water distribution piping under slabs shall be copper water tube min type L, brass, cast iron pressure pipe, galvanized steel, chlorinated polyvinyl chloride (CPVC) or polybutylene (PB) plastic pipe, or cross-linked polyethylene (PEX) plastic pipe, or tubing, all to be installed with approved fittings or bends. Any material subject to corrosive soils shall be protected when used in corrosive soils.

3409.1.3 Minimum pressure rating. Minimum working pressure rating for water distribution piping shall be 100 psi at 180°F. (689 kPa at 82°C.). Fittings shall be approved and compatible with the type of piping being used.

3409.2 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 3409.2. For 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**

3409.3 Estimating supply demand. Maximum supply demand in gallons per minute (gpm) (L/m) in the service pipe or in various parts of the water–distribution system shall be determined from Table 3409.3 after computing fixture unit loads from Table 3409.2. 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 (L/m) demand for fixtures supplied by the pipe to be sized.

3409.4 Size of fixture branches. The minimum sizes for fixture branches shall be determined from Table 3409.4.

3409.5 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 (L/m)], available water pressure [psi (kPa)] and friction loss due to developed length of pipe [feet (mm)], including equivalent length of fittings in accordance with the procedure outlined in Appendix C. Alternately, sizes may be determined in accordance with Tables 3409.5a through 3409.5d, which assume a nominal static pressure of 40 psi (276 kPa) or greater at the main shutoff valve, using the following procedure, but not more than 3 fixtures on 1/2" diameter pipe.

1. Determine the total fixture unit load (w.s.f.u.) served by the pipe interval to be sized (refer to Table 3409.2). 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 3409.2 which take into account probability factors of simultaneous use. Individual fixture branches should be sized from Table 3409.4 rather than Tables 3409.5a through 3409.5d.
2. Determine pipe size for each interval from the w.s.f.u. values obtained in Step 1 using Tables 3409.5a through 3409.5d, depending on the appropriate piping material being installed. (If preferred, w.s.f.u.'s may be converted to gpm (L/m) using Table 3409.3, as both w.s.f.u. and gpm (L/m) values are provided in Tables 3409.5a through 3409.5d.)
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 (L/m)] 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.

3409.6 Manifold parallel water distribution systems.

3409.6.1 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 3409.6.2 through 3409.6.8.

3409.6.2 Sizing of manifolds. Manifold shall be sized per Table 3409.6.2. Total gallons per minute is the demand of all outlets.

3409.6.3 Minimum size. The minimum size of individual distribution lines shall be 3/8 inch (9.5 mm).

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.

TABLE 3409.2
WATER–SUPPLY FIXTURE–UNIT VALUES FOR VARIOUS PLUMBING FIXTURES AND FIXTURE GROUPS

TYPE OF FIXTURES OR GROUP OF FIXTURE	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

For **SI:** 1 gpm = 3.785 L/m.

* 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 Table 3409.3 or from Figure C201 of Appendix C.

TABLE 3409.3
DEMAND FLOW RATE AS A FUNCTION OF FIXTURE UNIT LOAD

LOAD[1] (w.s.f.u.)	DEMAND[1] (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

For **SI:** 1 gpm = 3.785 L/m.

1. Interpolation may be used to obtain intermediate values.

TABLE 3409.4
MINIMUM SIZE OF FIXTURE BRANCHES[1] (Fixtures Water-supply Pipes)[2]

TYPE OF FIXTURE OR OUTLET	NOMINAL PIPE SIZE (inch)
Bathtub (with/without shower head) Clothes-washer supply fitting Dishwasher Kitchen sink Laundry tub (one and two compartment) Shower head Wall hydrant/sill cock/hose bibb	1/2
Bar sink Bidet Lavatory Water closet (close-coupled tank type)[3]	3/8

For **SI:** 1 inch = 25.4 mm.

1. Table not applicable to manifold system. See Section 3409.6.
2. For special fixtures or fittings, size according to the manufacturer's installation instructions.
3. Also see Section 3403.2 or according to the manufacturer's specifications.

TABLE 3409.5a
PIPE SIZING BASED ON VELOCITY LIMITATION FOR COPPER WATER TUBE[1, 2, 4]

NOMINAL PIPE SIZE (inches)	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

For **SI:** 1 inch = 25.4 mm, 1 gpm = 3.785 L/m, 1 foot per second = 0.3048 m/s.

1. The relation between carrying capacities in gpm and w.s.f.u. is based on Table C401 and Figure C101 of Appendix C.
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 3409.5d.
4. Values are based on materials which conform to the following standards:
   Copper water tube—ASTM B 88
   Schedule 40 steel pipe—ASTM A 53
   Polybutylene SDR 11—ASTM D 3309
   CPVC SDR 11—ASTM D 2846
   CPVC Schedule 40—ASTM F 441
   Polyethylene Schedule 40—ASTM D 2447

TABLE 3409.5b
PIPE SIZING BASED ON VELOCITY LIMITATION FOR STEEL PIPE — STANDARD WALL SCHEDULE 40[1,2,4]

NOMINAL PIPE SIZE (inches)	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

For **SI:** 1 inch = 25.4 mm, 1 gpm = 3.785 L/m 1 foot per second = 0.3048 m/s.

See Table 3409.5a for notes.

TABLE 3409.5c
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 (inches)	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

For **SI:** 1 inch = 25.4 mm, 1 gpm = 3.785 L/m, 1 foot per second = 0.3048 m/s.

See Table 3409.5a for notes.

TABLE 3409.5d
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 (inches)	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

For **SI:** 1 inch = 25.4 mm, 1 gpm = 3.785 L/m.

See Table 3409.5a for notes.

TABLE 3409.6.2
MANIFOLD SIZING

PLASTIC		METALLIC	
Nominal Size ID (inches)	Maximum[1] gpm	Nominal Size ID (inches)	Maximum[1] 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

For **SI:** 1 inch = 25.4 mm, 1 gpm = 3.785 L/m, 1 foot per second = 0.3048 m/s.

1. Based on velocity limitation: plastic—12 fps; metal—8 fps.

Note: See Table 3409.3 for w.s.f.u.

3409.6.4 Maximum length. The maximum length of individual distribution lines shall be 60 feet (18,288 mm) nominal.

3409.6.5 Orientation. Manifolds shall be permitted to be installed in a horizontal or vertical position.

3409.6.6 Support. Piping bundles shall be secured in accordance with the manufacturer's installation instructions and supported every 4 feet (1219 mm). Bundles that change direction 45 degrees or greater shall be protected from chaffing at point of contact with framing members by sleeving or wrapping.

3409.6.7 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.

3409.6.8 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 3410
SUPPORT

3410.1 General. Pipe and tubing support shall conform to Section 3105.

SECTION 3411
TESTING WATER–SUPPLY SYSTEMS

3411.1 General. Upon completion of a section or of the entire water–supply system, it shall be tested under an air pressure or a water pressure not less than 100 psi with no evidence of leakage. The water used for tests shall be obtained from a potable source of supply.

CHAPTER 35
SANITARY DRAINAGE

SECTION 3501
GENERAL

3501.1 Scope. 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 localities having a winter design temperature above 32°F. (0°C.) (ASHRAE 97.5 percent column, winter, see Chapter 3).

SECTION 3502
MATERIALS

3502.1 Piping within buildings. Drain, waste and vent (DWV) piping in buildings shall be as shown in Table 3502.1 except that galvanized wrought-iron or galvanized steel pipe shall not be used underground and shall be kept at least 6 inches (153 mm) above ground.

3502.2 Building sewer. Building sewer piping shall be as shown in Table 3502.2.

3502.3 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. Water-pipe fittings may be accepted for use in engineer designed systems when the design indicates compliance with Section 3601.2.1.

3502.3.1 Drainage. 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 one-fourth unit vertical in 12 units horizontal (2-percent slope) grade.

3502.4 Other materials. Sheet lead, lead bends, lead traps and sheet copper shall comply with Sections 3502.4.1 through 3502.4.3.

3502.4.1 Sheet lead. Sheet lead for the following uses shall weigh not less than indicated below.

1. Shower pans, 4 psf (0.192 kN/m^2).
2. Flashing of vent terminals, 3 psf (0.144 kN/m^2).
3. Prefabricated flashing for vent pipes, 2 ½ psf (0.120 kN/ m^2

3502.4.2 Lead bends and traps. Lead bends and lead traps shall not be less than ⅛-inch (3.2 mm) wall thickness.

3502.4.3 Sheet copper. Sheet copper for the following uses shall weigh not less than indicated below.

1. General use,. 12 ounces per square feet (3.82 L/m^2).
2. Flashing for vent pipes, 8 ounces per square feet (2.55 L/m^2)
3. Flush tank linings, 10 ounces per square feet (3.18 L/m^2)

SECTION 3503
JOINTS AND CONNECTIONS

3503.1 Tightness. Joints and connections in the DWV system shall be gas tight and water tight for the intended use or pressure required by test.

TABLE 3502.1
DRAIN, WASTE AND VENT PIPING AND FITTING MATERIALS

MATERIAL	STANDARD
Welded and Seamless Steel Pipe (black or galvanized)	ASTM A 53
Cast Iron Soil Pipe and Fittings (hub and spigot)	ASTM A 74
Cast Iron Fittings (Threaded)	ASTM A 126
Malleable Iron Fittings (Threaded)	ASTM A 197
Seamless Copper Pipe, standard sizes	ASTM B 42
Seamless Red Brass Pipe, standard sizes	ASTM B 43
Seamless Copper Tube	ASTM B 75
Seamless Copper Water Tube Type K, L and M	ASTM B 88
ABS-DWV Pipe and Fittings	ASTM D 2661
PVC-DWV Pipe and Fittings	ASTM D 2665
ABS Sewer Pipe and Fittings	ASTM D 2751
3.25-inch O.D. PVC-DWV Pipe and Fittings	ASTM D 2949
Thermo-Plastic Accessible and Replaceable Plastic Tube and Fittings	ASTM F 409
ABS-DWV Sch.40 Pipe with Cellular Core	ASTM F 628
Co-extruded PVC Plastic Pipe with Cellular Core	ASTM F 891
Cast Iron Soil Pipe and Fittings (hub and spigot)	CISPI HS74
Cast Iron Soil Pipe and Fittings (hubless)	CISPI 301
Cast Copper Alloy Solder-Joint Drainage Fittings	ASME B16.23
Copper Drainage Tube (DWV)	ASTM B 306
Mechanical Couplings for Drain, Waste and Vent Pipe and Sewer Pipe	CSA B602M
Solvent Cement for ABS-DWV Pipe and Fittings	ASTM D 2235
Solvent Cement for PVC-DWV Pipe and Fittings	ASTM D 2564
Socket Bell for PVC-DWV Pipe and Fittings	ASTM D 2672
Primers for Solvent Cemented PVC-DWV Pipe and Fittings	ASTM F 656

For **SI**: 1 inch = 25.4 mm.

TABLE 3502.2
BUILDING SEWER PIPING

MATERIAL	STANDARD
Cast Iron Pipe and Fittings	ASTM A 74
Cast Iron Pipe and Fittings	CISPI HS74
Cast Iron Soil Pipe and Fittings for Hubless Sanitary Systems	CISPI 301
Seamless Copper Tube	ASTM B 75
Copper Water Tube	ASTN B 88
Concrete Sewer, Storm Drain and Culvert Pipe	ASTM C 14
Compression Joints for Vitrified Clay Pipe and Fittings	ASTM C 425
Vitrified Clay Pipe and Fittings	ASTM C 700
Bitumenized Fiber Drain and Sewer Pipe	ASTM D 1861
ABS-DWV Pipe and Fittings	ASTM D 2661
PVC/DWV Pipe and Fittings	ASTM D 2665
ABS Sewer Pipe and Fittings	ASTM D 2751
3.25-inch O.D. PVC/DWV Pipe and Fittings	ASTM D 2949
Type PSM/PVC Sewer Pipe and Fittings	ASTM D 3034
Joints for Drain and Sewer Plastic Pipe Using Flexible Elastomeric Seals	ASTM D 3212
ABS Schedule 40 DWV Pipe with Cellular Core	ASTM F 628
Co-extruded PVC Schedule 40, PS 50 or PS 100 Plastic Pipe with Cellular Core	ASTM F 891
Copper Drainage Tube (DWV)	ASTM B 306
Mechanical Couplings for Drain Waste and Vent Pipe and Sewer Pipe	CSA B602M
Solvent Cement for ABS-DWV Pipe and Fittings	ASTM D 2235
Solvent Cement for PVC-DWV Pipe and Fittings	ASTM D 2564
Socket Bell for PVC-DWV Pipe and Fittings	ASTM D 2672
Primers for Solvent Cemented PVC-DWV Pipe and Fittings	ASTM F 656

For **SI**: 1 inch = 25.4 mm.

3503.2 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.

3503.3 Joint requirements, similar piping materials. Joints between similar piping materials shall be made in accordance with Sections 3503.3.1 through 3503.3.7.

3503.3.1 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 (25 mm) deep and shall not extend more than 1/8 inch (3.2 mm) below the rim of the hub. Lead shall be run in one pouring and shall be caulked tight.

3503.3.2 Cast-iron pipe, mechanical joints. Mechanical joints used with cast-iron pipe shall comply with Section 3503.3.2.1 or 3503.3.2.2.

3503.3.2.1 Hubless pipe. Joints for hubless cast-iron soil pipe shall be made with an approved elastomeric sealing sleeve and stainless steel-retaining sleeve.

3503.3.2.2 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.

3503.3.3 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.

3503.3.4 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 Fluxes shall conform to ASTM B 813.

3503.3.5 Clay or cement soil pipe joints. Joints in clay or cement piping shall be made using flexible compression joints, elastomeric rings, elastomeric couplings or oakum and cement.

3503.3.6 Plastic pipe joints. Joints in plastic piping shall be made with approved fittings by solvent cementing, elastomeric gaskets or other approved manufactured system.

3503.3.7 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 slip joints. When a ground joint connection is used and the assembled joint does not permit free movement, the joint need not be accessible.

3503.4 Joints between different piping materials. Joints between different piping material shall comply with Sections 3503.4.1 through 3503.4.6.

3503.4.1 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.

3503.4.2 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.

3503.4.3 Threaded pipe to cast-iron soil pipe. Joints between threaded pipe and cast-iron soil pipe shall be made with approved adapter fittings.

3503.4.4 Threaded pipe to copper or plastic pipe. Joints from threaded pipe to copper or plastic piping shall be approved.

3503.4.5 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 by 3 closet flange. The joint shall be bolted, with an approved gasket or setting compound between the fixture and the closet flange.

3503.4.6 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 3504
DETERMINING DRAINAGE FIXTURE UNITS

3504.1 DWV system load. The load on DWV-system piping shall be computed in terms of drainage fixture unit (d.f.u.) values in accordance with Table 3504.1.

TABLE 3504.1
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 clothes 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 ½ baths	7
2 baths	8
2 ½ baths	9
3 baths	10
3 ½ baths	11

1. For a continous or semicontinous 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 3505
DRAINAGE SYSTEM

3505.1 Drainage fittings and connections. Changes in direction in drainage piping shall be made by the appropriate use of sanitary tees, wyes, sweeps, bends or by a combination of these drainage fittings.

3505.1.1 Horizontal to vertical (single connection). Horizontal drainage lines connecting with a vertical stack shall enter through a wye, tee-wye, bend, sweep or sanitary tee. Short-pattern fittings or a sanitary tapped tee shall be an acceptable connection for branch lines serving one fixture.

3505.1.2 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.

3505.1.2.1 Prohibited connection. 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.

3505.1.3 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.

3505.1.4 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.

3505.1.5 Heel- or side-inlet l/4 bends, drainage. Heel-inlet ¼ bends shall be an acceptable means of connection, where the ¼ bends serves a water closet. A low-heel inlet shall not be used as a dry-vented connection. Side-inlet ¼ bends shall be an acceptable means of connection for wet-venting.

3505.1.6 Heel- or side-inlet ¼ bends, venting. A heel-inlet or side-inlet ¼ 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 fitting is part of a wet vent arrangement.

3505.1.7 Water closet connection between flange and pipe. A 3-inch (76 mm) ¼ bends or bend shall be acceptable for water closet or similar connections, provided a 4-inch-by-3-inch (102 mm by 76 mm) flange is installed to receive the closet fixture horn. Alternately, a 3-inch-by-4-inch (76 mm by 102 mm) elbow shall be acceptable with a 4-inch (102 mm) flange.

3505.1.8 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 (610 mm) or more.

3505.2 Drainage pipe cleanouts. Drainage pipe cleanouts shall comply with Sections 3505.2.1 through 3505.2.11.

3505.2.1 Materials. Cleanouts shall be liquid- and gas tight. Cleanout plugs shall be brass or plastic.

3505.2.2 Spacing. Cleanouts shall be installed not more than 75 feet (22 860 mm) apart in horizontal drainage lines of 4-inch (102 mm) nominal diameter or less.

3505.2.3 Underground drainage cleanouts. When installed in underground drains, cleanouts shall be extended vertically to or above finished grade either inside or outside the building.

3505.2.4 Change of direction. One cleanout shall be reqired for every four 45 degree changes located in series (a long sweep is equivalent to two 45 degree bends).

3505.2.5 Accessibility. Cleanouts shall be accessible. Minimum clearance in front of cleanouts shall be 18 inches on 3 inches (457 mm on 76 mm) and larger pipes, and 12 inches (305 mm) 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. Cleanouts shall not be located in a concealed floor/ceiling space located over a habitable area.

3505.2.6 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 (914 mm) of the building wall.

3505.2.7 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 or test tee within close proximity to the building drain exit point shall fulfill this requirement.

3505.2.8 Direction of flow. Cleanouts shall be installed so that the cleanout opens in the direction of the flow of the drainage line.

3505.2.9 Cleanout size. Cleanouts shall be of the same nominal size as the pipe up to 4 inches (102 mm) and not less than 4 inches (102 mm) for larger piping.

3505.2.10 Cleanout equivalent. A fixture trap or a fixture with integral trap, readily removable without disturbing concealed piping shall be acceptable as a cleanout equivalent.

3505.2.11 Connections to cleanouts prohibited. Cleanout openings shall not be used for the installation of new fixtures or floor drains except when approved and an acceptable alternate cleanout is provided.

3505.3 Horizontal drainage piping slope. Horizontal drainage piping shall be installed in uniform alignment at uniform slopes not less than one-fourth unit vertical in 12 units horizontal (2-percent slope) for 2 1/2-inch (64 mm) diameter and less, and not less than one-eighth unit vertical in 12 units horizontal (1-percent slope) for diameters of 3 inches (76 mm) or more.

3505.4 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 3504.1.
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 3504. 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 3505.4.1.
5. Determine the pipe diameter and slope of the building drain and building sewer based on the accumulated d.f.u. values, using Table 3505.4.2.

3505.4.1 Fixture branch and stack sizing.

1. Branches and stacks shall be sized according to Table 3505.4.1. Below-grade drain pipes shall not be less than 2 inches (51 mm) in diameter.
2. Minimum Stack Size. Drain stacks shall not be smaller than the largest horizontal branch connected, with the following exceptions:
   2.1 A 4-inch-by-3-inch (102 mm by 76 mm) closet bend or flange or a 4-inch (102 mm) closet bend into a 3-inch (76 mm) stack tee shall be acceptable (see Section 3505.1.7).

3505.4.2 Building drain and sewer size and slope. Pipe sizes shall be determined from Table 3505.4.2 on the basis of drainage load in fixture units (d.f.u.) computed from Table 3504.1.

TABLE 3505.4.1
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 ¼[1]	—	—
1 ½[2]	3	4
2[2]	6	10
2 ½[2]	12	20
3	20[3]	48[4]
4	160	240

For **SI**: 1 inch = 25.4 mm.

1. 1 ¼-inch pipe size limited to a single-fixture drain or trap arm. See Table 3701 .7.
2. No water closets.
3. Maximum three water closets.
4. Maximum six water closets.

TABLE 3505.4.2
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		
	⅛ inch	¼ inch	½ inch
1 ¼ [1,2]	—	—[1]	—[1]
2[2]	—	21	27
2 ½ [2]	—	24	31
3	20[3]	42	48
4	180	216	250

For **SI**: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

1 1 ½-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.

3 Maximum three water closets.

4. No building sewer shall be less than 4 inches in size.

SECTION 3506 Deleted

SECTION 3507
SUMPS AND EJECTORS

3507.1 Sewage ejectors or sewage pumps. A sewage ejector, sewage pump, or grinder pump receiving discharge from a water closet shall have minimum discharge velocity of 1.9 feet per second (0.579 m/s) throughout the discharge piping to the point of connection with a gravity building drain, gravity sewer or pressure sewer system. A nongrinding pump or ejector shall be capable of passing a 1 ½-inch-diameter (38 mm) solid ball, and the discharge piping shall have a minimum diameter of 2 inches (51 mm).

The discharge piping of grinding pumps shall have a minimum diameter of 1 ¼ inches (32 mm). All pumps shall be protected from backflow by a backwater or check valve.

3507.1.1 Sump alarms. Sumps that discharge by means of automatic pumping equipment shall be provided with an approved, electrically operated high water indicating alarm. A remote sensor shall activate the alarm when the fluid level exceeds a preset level that is less than the maximum capacity of the sump. The alarm shall function to provide an audiovisual signal to occupants within the dwelling. Electrical power for the alarm shall be supplied through a branch circuit separate from that supplying the pump motor.

3507.2 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.

3507.2.1 Drainage piping. 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 opcn 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.

SECTION 3508
BACKWATER VALVES

3508.1 General. 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 the elevation of the next upstream manhole shall not discharge through the backwater valve.

3508.2 Construction. 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 of the bolted type with gasket.

CHAPTER 36
VENTS

SECTION 3601
VENT SYSTEMS

3601.1 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 (249 Pa) under design load conditions.

3601.1.1 Required drain and vent stack. Buildings shall have at least one 3 inch soil stack running from the building drain up through the building, with the stack vent terminating outdoors above the topmost branch interval per Section 3601.5. Additional branches may be served by air admittance valves installed in accordance with Sections 3601.4 and 3601.5.6. Valves shall be sized according to Table 3601.5 6.

3601.1.2 Prohibited use. The plumbing vent system shall not be used for purposes other than the venting of the plumbing system.

3601.2 Vent slopes and connections. Vent slopes and connections shall comply with Sections 3601.2.1 through 3601.2.5.

3601.2.1 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.

3601.2.2 Vent connection to a horizontal drain. When 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.

3601.2.3 Vent stack connection at base. Vent stacks shall connect full size at their base to the drainage system, below the lowest fixture branch.

3601.2.4 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.

3601.2.5 Crown venting prohibited. No vent shall be installed within two pipe diameters of the trap weir.

3601.2.6 Water Closets. All fixtures discharging downstream from a water closet shall be individually vented.

3601.3 Common vents. Common vents shall comply with Sections 3601.3.1 through 3601.3.3.

3601.3.1 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.

3601.3.2 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

3601.3.3 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 (153 mm) above the flood-level rim of the highest fixture and terminate in accordance with Section 3601.5. This header shall be sized in accordance with the requirements of Section 3601.7.

3601.4 Air admittance valves. Approved air admittance valves complying with ASSE 1051 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 (102 mm) above the trap arm of the fixture served and shall be accessible for periodic inspection and/or replacement. Air admittance valves shall be sized to accommodate the fixture unit load of the branch or fixture that it serves in accordance with Table 3601.5.6. Devices designed to accommodate multiple pipe size connections shall be permitted.

3601.5 Vent terminals. Vent terminals shall comply with Sections 3601.5.1 through 3601.5.6.

3601.5.1 Location of vent terminal. Vent terminals shall not be located beneath doors, windows or other openings nor shall a vent terminal be within 10 feet (3058 mm) horizontally of an opening to the interior unless it is at least 2 feet (610 mm) above the top of the opening.

3601.5.2 Vent extension above roofs. Vent pipe extensions through the roof shall terminate at least 6 inches (153 mm) 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 (2134 mm) above the roof.

3601.5.3 Vent extension through wall or overhang. Vent terminals extending through a wall, when approved by the Plumbing Official, shall be located at least 10 ft. horizontally from any lot line. They shall be turned to provide an opening upward. They shall be effectively screened and shall meet the requirements of 3601.5.1. Vent terminals shall not terminate under the overhang of the building.

3601.5.4 Vent pipe flashing and sealing. Vent extensions through roofs shall be made water tight by use of flashings. Vent extensions in walls or soffits shall be made weather tight by caulking.

3601.5.5 Frost closure. DELETED

3601.5.6 Vent terminals in attic spaces. Vent terminals equipped with approved air admittance valves may be located in accessible attic spaces when the building drainage system connects to a vented sewer. Valves complying with ASSE 1051 shall be installed above the attic insulation and shall be sized according to Table 3601.5.6.

3601.6 Dry vent sizing. All dry portions of a venting system including individual and common vents extending from trap arms, stack vents, vent stacks, relief vents or other dry vents shall be sized based on the accumulated load. The diameter of each vent shall be at least one-half the diameter of the required drainage pipe size computed in accordance with Section 3505.4 except that the vent pipe shall not be less than 1 ¼ inches (32 mm) in diameter. Where vents exceed 40 feet (12 192 mm) in length, the vent shall be increased by one nominal pipe size. The developed length shall be measured from the farthest point of the vent connection to the drainage system to outside the building.

Exceptions:

1. Sump vents, see Section 3601.10.
2. Engineered vent sizing in accordance with Appendix B.

3601.7 Wet venting. Wet venting shall comply with Sections 3601.7.1 through 3601.7.4.

3601.7.1 Horizontal wet vent. A combination of fixtures located on the same floor level are permitted to be vented by a horizontal wet vent. The wet vent shall extend from the connection of the dry vent along the direction of the flow in the horizontal branch drain to the most downstream wet vented fixture drain connection. The size of the wet vent shall be in accordance with Table 3601.7.1. Each fixture drain being wet vented shall connect independently to the horizontal branch drain. Fixtures that discharge above the elevation of the horizontal branch drain, thereby requiring vertical drain sections, shall be individually or common vented, or shall comply with Section 3602.3 of this code. The dry vent shall be connected between the two most upstream fixtures. See Figures 3601.7.1a and 3601.7.1b for typical wet vent configurations.

3601.7.2 Vertical wet vent. A combination of fixtures located on the same floor level are permitted to be vented by a vertical wet vent. The vertical wet vent shall extend from the connection of the dry vent down to the lowest fixture drain connection. The size of the wet vent shall be in accordance with Table 3601.7.1. Each fixture drain shall connect independently to the vertical wet vent. All water closet fixture drains shall connect at the same elevation. Other fixture drains shall connect above or at the same elevation as the water closet fixture drains. The dry vent connection to the vertical wet vent shall be the individual or common vent serving one or two fixtures.

3601.7.3 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 3601.8). The dry vent extension of the wet vent shall be sized according to the d.f.u. load of the waste fixtures served (see Figures 3601.7.1a, Items A, C and D, and 3601.7.1b, 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 Figures 3601.7.1a, Item B, and 3601.7.1b, Item C).

3601.7.4 Waste stack serving a kitchen group. When 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 (51 mm) (see Figure 3601.7.4).

3601.8 Single stack system venting. Single stack venting systems shall comply with Sections 3601.8.1 through 3601.8.4.

3601.8.1 General. The stack shall be considered a vent for all fixtures discharging to the stack when installed in accordance with the requirements of this section.

3601.8.2 Stack installation. The stack shall be vertical and shall not be offset. All fixture drains shall connect separately except that fixtures within the same group shall be permitted to be connected to a common drain. See Figures 3601.8.2a and 3601.8.2b for typical stack vent installations.

3601.8.3 Stack vent. A stack vent shall be provided for the stack. The size of the stack vent shall be at least one-half the diameter of the required stack size but not less than 1 ¼.

3601.8.4 Stack size. The waste stack shall be sized based on the total discharge to the stack and the discharge within a branch interval in accordance with Table 3601.8.4. The stack shall be the same size throughout its length.

TABLE 3601.5.6
AIR ADMITTANCE VALVE MAXIMUM LOAD LIMITATIONS FOR HORIZONTAL FIXTURE BRANCHES

NOMINAL PIPE SIZE (inches)	D.F.U. ANY HORIZONTAL FIXTURE BRANCH
1 ¼	1
1 ½	3
2	6
3	20[1]
4	160

For SI: 1 inch = 25.4 mm.

[1] Not more than two water closets or bathroom groups per interval.

TABLE 3601.7.1
WET VENT SIZE

PIPE SIZE INCHES	FIXTURE UNIT LOAD (dfu)
1 ½	1
2	4
2 ½ [1]	6
3	12
4	32

For SI: 1 inch = 25.4 mm.

[1] No water closets.

TABLE 3601.8.4
SINGLE STACK SYSTEM SIZING

STACK SIZE (inches)	TOTAL DISCHARGE INTO ONE BRANCH INTERVAL (d.f.u.)[1]	TOTAL DISCHARGE FOR STACK (d.f.u.)
1 ½	1	2
2	2	4
2 ½	NL	8
3	NL	24
4	NL	50

For SI: 1 inch = 25.4 mm.
1. NL mean no limit.

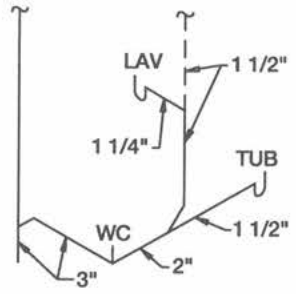
3601.9 Sump vent sizes and lengths. Drainage piping below sewer level shall be vented in a similar manner to that for a gravity system. Building and sump vents,. where required, shall be sized in accordance with Table 3601.10.

TABLE 3601.9
SIZE AND LENGTH OF SUMP VENTS

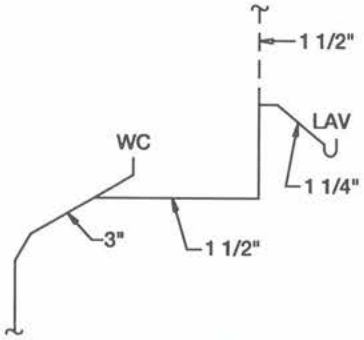
DISCHARGE CAPACITY OF SUMP PUMP (gpm)	VENT PIPE SIZE (inches)		
	1 1/4	1 1/2	2
	Length of vent (feet)		
10	N.L.*	N.L.	N.L.
20	270	N.L.	N.L.
40	72	160	N.L.
60	31	75	270

For SI: 1 inch = 25.4 mm 1 foot = 304.8 mm. 1 gpm = 3.785 L/m.

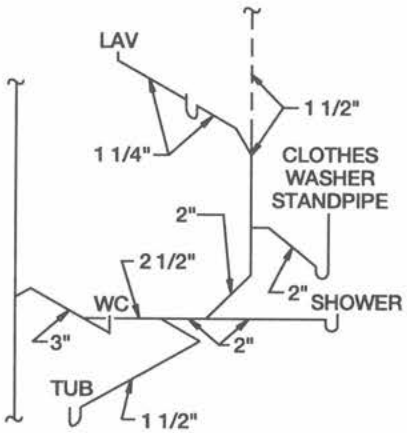
* No practical limit.



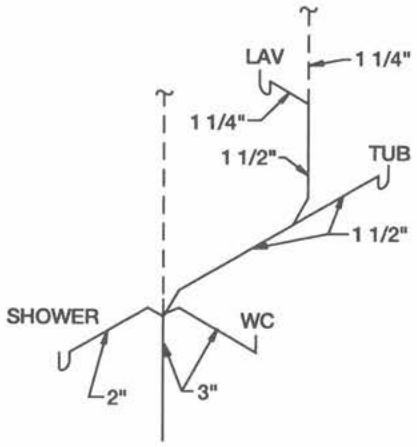
A. TYPICAL SINGLE-BATH



B. TYPICAL POWDER ROOM



C. MORE ELABORATE
SINGLE-BATH ARRANGEMENT



D. COMBINATION WET - AND
STACK - VENTING WITH
STACK FITTING

FIGURE 3601.7.1a
TYPICAL SINGLE-BATH WET-VENT ARRANGEMENTS

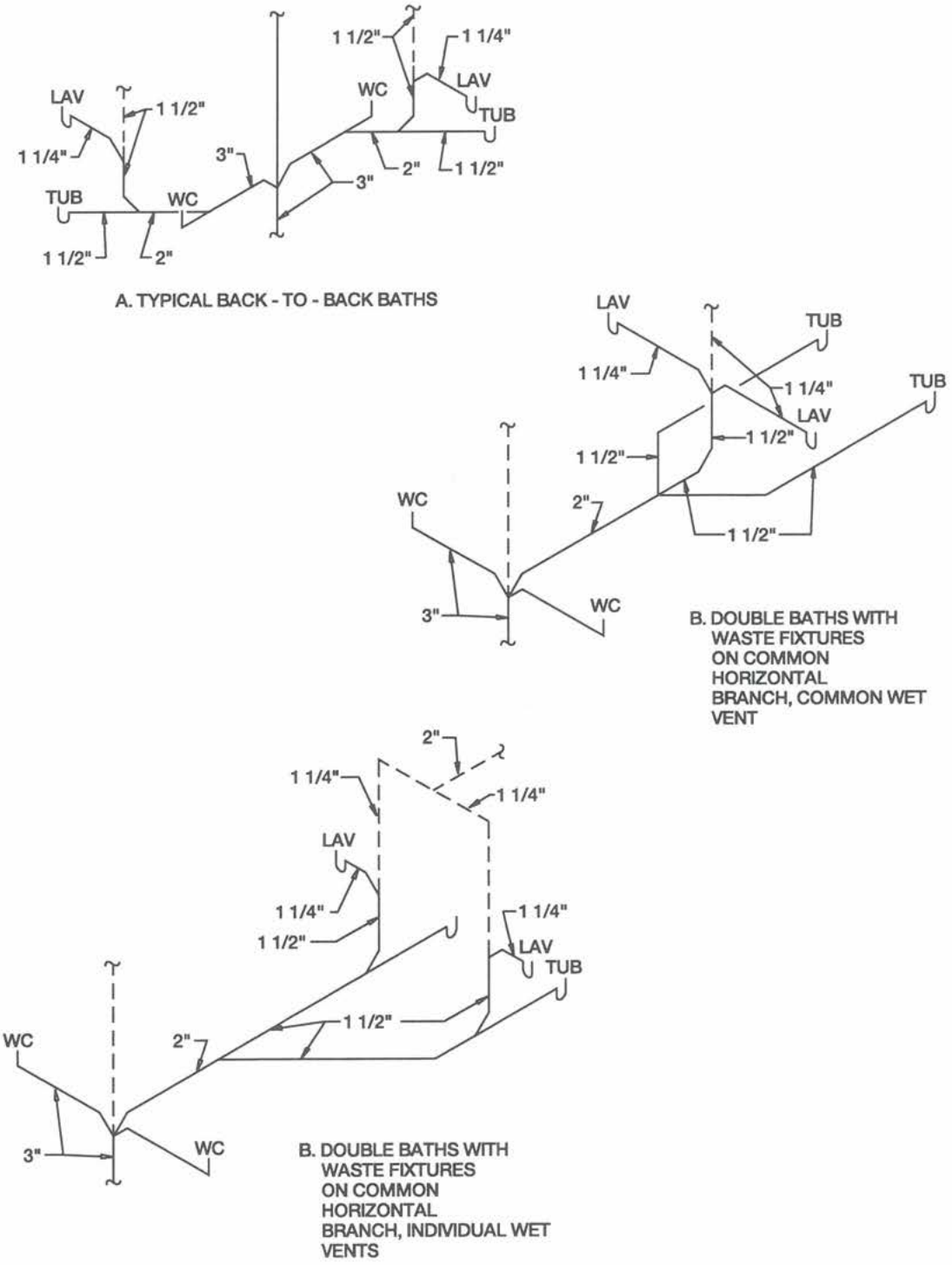


FIGURE 3601.7.1 b
TYPICAL DOUBLE-BATH WET-VENT ARRANGEMENTS

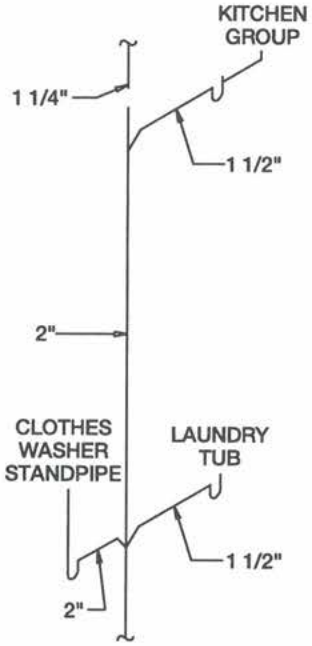


FIGURE 3601.7.4
WASTE STACK SERVING AS WET VENT FOR LAUNDRY GROUP

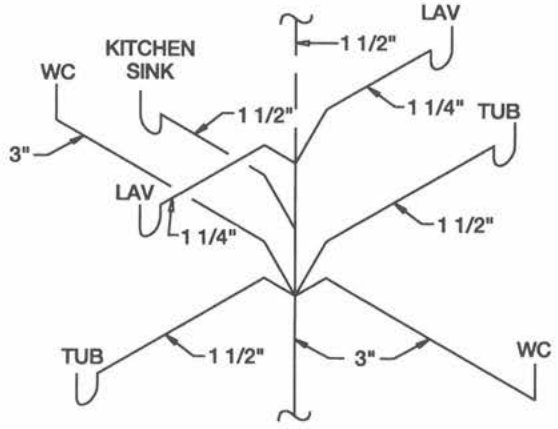


FIGURE 3601.8.2a
CONNECTING FIXTURE DRAIN TO STACK IN STACK-VENTED SYSTEMS

SECTION 3602
TRAP ARMS

3602.1 Maximum length of trap arm. Each fixture trap shall have a protecting vent located so that the maximum developed length of the trap arm is within the requirements of Table 3602.1. Minimum trap arm length shall be two pipe diameters (see Section 3601.2.5).

TABLE 3602.1
MAXIMUM LENGTH OF TRAP ARM

DIAMETER (inches)	LENGTH (feet)
1 l/4	3'-6"
1 1/2	5'-0"
2	8'-0"
3	10'-0"
4	12'-0"

For **SI**: 1 inch=25.4 mm, 1 foot=304.8 mm.

3602.2 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.

3602.3 Vertical leg for waste fixture drains. Deleted.

3602.4 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.

CHAPTER 37
TRAPS

SECTION 3701
FIXTURE TRAPS

3701.1 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 or approved plastic. Tubular brass traps shall not be less than No. 20 gage (0.8 mm) 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.

3701.2 Trap seals. Traps shall have a liquid seal of not less than 2 inches (51 mm) and not more than 4 inches (102 mm). Traps that could lose their seal due to evaporation because of infrequent use, such as floor drains, may be fitted with a trap primer.

3701.3 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 3601).

3701.4 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.

3701.5 Prohibited trap designs. The following types of traps are prohibited:

1. Bell traps.
2. Separate fixture traps with interior partitions, except those lavatory traps made of plastic, stainless steel or other corrosion-resistant material.
3. "S" traps.
4. Drum traps.
5. Trap designs with moving parts.

3701.6 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 perrnitted. The vertical distance from the fixture outlet to the trap weir shall not exceed 24 inches (610 mm). 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 (762 mm) 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 be 2" in diameter and not be less than 18 inches (762 mm) or more than 48 inches (1219 mm) as measured from the crown weir. The standpipe shall extend 34 inches minimum above the base of the clothes washer unless recommended otherwise by the manufacturer. The outlet of the laundry tray shall be a maximum horizontal distance of 30 inches (762 mm) from the standpipe trap.

3701.7 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 3701.7. No trap, including integral traps, shall be larger than the drainage pipe into which it discharges.

TABLE 3701.7
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	2
Dishwasher (on separate trap)	1 1/2
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	2
Water closet	*

For **SI**: 1 inch = 25.4 mm.
* Consult fixture standards for trap dimensions of specific bowls.

CHAPTER 38
SEWAGE DISPOSAL

SECTION 3801
GENERAL

3801.1 Scope. Public sewers and private disposal systems shall conform to the requirements of the local town, city, or Health Department.

3801.2 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 when 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.

3801.3 Mandatory connection to a sewage system. Plumbing fixtures and drainage piping shall be connected to a public sewer or and approved private or individual sewage disposal system.

3801.4 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 field shall not be connected to public sewers or to building sewers leading to public sewers.

SECTION 3802
BUILDING SEWER SIZE

3802.1 Required size. The size of building sewer shall be determined in accordance with Table 3505.4.2.

3802.2 Installation. Building sewers shall be installed at a uniform slope of not less than one-fourth unit vertical in 12 units horizontal (2-percent slope) and may be reduced to one-eighth unit vertical in 12 units horizontal (1-percent slope) in accordance with Section 3505.4.2 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. Waste and soil piping leaving the building shall have a minimum cover of 3 inches.

CHAPTER 39
ENERGY CONSERVATION

SECTION 3901
GENERAL REQUIREMENTS

3901.1 These insulation requirements apply to all new one and two-family dwellings which are heated and/or cooled regardless of the type of fuel used (electric, oil, gas, or wood). The CABO Model Energy Code, 1995 edition shall be accepted as meeting the minimum requirements of Chapter 39, except that envelope requirements may not be traded-off against the use of high efficiency heating and/ or cooling equipment.

3901.2 It is imperative that close attention be paid to the installation of the materials specified to realize benefits of these requirements.

1. The vapor-resistant facing furnished on blanket and roll type insulation shall always face the interior of the structure. Insulation shall be wedged between pipes and electrical outlets and the external surface of the wall.
2. If unfaced blankets or rolls are used, a vapor retarder of at least 4 mil polyethylene or its equivalent shall be stapled to the studs or foil backed gypsum board shall be used on the interior wall.
3. Voids shall not exist at the top or bottom of the stud cavity.
4. All cracks around windows and doors shall be filled with insulation with a vapor retarder properly installed.
5. Vapor retarders shall be carefully checked to assure that no tears exist and any tear shall be patched.
6. The manufacturers' installation procedures for all insulation shall be strictly adhered to.

3901.3 On blanket and roll-type insulation furnished with a vapor resistant facing, the R-Value of the insulation shall be marked at three foot intervals on the exposed facing.

3901.4 For unfaced blankets and rolls, the manufacturer shall furnish sufficient identifying markings to indicate the insulation R-Value.

3901.5 When loose fill insulation is proposed, the R-value of the material shall be determined in accordance with ASTM C-687.

3901.6 When the exterior sheathing or exterior siding of any insulated stud cavity wall has a permeance of less than 0.6 perm (ASTM Dry Cup Method) the interior vapor retarder shall be a minimum of 4 mil polyethylene or its equivalent with all penetrations sealed by either taping or caulking. It is not the intent of this rule to require taping or caulking around electrical outlet receptacles.

3901.7 For buildings constructed so as to have portions of an assembly of the envelope fall below the specified R-Value, trade-offs are allowed on a BTU-for-BTU basis. The required thermal value of any one assembly, such as roof/ceiling, door, window, wall, or floor may be increased and the thermal value for other components decreased, provided the overall heat loss and heat gain from the entire building envelope does not exceed the total resulting from conformance to the required thermal values. Such deviation shall require a heat loss and heat gain analysis in accordance with the ASHRAE Handbook of Fundamentals or ACCA Manual J.

3901.8 An insulation certification card shall be furnished by the insulation applicator and posted at a conspicuous location within the structure. This certification shall indicate the R-Value, minimum thickness, maximum coverage and minimum weight per square foot of the insulation installed for the walls, ceiling and floor.

3901.9 A prescriptive Compliance Worksheet (Appendix J) shall be furnished to the CEO for the inspection listed in Section 112.1.6.

3901.10 The United States has been divided into zones by the US Department of Energy. North Carolina is listed as zones 6, 7, 8, 9, and 11 as shown on Figure 3901. By looking at the county name on Figure 3901, pick the zone corrosponding to that county and use the values listed in Table 3905 to determine the prescriptive minimum insulation values and maximun window and door openings allowed.

SECTION 3902
MINIMUM R-VALUE FOR EXTERIOR WALLS

All walls within the heated or cooled space exposed to the exterior shall be insulated as specified in Table 3905.

Exceptions:

1. Solid wood walls having a weight greater than or equal to 20 psf may have a total R-Value of not less than R-9.
2. Concrete or masonry walls having a weight greater than or equal to 30 psf may have a total R-Value of not less than R-9 with insulation placed on the exterior of the wall mass or R-11 with insulation placed on the interior of the wall mass.
3. Unheated basement walls where the floor/ceiling of the basement is insulated in accordance with Section 3904.

SECTION 3903
MINIMUM R-VALUE FOR CEILINGS

3903.1 All ceilings within the heated or cooled space exposed to the exterior shall be insulated as specified in Table 3905.

Exception: Cathedral ceiling may be insulated with a minimum total R-Value of R-19 (through the cavity section), when other components are increased in accordance with Section 3901.7.

3903.2 Blown or poured type loose fill insulation may be used in attic spaces where the slope of the roof is a minimum of 2-1/2 feet in 12 feet and there is at least 30 inches clear headroom at the roof ridge. (Clear headroom is defined as the distance from the top of the bottom chord of the truss or ceiling joists to the underside of the roof sheathing.)

3903.3 When soffit vents are installed, adequate baffling of the vent opening shall be provided to deflect the incoming air above the surface of the material and shall be installed at the soffitt. Baffles shall be in place at the time of inspection.

3903.4 A minimum of one (1) inch air space shall be provided between the insulation/baffle and roof deck. Minimum ventilation for roof/ceiling cavities shall conform to Section R-806.

SECTION 3904
MINIMUM R-VALUE FOR FLOORS

3904.1 All floors exposed to a crawl space, unconditioned basements, unheated garages, or breezeways shall be insulated as specified in Table 3905.

3904.2 All slab-on-grade floors within the heated or cooled space,which exceed 2,800 HDD65 (see ACP Zone Tables in North Carolina State Building Code, Volume X-Energy), shall be insulated around the perimeter of the floor exposed to the outside with rigid insulation having a minimun "R" value of R-5.0 and specifically designed and recommended by the Manufacturer for this type application. Foam plastic insulation shall be installed in accordance with Section 323.3.5. Any heat loss due to required inspection gap or treatment gap shall be disregarded. The insulation shall be installed as follows: (See Figures in Appendix E).

1. Insulation shall be installed downward to the bottom of a floating slab then horizontally beneath the slab for a total distance of 24 inches.
2. Insulation shall be installed downward to the bottom of a monolithic slab, then horizontally away from the slab for a total distance of 24 inches.
3. Insulation extending above grade shall be protected from physical damage.
4. A 6 mil polyethylene sheeting or equivalent shall be installed as a vapor retarder under the slab. The edges of the vapor retarder shall be lapped at least 12 inches and extended to the outer edge of the slab.
5. A heated slab shall have the required R-Value increased by 2.0.

SECTION 3905
EXTERIOR DOORS AND WINDOWS

3905.1 All unglazed doors within the heated or cooled space exposed to the exterior shall have a minimum R-Value of R-1.66.

3905.2 All doors with glass units shall be in accordance with Table 3905.

3905.3 All window units shall be in accordance with Table 3905. A thermal break shall be provided on all metal windows.

3905.4 All doors and windows opening to the exterior or to unconditioned areas shall be fully weatherstripped, gasketed or otherwise treated to limit infiltration. A non-hardening sealant shall be used to caulk around all window and door frames.

Table 3905
Minimum Thermal Envelope Requirements & Maximum Door and Window Openings Allowed

ZONE	WALL R-Value		CEILING R-Value	FLOOR R-Value	%WINDOW & DOOR OPENINGS ALLOWED			
	Wall	Sheathing			Metal/Thermal Break U=0.67	Wood Vinyl U-0.56	Wood Vinyl with Low E U=0.52	Wood Vinyl Low-E Inert Gas High Performance U=0.35
6	13	1.0	30	19	17	21	23	33
7	13	1.0	30	19	15	18	20	28
8	13	1.0	30	19	14	16	18	25
9	13	1.0	30	19	13	15	16	23
11	15	1.0	38	19	9	13	14	17

Notes:

1. % Openings is based upon wall area and includes doors and windows.
2. R-Values is insulation products only. The R-value listed for wall & sheathing can be used in any combination to meet the minimun combined values listed.
3. May use the 1995 MEC (MECcheck version 2.0/1995 MEC) instead of the opening values listed. Envelope requirements may not be traded-off against the use of high efficiency heating and/or cooling equipment.
4. 1% of the total gross wall area may be single glazing.
5. Use figure 3905 to determine which zone to use above.

SECTION 3906
AIR LEAKAGE

Exterior joints in the building envelope that are sources of air leakage such as around window and door frames; between wall cavities and window or door frames; between walls and foundations; between walls and roof/ceilings and between wall panels; openings at penetrations of utility services through walls, floors and roofs; and all other openings in the building envelope shall be caulked, gasketed, weatherstripped or otherwise sealed in an approved manner.

SECTION 3907
DUCT SEALING

All ducts serving heating or air conditioning equipment shall be sealed in accordance with Chapter 19.

NORTH CAROLINA

SEE NEXT PAGE FOR FIGURE 3901

Zone	County	Zone	County	Zone	County	Zone	County	Zone	County	Zone	County	Zone	County	Zone	County
8	Alamance	8	Caldwell	7	Currituck	7	Greene	7	Lee	8	NewHanover	7	Richmond	6	Tyrell
8	Alexander	7	Camden	6	Dare	8	Guilford	7	Lenoir	7	Northampton	7	Robeson	7	Union
11	Alleghany	6	Carteret	8	Davidson	7	Halifax	7	Lincoln	6	Onslow	8	Rockingham	8	Vance
7	Anson	8	Caswell	8	Davie	7	Harnett	9	Macon	8	Orange	7	Rowan	7	Wake
11	Ashe	8	Catawba	6	Duplin	9	Haywood	9	Madison	6	Pamlico	7	Rutherford	8	Warren
11	Avery	8	Chatham	8	Durham	9	Henderson	7	Martin	7	Pasquotank	6	Sampson	7	Washington
6	Beaufort	9	Cherokee	7	Edgecombe	7	Hertford	8	McDowell	6	Pender	7	Scotland	11	Watauga
7	Bertie	7	Chowan	8	Forsyth	7	Hoke	7	Mecklenburg	7	Perquimans	7	Stanly	7	Wayne
6	Bladen	9	Clay	8	Franklin	6	Hyde	11	Mitchell	8	Person	9	Stokes	9	Wilkes
6	Brunswick	7	Cleveland	7	Gaston	8	Iredell	7	Montgomery	7	Pitt	9	Surry	7	Wilson
9	Buncombe	6	Columbus	8	Gates	9	Jackson	7	Moore	7	Polk	9	Swain	8	Yadkin
8	Burke	6	Craven	9	Graham	7	Johnson	7	Nash	8	Randolph	9	Transylvania	11	Yancey
7	Cabarrus	7	Cumberland	8	Granville	6	Jones								

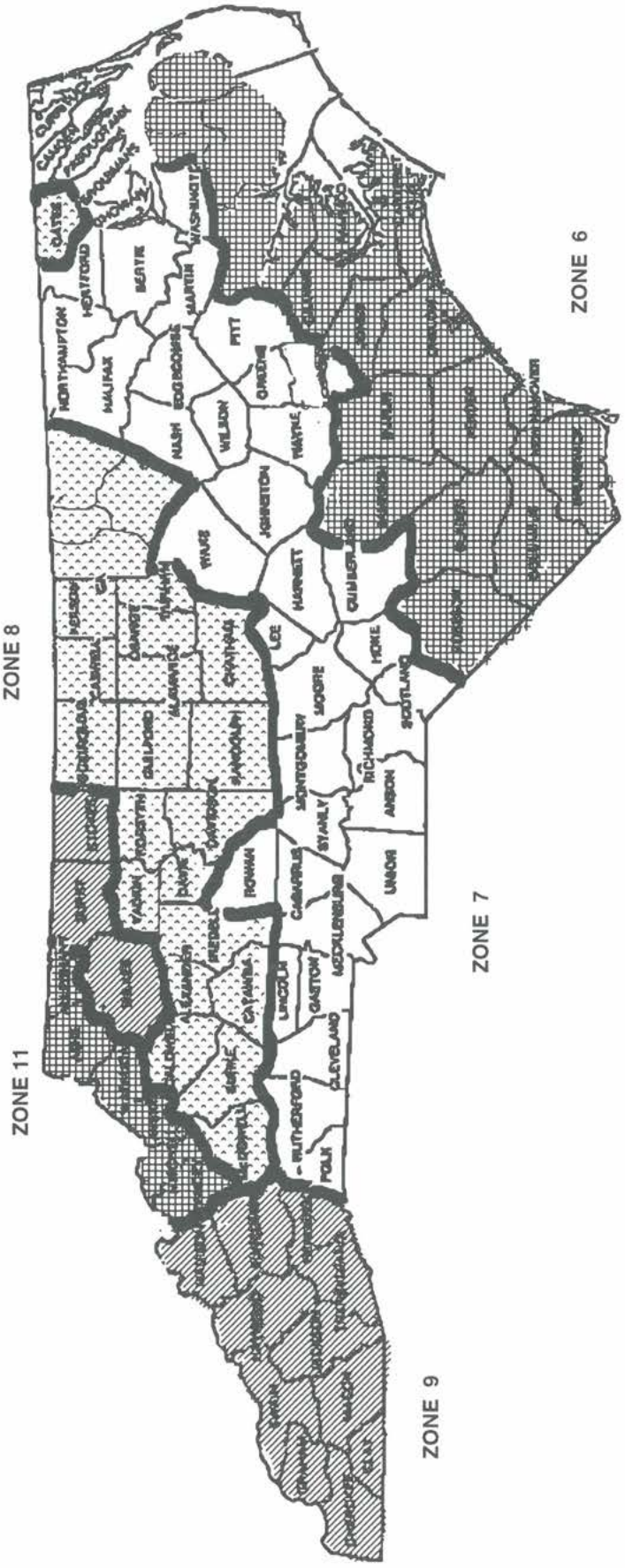


FIGURE 3901

CHAPTER 40
HIGH WIND ZONES

SECTION 4001
GENERAL

The provisions of this Chapter shall be applicable to buildings constructed in high wind zones as noted by the text. These provisions shall be in addition to or in lieu of the requirements for the Code requirements of Chapters 1-8.

4001.1 Alternate Construction. In lieu of specific code requirements for structures in the 90, 100, and 110 miles per hour wind zones, compliance with Southern Building Code Congress International Standard SSTD10 or AF&PA Wood Frame Construction Manual for One and Two-Family Dwelling -1995 SBC High Wind Edition is acceptable.

DEFINITIONS

Fetch: The width of a body of water measured in an arc from -45 degrees to +45 degrees from a line tangent to the tidal shoreline.

Wind Zone, 100E: For the purpose of this Code, Zone "E" is defined at that part of the 100 mph wind zone which fits either of the following conditions:

1. Less than 10 miles from the ocean coastline.
2. Less than 1 mile from any body of water for which the fetch does not reduce to less than 1 mile before the body of water connects to the ocean.

SECTION 4002

TABLE 4002(a)
Design Pressures for Doors and Windows [1,2,3,4]
Positive and negative in psf
(See Figure 308.5 for required glass thickness)

Velocity(mph)	Mean Roof Height (ft)		
	15	25	35
90	25	29	32
100	31	35	39
110	37	43	47

1. Alternate pressures may be determined by using North Carolina State Building Code-General Construction, ASCE-7, or the 1994 Standard Building Code.
2. If window or door is more than 4 ft. from a corner, the pressure from this table shall be permitted to be multiplied by 0.87. This adjustment does not apply to garage doors.
3. For windows or doors in structures with a roof slope of 10 degrees(2:12) or less from the horizontal, the pressures from this table may be multiplied by 0.90.
4. Design pressure ratings based on the standards listed in Section 608 or 609 are adequate documentation of capacity to resist pressures from the table.

TABLE 4002(b)
Design pressures in PSF for Garage Doors

Velocity(mph)	Mean Roof Height (ft)		
	15	25	35
90	20	23	35
100	25	29	32
110	30	35	39

1. The pressures in this table are for garage doors at least 9 ft x 7 ft and at least 2 ft from a corner.
2. Alternate design pressures may be determined by using the North Carolina State Building Code General Construction, ASCE 7-93, or the 1994 Standard Building code.
3. For doors in a structure with a roof slope of 10 degrees (2:12) or less from the horizontal the pressures from this table may be multiplied by 0.90.
4. Design pressure ratings based on tests done according to ASTM E330 are adequate documentation.
5. Garage doors on the ground level of a structure in a flood zone do not have to meet the above design pressures provided all of the following conditions are met:
   a) Structure is anchored to the girders and top of the piling to resist the forces given in Chapter 40.
   b) The garage door occurs below the top of the piling.
   c) Provide openings at the garage level that comply with either of the following options: 1. Design all exterior walls at the garage level to break away at 20 psf or less or: 2. Provide openings (in walls at the garage level without the garage door) equal to at least 20% of the total wall area from the ground to the roof.

SECTION 4003
FOOTINGS

4003.1 Foundation Wall Footings. Foundation wall footings shall be a minimum of 8" x 24" for houses 2-1/2 stories and less. The footing for a three story building shall be 10" x 24". Footings shall be reinforced with three #4 (or two #5 bars) at 3 inches above the bottom of the footing. The bars shall be continuous or lapped 25 inches at all splices.

4003.2 Pier and Curtain Wall Footings.

4003.2.1 Enlarged Footings at Piers. The curtain wall footing must meet the minimum projection requirements in Figure 403.1(b) and footing dimensions for the pier footings shall comply the Table 4003.2.1.

TABLE 4003.2.1
Footings to Resist Uplift
From Piers in 100E and 110 mph Wind Zones
Supporting Girders in Exterior Walls

	Footing Size Girder Span		
Velocity (mph)	4'-0"	6'-0"	8'-0"
100E	2'-0" x 2'-0" x 10"	2'-4" x 2'-0" x 10"	2'-8" x 2'-8" x 10"
110	3'-0" x 3'-0" x 10"	3'-4" x 3'-4" x 12"	3'-8" x 3'-8" x 12"

Note: See Table 403.1a for 90 &100 mph.

4003.2.2 Continuous width footings. Uniform continuous width footings for pier and curtain wall foundations shall be a minimum of 8 inches thick and 24 inches wide. Footings shall be reinforced with three #4 bars (or two #5 bars) at 3 inches above the bottom of the footing. The bars shall be continuous or lapped 25 inches at all splices.

4003.3 Footing dowels. All footings shall have dowels to match reinforcing in the foundation wall or pier above (See Section 4004.1.1 & 4004.3). Dowels shall have a standard hook embedded in the footing and shall lap the wall or pier reinforcing at least 25 inches for a No. 5 and smaller reinforcing bar.

SECTION 4004
WALL AND FOUNDATION ANCHORAGE

4004.1 Anchorage. Exterior walls of structures in the 100E (See definitions) and 110 mph wind zones shall be anchored to the footing to resist either the forces specified in Section 4008.2 or the prescriptive requirements of this Section. Exterior walls of structures in 90 and 100 mph wind zones shall be anchored to the foundation wall or pier/curtain wall as specified in Figure 403.1a , Note 5, (applies to backfill less than 30") and are exempt from the requirements of this Section.

TABLE 4004.1(a)
Structural Anchorage

Wind Speed (mph)	100E	110
Maximum Spacing (inches)	21	18

1. Required spacing of 1/2-inch anchor bolts where a **bond beam** is required and **for slab on grade with a single sole plate**. (See figure 403.1c for 100 mph or less.)

4004.1.1 Exterior Foundation Walls. Vertical reinforcement shall be installed not more than 2 feet from each corner at intervals not to exceed Table 4004.1.1 with all reinforced cells grouted and shall either terminate in a bond beam or connect to the wall above.

TABLE 4004.1.1
Wall Reinforcement or Continuous Anchorage

Bar/Bolt Size (inches)	5/8	1/2	3/8
Maximum Spacing (inches)	96	72	42

1. Applies to 100E and 110 MPH wind zones.
2. Continuous anchorage from footing to girder or wall framing.
3. Applies to footing dowel bars, vertical reinforcement, and anchor bolts.
4. Spacing may exceed the tabulated values by up to 8 inches provided the total number of required bars is installed.

4004.1.2: An 8" x 8" concrete or CMU bond beam with one #5 bar shall be used at the floor level. The bar shall be continuous or lapped 25 inches at all splices.

Exception: The bond beam may be eliminated where the uplift connectors are continuous from the footing to the exterior wall framing and the rim band is continuous (doubled or adequately spliced).

4004.2.2 A minimum 2 x 6 sill plate shall be installed.

Exception: Where the uplift connectors are continuous from the footing to the exterior wall framing.

4004.2.3 Sill plates shall be anchored with 1/2 inch anchor bolts with 2 x 2 x 1/8 inch washers at intervals not to exceed Table 4004.1(a). Where the vertical reinforcement bars/bolts terminate at the sill plate with a connector capable of developing the bar/bolt capacity, approved strap anchors from the sill plate to the wall framing shall be installed (Note: Cable clamps have no rated capacity when used with reinforcing steel or bolts).

Exception: Where the uplift connectors are continuous from the footing to the exterior wall framing, the spacing of the continuous anchorage may be increased per Table 4004.1.1.

4004.3 Exterior Foundation Piers. Vertical reinforcement shall be installed not more than 2 feet from each corner at intervals not to exceed Table 4004.1.1 with all reinforced cells grouted and shall connect to a sill plate, to the exterior girder, or to the wall above. See figures 4004.3(a) thru 4004.3(d).

4004.3.1 Where the vertical reinforcement bars terminate at the sill plate, a minimum 2 x 6 sill plate and approved strap anchors from the sill plate to the wall framing shall be installed.

4004.3.2 Two #4 footing dowel bars shall be embedded into the footing and grouted to the top of each pier. If the vertical reinforcement bars are placed inside the piers (not between the pier/curtain wall), then one footing dowel bar may be omitted from each pier.

4004.3.4 Exterior Concrete Slab-on-Grade Footings. Vertical reinforcement shall be installed at intervals not to exceed Table 4004.1.1 and shall terminate in a double sole plate.

Exception: Vertical reinforcement (anchorage) shall be installed at intervals not to exceed Table 4004.1a. where the bars terminate in a single sole plate. Approved strap anchors shall be installed from the single sole plate to the wall.

TABLE 4005(a)
STUDS IN 90, 100, AND 110 MPH WIND ZONES

REQUIREMENTS FOR WOOD STUD IN: EXTERIOR WALLS SUPPORTING ONE FLOOR, ROOF AND CEILING OR LESS
EXTERIOR NON LOADBEARING WALLS IN TWO STORY STRUCTURES OR LESS
INTERIOR WALLS SUPPORTING ONE FLOOR, ROOF AND CEILING OR LESS

		90 MPH		90 MPH		100 MPH		110 MPH	
				NOMINAL STUD SIZES					
STUD	STUD	2 x 4	2 x 6	2 x 4	2 x 6	2 x 4	2 x 6	2 x 4	2 x 6
LENGTH	SPACING	SPECIES-SPRUCE PINE FIR(SOUTH) WITHOUT STRUCTURAL SHEATHING		SPECIES: SPRUCE PINE FIR (SOUTH) WITH 3/8" WOOD STRUCTURAL SHEATHING					
8	16	#2	STUD	STUD	STUD	STUD	STUD	#2	STUD
8	24	#2	STUD	#2	STUD	#2	STUD	#2	STUD
10	16	#2	STUD	#2	STUD	#2	STUD	DESIGN	STUD
10	24	DESIGN	#2	DESIGN	#2	DESIGN	#2	DESIGN	#2
		SPECIES: SPRUCE PINE FIR WITHOUT STRUCTURAL SHEATHING		SPECIES: SPRUCE PINE FIR WITH 3/8" WOOD STRUCTURAL SHEATHING					
8	16	STUD	STUD	STAND	STUD	STUD	STUD	#3	STUD
8	24	#2	STUD	#3	STUD	#2	STUD	#2	STUD
10	16	#2	STUD	#2	STUD	#2	STUD	#2	STUD
10	24	DESIGN	STUD	#2	STUD	DESIGN	STUD	DESIGN	STUD
		SPECIES: SOUTHERN PINE WITHOUT STRUCTURAL SHEATHING		SPECIES: SOUTHERN PINE WITH 3/8" WOOD STRUCTURAL SHEATHING					
8	16	STUD	STUD	STAND	STUD	STAND	STUD	STUD	STUD
8	24	#2	STUD	STUD	STUD	#2	STUD	#2	STUD
10	16	#2	STUD	STUD	STUD	#2	STUD	#2	STUD
10	24	DESIGN	STUD	#2	STUD	#2	STUD	DESIGN	STUD

EXPLANATION OF TABLE ENTRIES

DESIGN	STUDS WITH THIS ENTRY SHALL BE DESIGNED IN ACCORDANCE WITH ACCEPTED ENGINEERING PRACTICE
#2	#2 GRADE CONSTRUCTION
#3	#3 GRADE
STUD	STUD GRADE
STANDARD	STANDARD GRADE
UTILITY	UTILITY GRADE

3/8" WOOD STRUCTURAL SHEATHING SHALL BE ATTACHED WITH 8D NAILS AT 6" AT PERIMETER & 12" AT INTERMEDIATE SUPPORTS
WHEN A GRADE IS SPECIFIED IN THE TABLE ANY GRADE ABOVE IT IN THIS LIST MAY BE USED.

4005
WALL CONTRUCTION

4005.1 Construction. Exterior walls of wood frame construction shall be in accordance with Figures 602.3a and 602.3b. Components of exterior walls shall be fastened in accordance with Table 602.3a. Walls of wood frame construction shall be designed and constructed in accordance with NFoPA "National Design Specificatons for Wood Construction", listed in Chapter 43.

Exterior walls subject to wind pressures of 100 miles per hour or greater as established in Table 301.2a shall be designed in accordance whith accepted engineering practice (such as Tables 4005(a) thru 4005(b)).

In bearing walls, studs which are not more than 10 feet in length shall be spaced not more than is specified in Table 4005(a) and 4005(b) for the corresponding stud size.

SECTION 4006
STRUCTURAL BRACING

4006.1 Structural Bracing in 100 mph wind zones.

1. When the wall studs are engineered and do not require structural sheathing, for one story or top story - brace each corner and at 25 foot intervals with 1 x 4 let-in bracing or 4" x 8" wood structural panels.
2. All other stories - wood structural sheathing panels.

4006.2 Structural bracing in 100E and 110 mph wind zone. All stories - wood structural sheathing panels. Blocking shall be installed if less than 50% of the wall length is sheathed. Where blocking is required, all panels shall be fastened at 3 inches on center along the edges and 6 inches on center at intermediate framing. If a wall is sheathed less than 25% of its length, then that wall shall be designed in accordance with approved engineering practice.

4006.3 Gable endwalls. Gable endwalls in the 90, 100, 110 mph wind zones shall either be supported by lateral bracing at the ceiling or have continuous studs from the floor to the roof. 2 x 4 studs at 16 inches on center are limited to 10 feet in length between supports. Non bearing 2 x 6 SPF#2 studs at 16 inches on center with 3/8" wood structural panel sheathing are limited to unsupported lengths of 18 feet in 90 mph, 16 feet in 100 and 100E and 14 feet in 110 mph wind zones. Wood structural panel sheathing shall extend 12 inches beyond construction joints.

4006.4 Lateral support at ceiling. Where studs are not continuous, the ceiling must be used to support the endwall. 2 x 4 lateral bracing shall be installed on the top of ceiling joists or truss bottom chords at 8 feet on center and extend 8 feet inward from the gable endwall. See Figure 4006.7(a).

4006.5 Full height studs: Full height studs may be sized using the bracing at the ceiling to limit the stud length. See Figure 4006.5

Table 4005(b)

Exterior Bearing Walls [1,2,3,4,5] First Floor of Three Story				
	SPF		SP	
WIND Zone (mph)	2 X 4 @ 12" oc Structural Sheathing	3 X 4 or 2 X 6 @16"oc Structural Sheathing	2 X 4 @ 12" oc Structural Sheathing	3 X 4 or 2 X 6 @16"oc Structural Sheathing
90	#2	Any Grade	Any Grade	Any Grade
100	#2	Any Grade	#2, #3, Stud	Any Grade
110	#2	Any Grade	#2, #3, Stud	Any Grad

Exterior Non-Bearing Walls [1,2,3,4,6] First Floor of three Story						
	SPF			SP		
WIND Zone (mph)	2 X 4 @ 12" oc Blocking	2 X 4 @ 16" oc Blocking	3 X 4 or 2 X 6 @ 16" oc Blocking	2 X 4 @ 12" oc Blocking	2 X 4 @ 16" oc Blocking	3 X 4 or 2 X 6 @ 16" oc Blocking
90	#2, Stud	#2	Any Grade	Any Grade	#2, #3, Stud	Any Grade
100	#2, Stud	NP	Any Grade	#2, #3, Stud	#2, #3, Stud	Any Grade
110	#2	NP	Any Grade	#2, #3, Stud	#2	Any Grade

1. Any grade = any grade except Standard, Utility and Economy.
2. Corner bracing is REQUIRED where "Blocking" is specified.
3. 2 - 2 X 4's @ 16" or 1 - 2 X 4 @ 8" may be used where 3 X 4 @ 16" is specified.
4. Refer to 4006 and 4008.4 for sheathing requirements.
5. Bearing stud height is limited to 10 feet.
6. 2X full depth blocking @ mid-height.

4006.6 Cathedral endwalls. Studs shall be continuous from the uppermost floor to either the ceiling or the roof.

4006.7 Overhang at endwalls. The overhang is limited to 12 inches where a laddered soffit is installed. The overhang may be incrreased to 24 inches where outlookers are framed over a dropped endwall into the first rafter or truss. See Figure 4006.7(a) and 4006.7(b). If the overhang exceeds 24 inches, then the overhang shall be designed in accordance with approved engineering practice.

4006.8 Roof Sheathing Attachment. The roof sheathing panes edges shall be blocked and nailed at the end two rafter or truss spaces. See Figure 4006.8.

Exception: The panel edges need not be blocked where 2 x 4 diagonal braces are framed from the top of the endwall to the lateral bracing at the ceiling.

SECTION 4007
MASONRY WALL CONSTUCTION

4007.1 Reinforcement. Masonry walls subject to wind loads of 100 mph or greater, as established in Table 301.2a, shall be constructed in accordance with Tables 4007.1a or Table 4007.1b or the requirements of Figures 4007.1(a) and 4007.1(b) and this Section. In addition, the minimum area of reinforcement shall not be 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 (9.5 mm) in diameter. Principal wall reinforcement shall have a maximum spacing of 4 feet (1219 mm) on center.

Note: For 90 mph wind zones See Figure 604.10 and Table 604.8.

TABLE 4007.1a
H/t LATERAL SUPPORT RATIOS FOR UNREINFORCED EXTERIOR MASONRY WALLS [1, 2, 4, 5]

Other than Enclosed Buildings [3] Design Wind Speed, mph		
Wall Construction	100	110
Solid Mas. Units	13	11
Hollow concrete Mas. Units or Mas. Bonded Hollow Walls	9	8
Cavity walls Identical wythes	The H/t ratio shall be 0.70 of the H/t ratio for single wythe walls. The t value shall be the sum of the nominal thickness of the individual wythes.	
Cavity walls with wythes of different types or size masonry	The wall shall be designed based on ACI-530 or the H/t ratio may be 0.70 of the H/t ratio of a single wythe hollow wall. The t value shall be the sum of the nominal thickness of the individual wythes.	

1. H=clear height or length between lateral supports.t=nominal wall thickness.
2. All masonry units shall be laid in Type M, S or N mortar. Where Type N mortar is used and the wall spans in the vertical direction, the ratios shall be reduced by 10%.
3. Design based on partially enclosed building.
4. These values are based on using masonry cement mortar. If nonair-entrained portland cement/lime mortar is used the values in the table may be increased by 1.25. Larger H/t ratio's may be used if the design is done in accordance with ACI-530.
5. Larger H/t ratio's may be used if the design is done in accordance with ACI-530.

TABLE 4007.1b
H/t LATERAL SUPPORT RATIOS FOR UNREINFORCED EXTERIOR MASONRY WALLS [1,2,4,5]

	Enclosed Building [3] Design Wind Speed, mph	
Wall Construction	100	110
Solid Mas. Units	15	13
Hollow concrete Mas. Units or Mas. Bonded Hollow Walls	10	9
Cavity walls Identical wythes	The H/t ratio shall be 0.70 of the H/t ratio for single wythe walls. The t value shall be the sum of the nominal thickness of the individual wythes.	
Cavity walls with wythes of different types or size masonry	The wall shall be designed based on ACI-530 or the H/t ration may be 0.70 of the H/t ratio of a single wythe hollow wall. The t value shall be the sum of the nominal thickness of the individual wythes.	

1. H = clear height or length between lateral supports.
   t = nominal wall thickness.
2. All masonry units shall be laid in Type M, S or N mortar. Where Type N mortar is used and the wall spans in the vertical direction, the ratios shall be reduced by 10%.
3. Enclosed buildings are buildings in which the openings in any wall do not exceed the sum of the percentages of openings in the remaining walls and roof surfaces by 5%. Buildings in which the 5% limit is exceeded by one wall may still be considered enclosed if the percentage of openings in no other wall exceeds 20%.
4. These values are based on using masonry cement mortar. If nonair-entrained portland cement/lime mortar is used the values in the table may be increased by 1.2.
5. Larger H/t ratio's may be used if the design is done in accordance with ACI-530.

SECTION 4008
ROOF TIE DOWN

4008.1 Roof Tie Down. Roof assemblies in the 90, 100, and 110 mph wind zones as established in Table 301.2a shall have rafter or truss ties provided in accordance with either Table 4008.2 or the prescriptive requirements of this Section 4008. Anchorage in the 90 and 100 mph wind zones shall be continuous from the roof to the foundation wall or pier. Anchorage in the 100E and 110 mph wind zones shall be continuous from the roof to the footing (See Section 4004.1)

4008.2 Considerations. For trusses, the nailing requirements from Table 4008.2 shall include the nailing requirements for both rafters and ceiling joists. As an alternate to the anchorage requirements of Tables 602.3a and 4008.2, the anchorage for roof members may be based on a designed connection taking into account all horizontal and vertical forces. Forces for alternate anchorage design may result from wind uplift; wind lateral on roof; wind lateral on walls to be transferred to a ceiling/ roof diaphragm; diaphragm shear to be transferred to the top plate of the wall; roof/ceiling loads; and other loads depending on the specific building design. If roof members align with the studs the connection may be made from the roof member directly to the studs. If the connection is from the roof member to the top plate, a double top plate is required and both connections must meet the requirements of Table 4008.2 Where ceiling joists are not parallel with and connect to the roof members, the anchorage requirements for each roof member shall be increased by 110 pound. Hip end walls and hip rafters shall be anchored in accordance with this section.

TABLE 4008.2
ROOF TIE DOWN REQUIREMENTS

Basic Wind Velocity	Maximum Structure	Roof Slope	Anchorage along Exterior Wall
90	36 feet	2:12 to 12:12	345 lb/ft
100	36 feet	2:12 ro 12:12	475 lb/ft
110	36 feet	2:12 to 12:12	615 lb/ft

1. Alternate to the requirements of this table or roof not covered by this table shall be designed in accordance with the North Carolina State Building Code, Volume I-General Construction or SSTD-10, "Standard For Hurricane Resistant Residential Construction"
2. See Section 4105 for material requirements in Coastal High Hazard Areas and Ocean Hazard Areas

4008.3 Anchorage from roof to wall. 1-1/2 inch by 18 gage fabricated metal ties at 24 inches on center with five 8d nails at each end may be used to resist the uplift loads from the roof to the double top plate. Install one tie at each end of each rafter or truss member in 90 mph and two ties at each end of each rafter or truss member in 100, 100E, and 110 mph wind zones.

4008.4 Anchorage using wood structural panels. Wood structural panel sheathing may be used to resist both lateral load and uplift simultaneously. Panels shall be installed as follows:

1. Panels may be installed with face grain either parallel or perpendicular to studs.
2. Panels shall be 3/8" minimum thickness.
3. Nail spacing shall be 8d at 6 inches on center along vertical edges of panel and 12 inches at intermediate vertical framing.
4. Horizontal nail spacing at double top plates, band joists, and girders shall be a double row of 8d staggered at 3 inches on center.
5. Panels shall extend 12 inches beyond construction joints and shall overlap girders their full depth.
6. Panel attachment to framing shall be as illustrated in Figure 4008.4.
7. Blocking shall be required at all joints if sheathing is used to resist uplift.

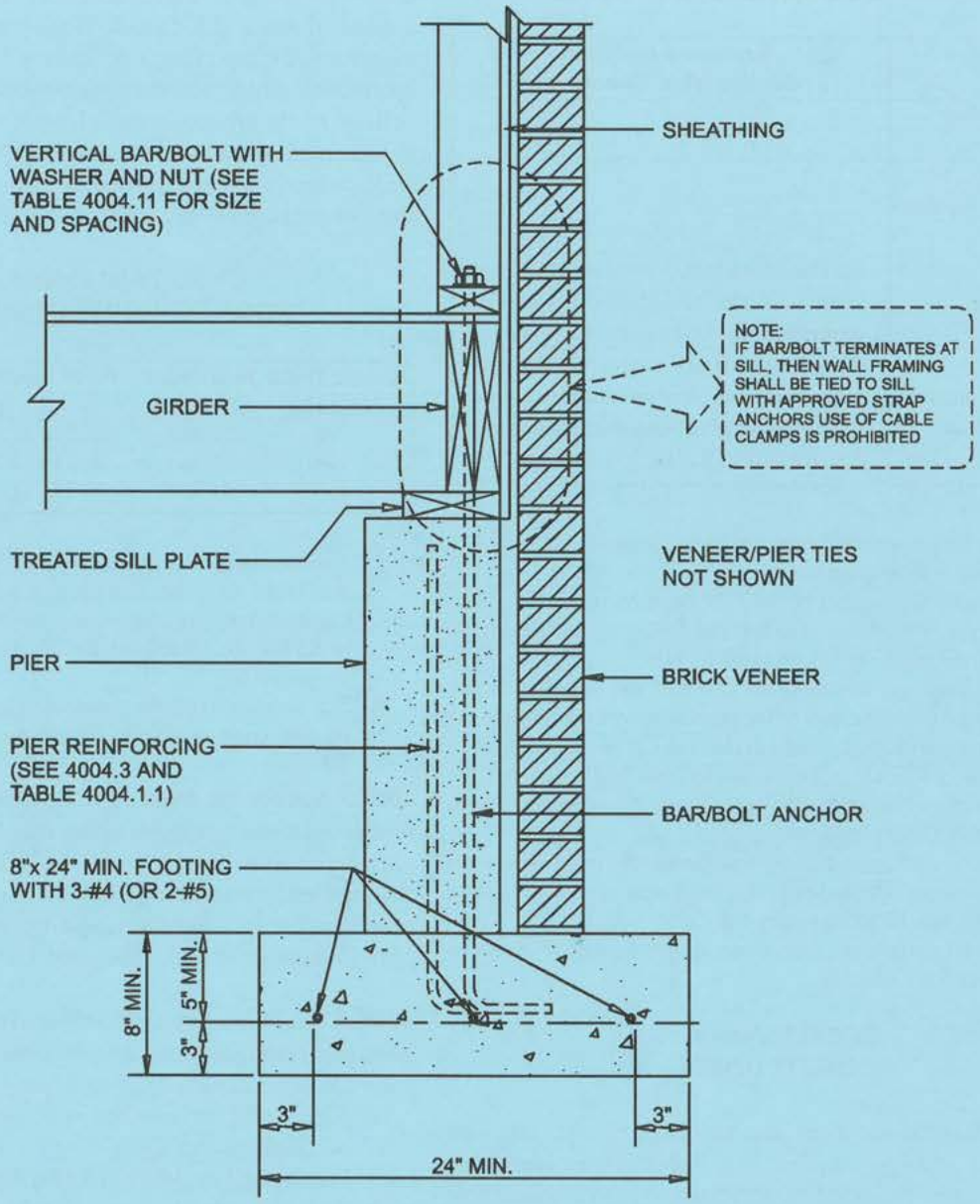


FIGURE 4004.3a
CONTINUOUS VENEER
PIER/CURTAIN WALL

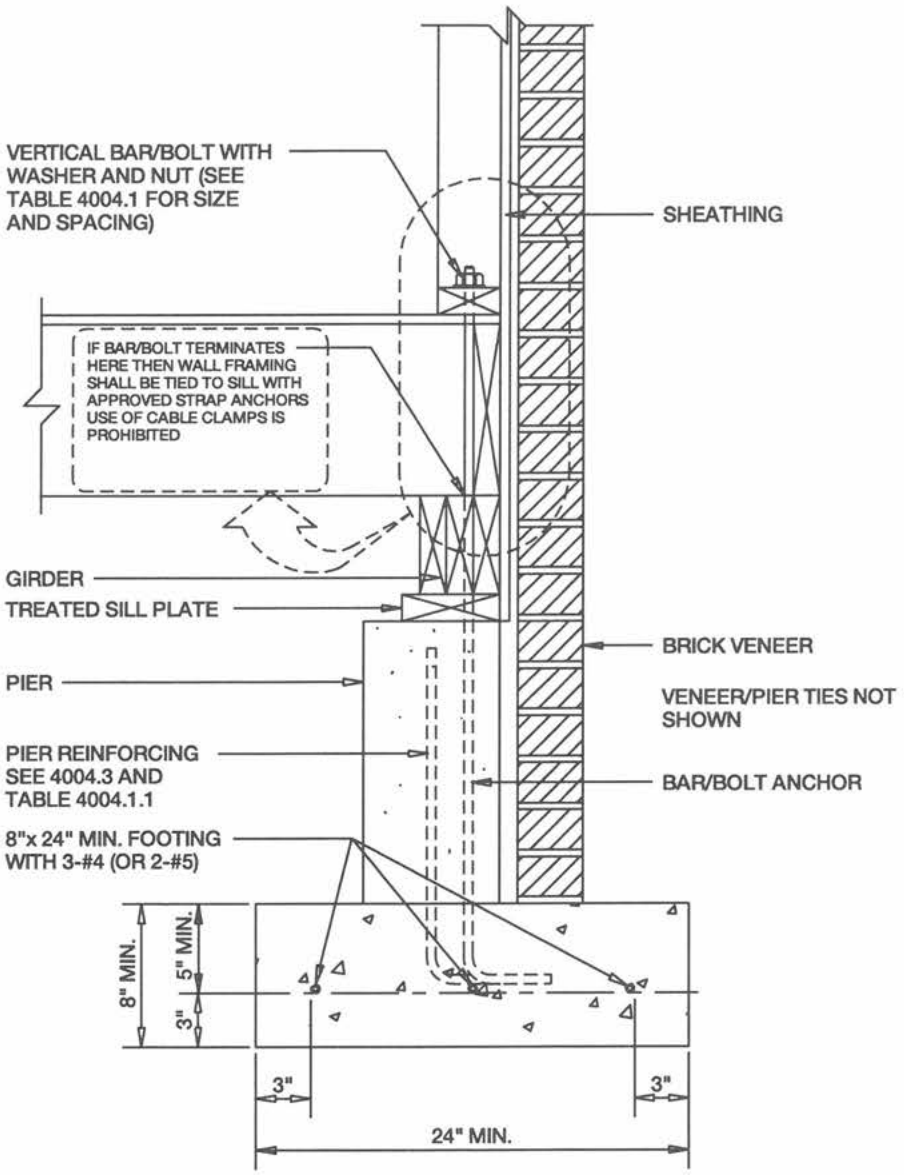


FIGURE 4004.3b
CONTINUOUS VENEER
PIER/CURTAIN WALL

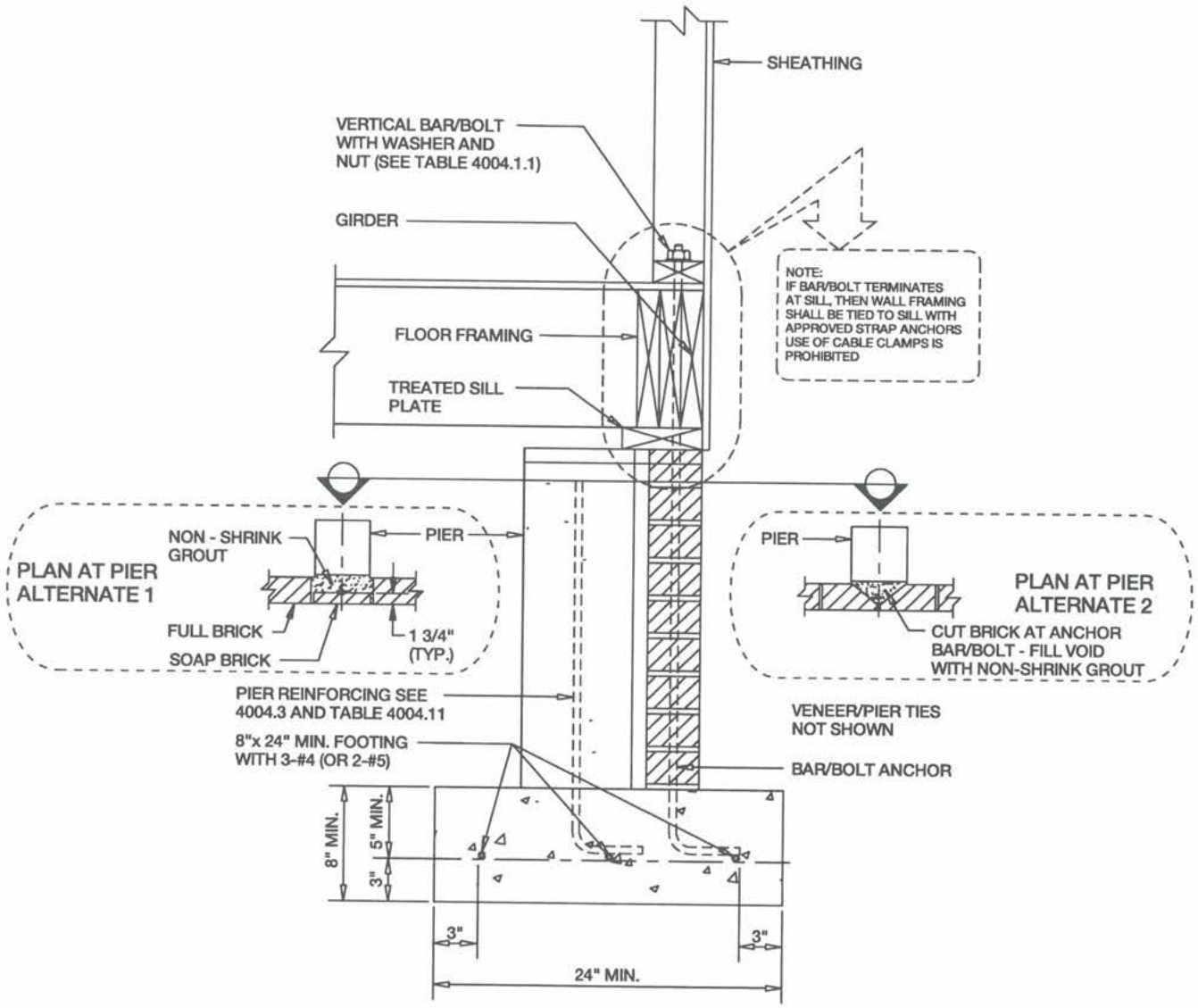


FIGURE 4004.3C
VENEER SKIRT WALL
PIER/CURTAIN WALL

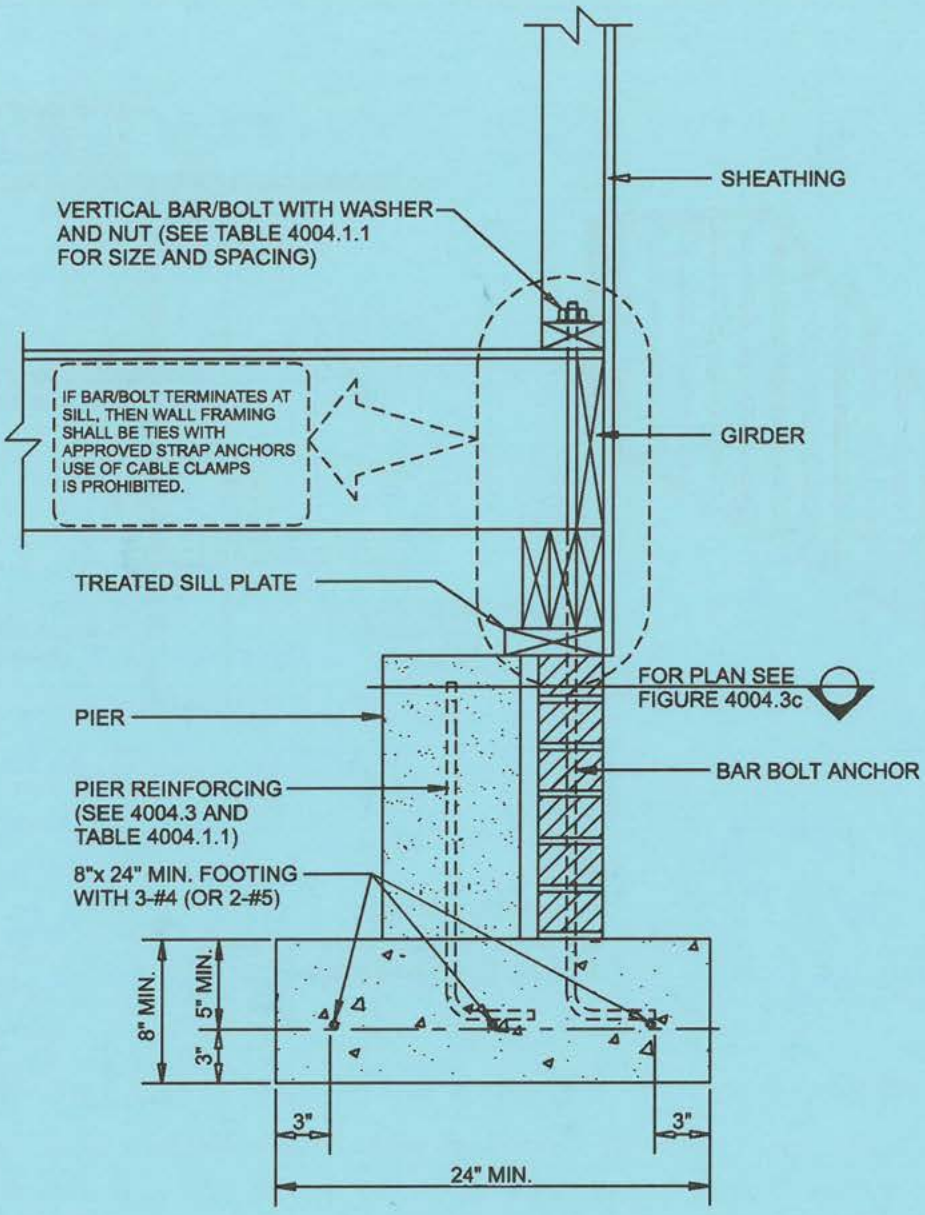


FIGURE 4004.3d
VENEER SKIRT WALL
PIER/CURTAIN WALL

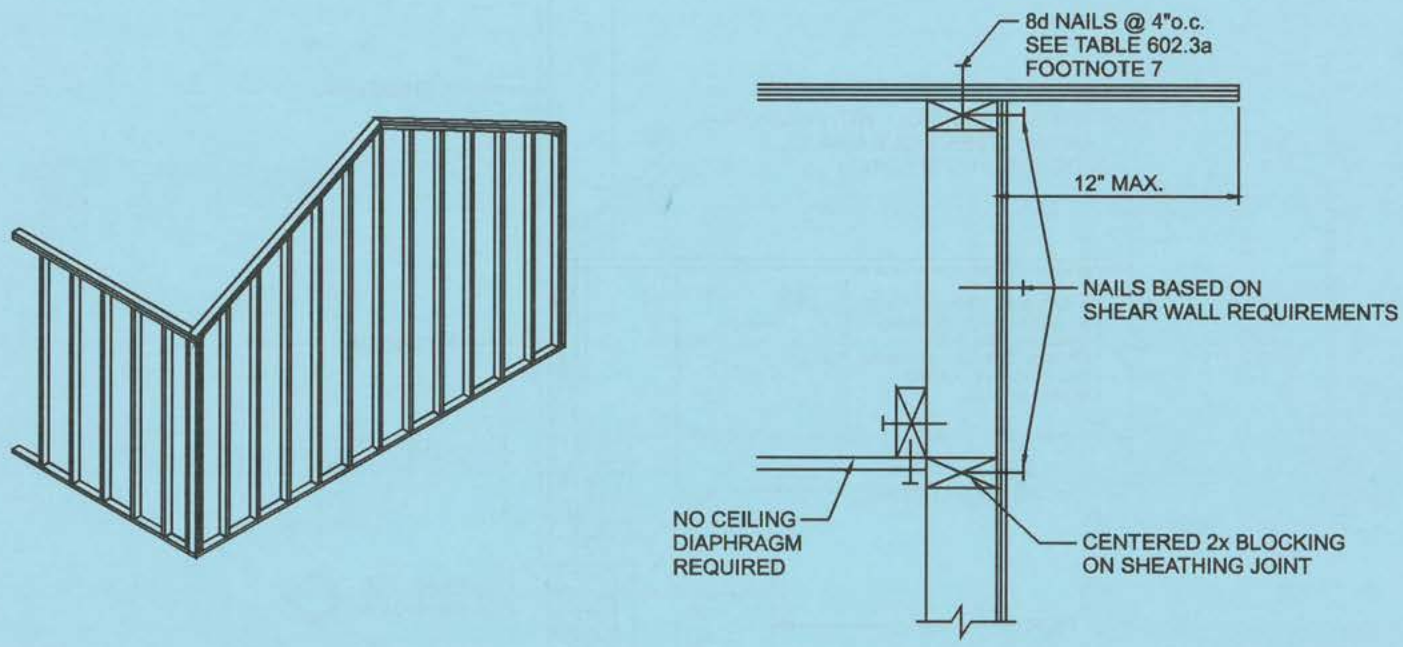


FIGURE 4006.5
GABLE ENDWALL BALLOON FRAMING
PREFERRED METHOD

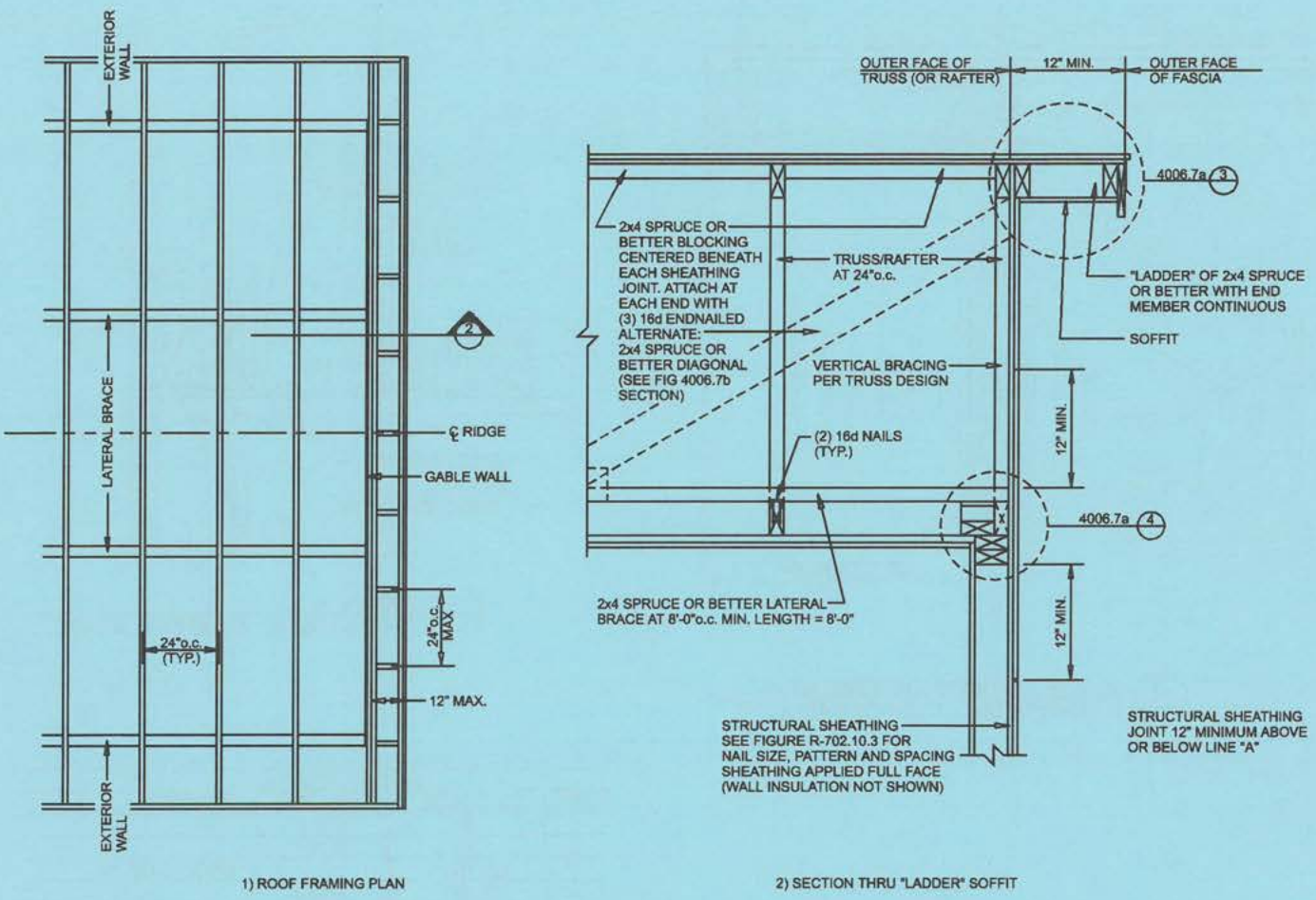


FIGURE 4006.7a
OVERHANG AT ENDWALLS
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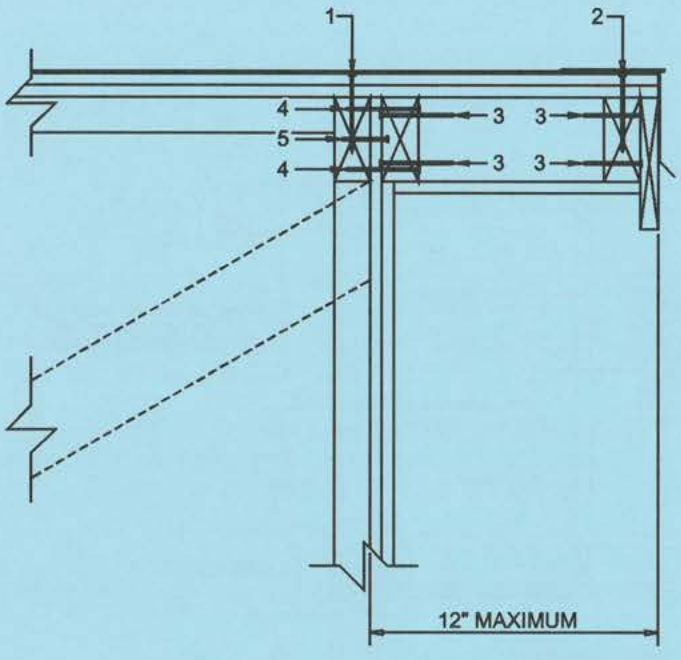
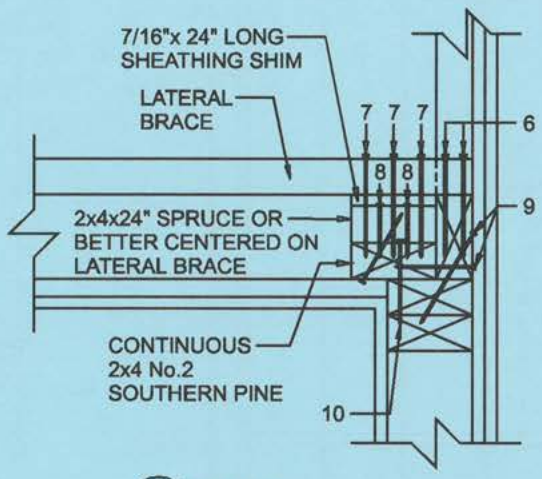


3 4006.7a - "LADDER" ATTACHMENT
NAILING DETAIL AT TOP OF GABLE



4 4006.7a
NAILING DETAIL AT LATERAL BRACE

NAIL SCHEDULE			
MARK	No. & SIZE	SPACING	REMARKS
1	8d	4"o.c.	
2	8d	6"o.c.	
3	(2) 16d		EACH SIDE
4	(2) 16d	24"o.c.	
5	8d	6"o.c.	
6	(2) 16d		EACH TRUSS
7	(5) 16d		TYPICAL
8	(6) 16d (* TO 2x4 BELOW)		ALTERNATE: (8) 8d
9	16d	8"o.c.	ALTERNATE TOENAIL & ENDNAIL
10	16d	8"o.c.	

FIGURE 4006.7a
OVERHANG AT ENDWALLS

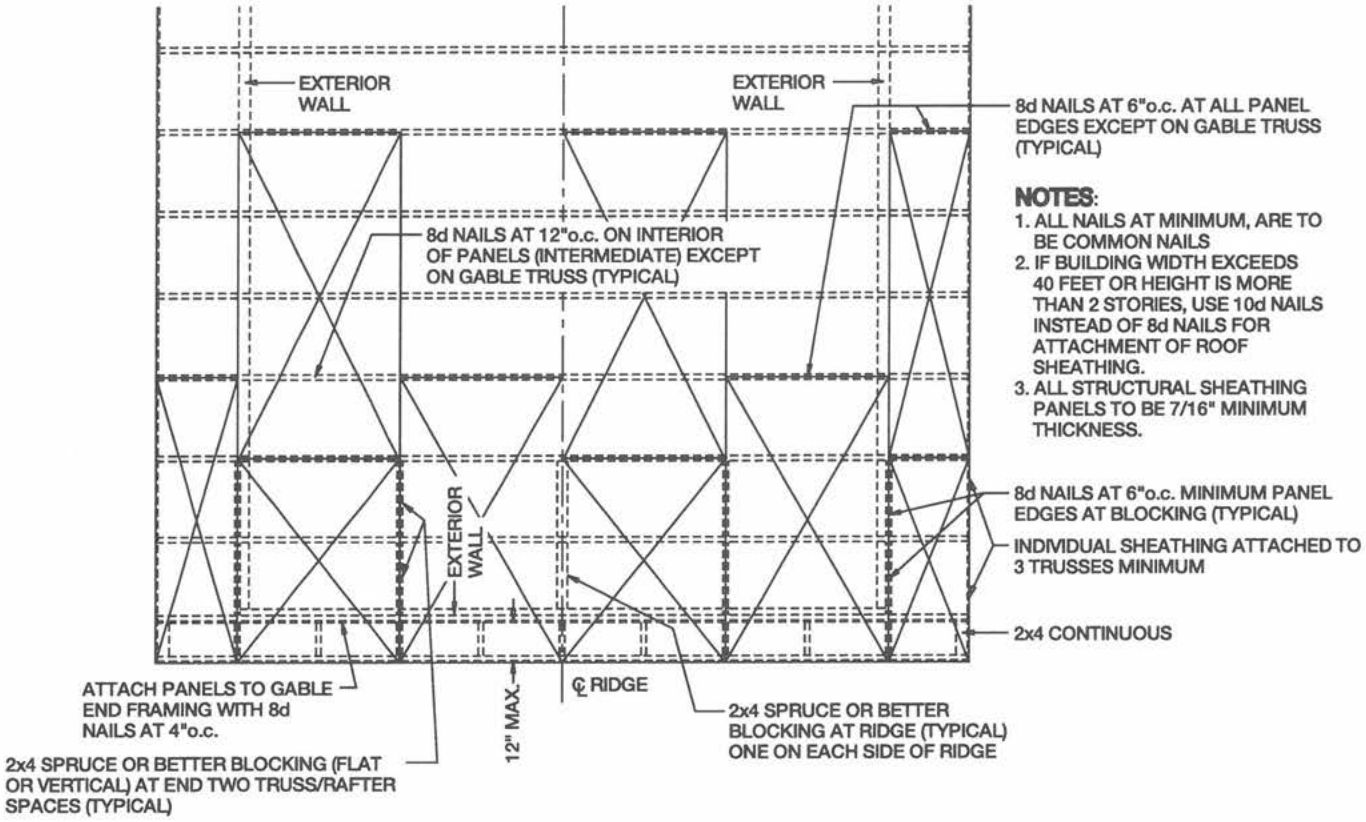
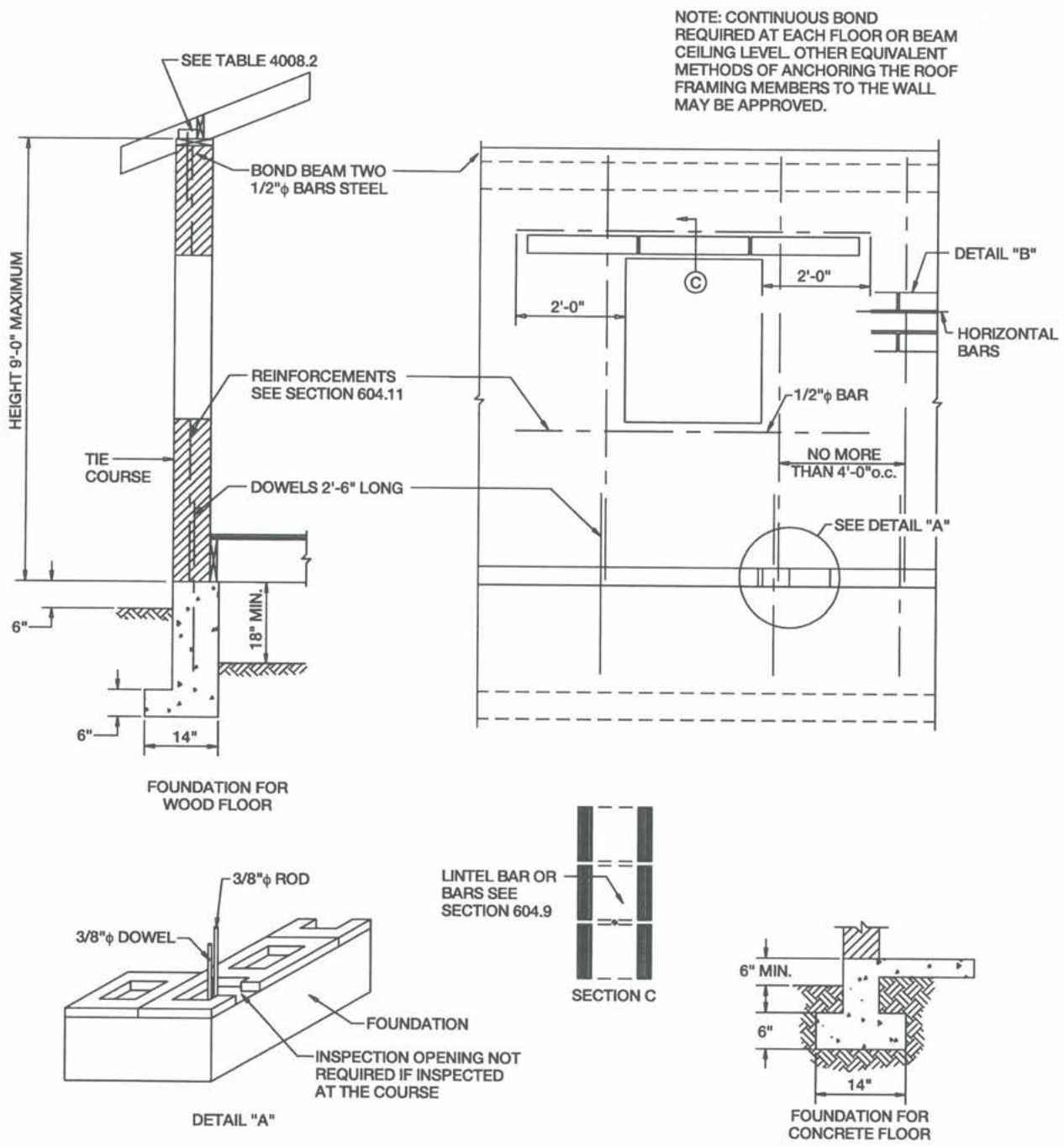
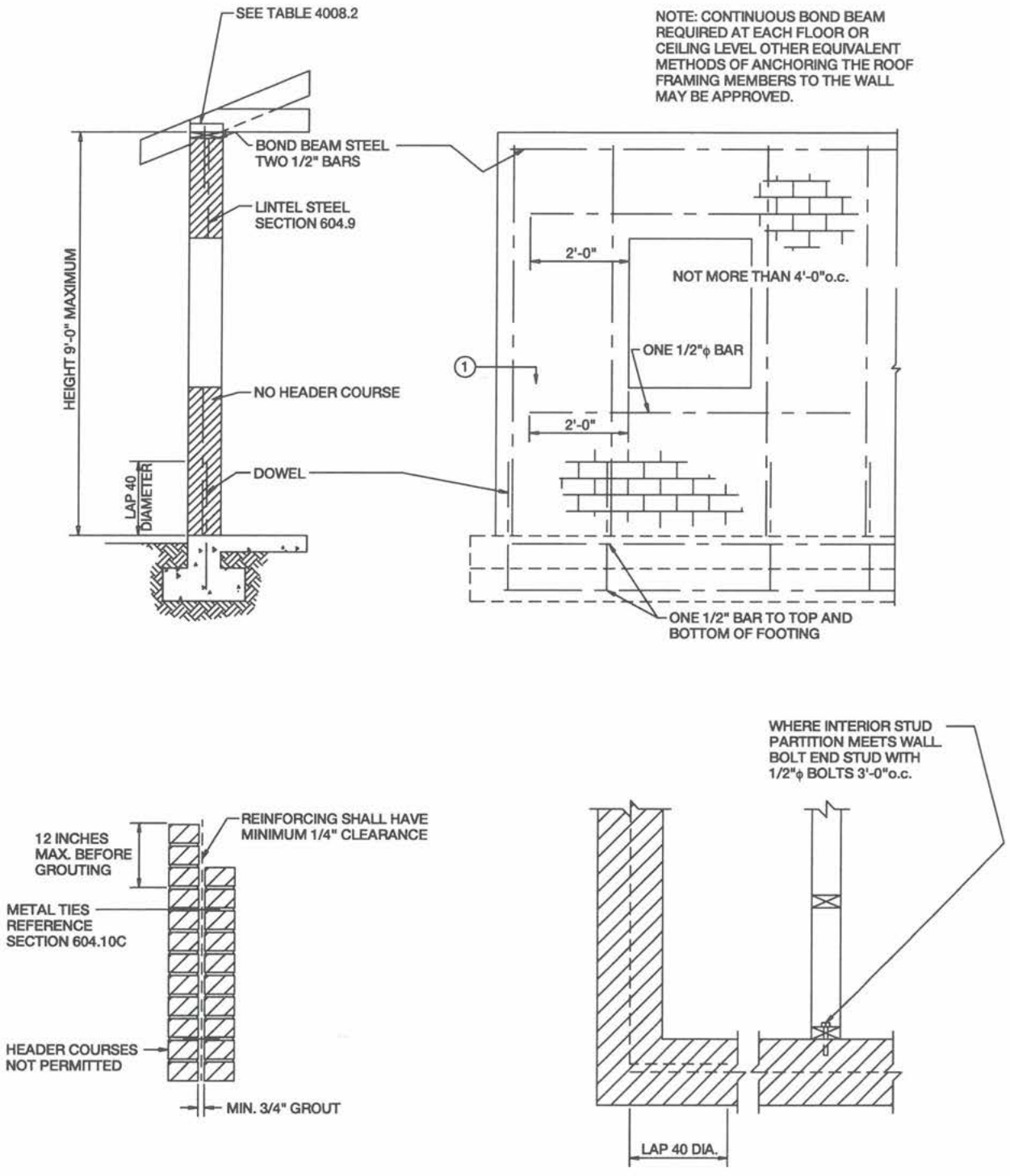


FIGURE 4006.8
ROOF SHEATHING ATTACHMENT PLAN



For **SI:** 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 psf = 0.0479 kN/m^2

Figure 4007.1(a)
REQUIREMENTS FOR REINFORCED GROUTED MASONRY CONSTRUCTION IN SEISMIC ZONE 3 OR 4 OR WHERE WIND ZONES ARE 100 MPH OR GREATER



For **SI:** 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 psf = 0.0479 kN/m^2

Figure 4007.1(b)
REQUIREMENTS FOR REINFORCED HOLLOW-UNIT MASONRY CONSTRUCTION IN SEISMIC ZONE 3 OR 4 OR WHERE WIND ZONES ARE 100 MPH OR GREATER

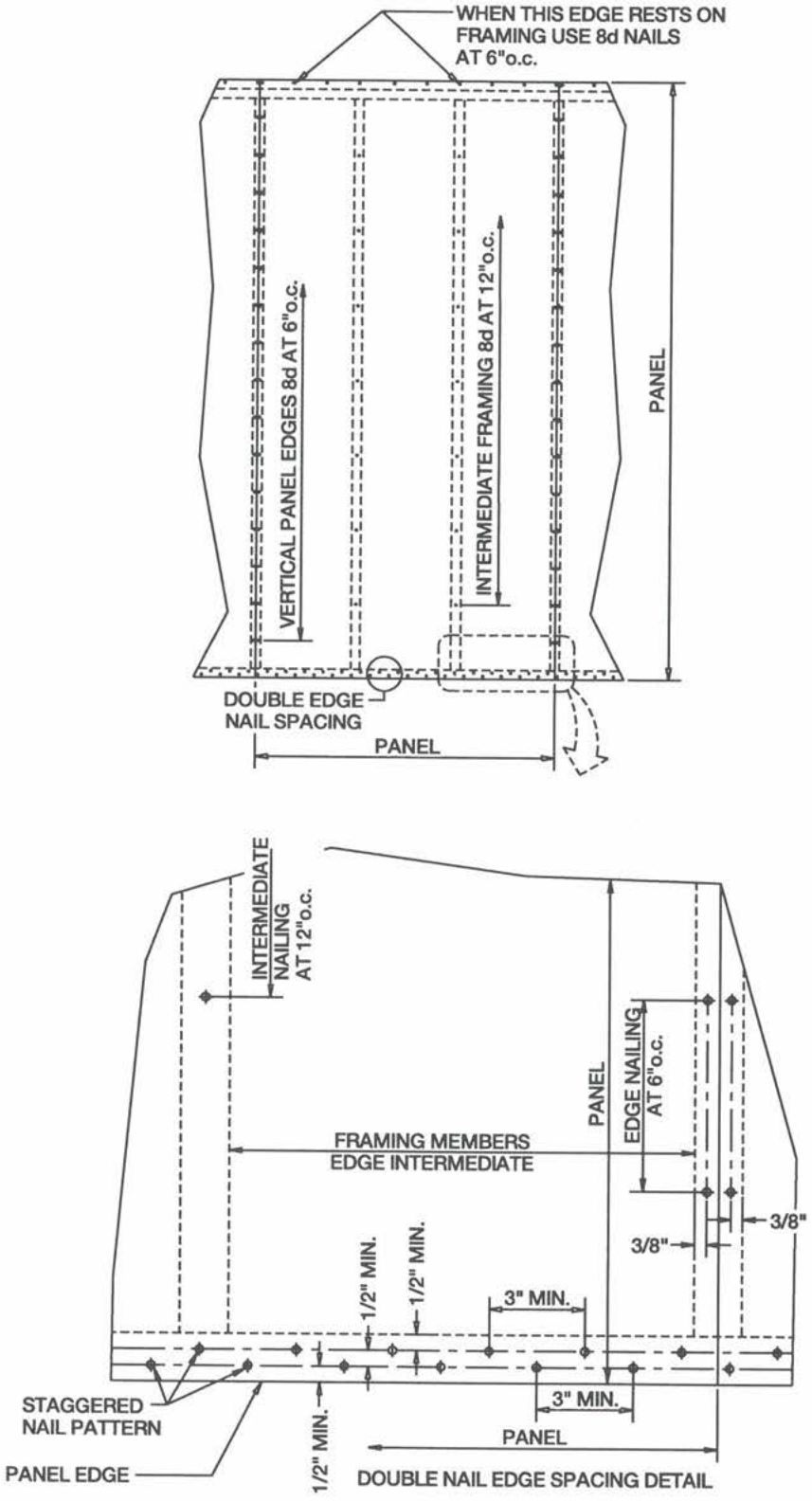


FIGURE 4008.4
PANEL ATTACHMENT TO COUNTER UPLIFT
HORIZONTAL OR VERTICAL

CHAPTER 41
COASTAL AND FLOOD PLAIN CONSTRUCTION STANDARDS

SECTION 4101
PURPOSE, APPLICATION, AND SCOPE

The requirements set forth in this section shall apply to all construction located within areas identified by governmental agency (state and federal) as coastal high hazard areas, ocean hazard areas, the regulatory flood plain areas, and all areas designated as 110 MPH wind zone. See Table No. 301.2a.

SECTION 4102
DEFINITIONS

MSL. Mean sea level as defined by National Geodetic **Vertical Datum.**

Base Floor Elevation: The peak water elevation in relation to MSL expected to be reached during a design flood which is established by the Building Code Council as a flood having a one percent chance of being equalled or exceeded in any given year.

Coastal High Hazard Area. An area subject to coastal flooding and high velocity waters including storm wave wash, as shown by Federal Emergency Management Agency Maps and subject to the approval of the Building Code Council.

Ocean Hazard Area. An area, as identified by the North Carolina Coastal Resources Commission, and subject to approval by the Building Code Council, near the shoreline of the Atlantic Ocean which has been identified as subject to at least one of the following hazards: (A) Historical or predicted future trends of long term erosion, (B) erosion expected to occur during a coastal storm reaching the base flood elevation, or (C) shoreline fluctuations due to tidal inlets.

Flood Plain. Land below base flood elevation, which of record has in the past been flooded by storm water-surface runoffs, or tidal influx: and–as defined by the Corps of Engineers' maps, the Federal Emergency Management Agency maps or as approved by Building Code Council.

Lowest Floor. The lowest floor of the lowest enclosed area (including basement). An unfinished or flood resistant enclosure, usable solely for parking of vehicles, building access or storage in an area other than a basement area is not considered a building's lowest floor; provided

1. That the walls are substantially impermeable to the passage of water and the structural components have the capability of resisting hydrostatic and hydrodynamic loads and effects of bouyancy or,
2. Construction shal be designed to automatically equalize hydrostatic flood forces on exterior walls by allowing the entry and exit of flood waters.

Regulatory Flood Plain. (Same as flood plain defined above)

SECTION 4103
PILING STANDARDS

4103.1 All one and two family dwellings in areas identified as coastal high hazard areas or ocean hazard areas shall be constructed on a pile foundation of wood or concrete.

4103.2 Concrete Piles. Concrete piles may be used if made and installed in accordance with North Carolina State Building Code, Volume I–General Construction, Chapter 18.

4103.3 Size of wood piles. Round timber piles shall not be less than 8 inches in diameter at building level and have a minimum tip diameter of 6 inches. Square timber piles shall not be less than 8 inches square, nominal. Piles supporting uncovered stairs, uncovered walkways and uncovered decks shall be 6 inches x 6 inches minimum, or if round, have a minimum tip diameter of 6 inches x 6 inches minimum, or if round, have a minimum tip diameter of 6 inches. Piles supporting uncovered stairs, uncovered walkways and uncovered decks less than five (5) feet above grade may be 4 inches x 4 inches minimum.

4103.4 Required depth of piles. Pile tip shall extend to a depth of not less than 8 feet below the natural grade or finished grade of the lot whichever is lower. All pilings within the Ocean Hazard Area shall have a tip penetration of at least 5.0 feet below mean sea level or 16 feet below average original grade whichever is least. Structures within Ocean Hazard Areas which are placed upon the site behind a line 60 times the annual erosion rate away from the most seaward line of stable natural vegetation area exempt from this additional tip penetration requirement.

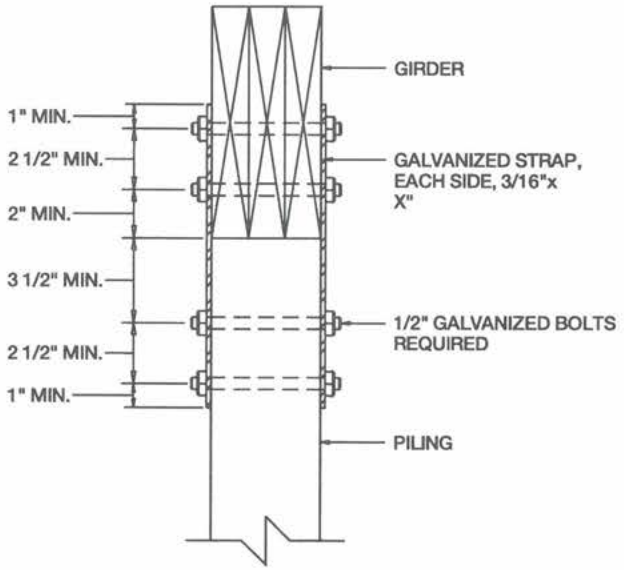
4103.5 Spacing of wood piles. The maximum center-to-center spacing of wood piles shall not be more than 8 feet on center under load bearing sills, beams, or girders. However, for dwellings having more than two stories above piles or where the piling spacing exceeds 8 feet on center, the pile foundation shall be designed by a Professional Engineer or Architect. Pile spacing in the non-load bearing direction may be 12 feet.

4103.6 Tieing and bracing of wood piles. If sills, beams, or girders are attached to the piling, a minimum of two-5/8 inch galvanized steel bolts per beam member shall be through bolted at each piling connection. Piling shall not be notched so that the cross-section is reduced below 50%. Sills, beams, or girders may be attached using 3/16 inch x 4 inch x 18 inch hot dip galvanized straps, 1 each side, bolted with two 1/2 inch galvanized through bolts. (See Figure 4103.6). Bracing of pile foundations is required where the clear height from ground to sill, beam, or girder exceeds 10 feet or the dwelling is more than one story above piles. A line of X bracing is defined as a row of piles with X bracing provided in at least 2 bays. A line

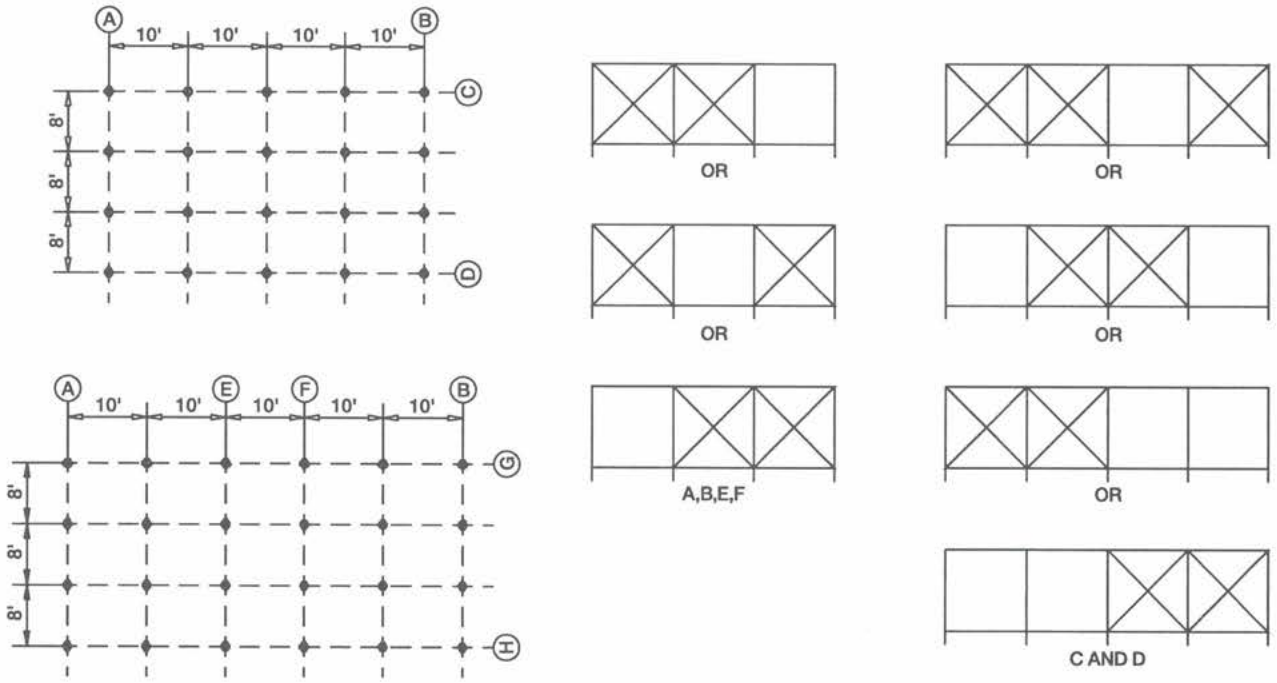
of X bracing shall be provided at all exterior pile lines. Where the perimeter lines of X bracing exceed 40 feet, an additional line of X bracing shall be provided near the center of the building. (See Figure 4103.6). X bracing shall be with 2x10's through bolted with two-3/4 inch bolts each end. The building inspector may accept alternate bracing designs if they bear the seal of a Professional Engineer or Architect.

4103.7 The minimum net retention of preservatives shall be in accordance with Section 322.

4103.8 Piling may be placed by auger, jetting, or drop hammer. Piling shall receive a final set by drop hammer or other approved methods, acceptable to the Building Inspector to insure compaction of material at end bearing.



FIGURES 4103.6



FIGURES 4103.6
ELEVATIONS
(SHOWING POSSIBLE ARRANGEMENT OF X BRACING IN LINE) (G AND H SIMILAR)

SECTION 4104
ELEVATION STANDARDS

4104.1 The lowest structural member excluding pilings and bracing supporting the lowest habitable floor in the coastal high hazard area and ocean hazard area, shall be elevated above the base flood elevation.

4104.2 The elevation of the first habitable floor of all structures in the Regulatory Flood Plain except in the coastal high hazard and ocean hazard areas shall be above the base flood elevation.

Exception: This requirement does not apply to the addition, renovation or reconstruction to any building which was constructed prior to the initial Flood Insurance Study for that area if the addition, renovation or reconstruction does not exceed 50% of the present market value of the structure.

4104.3 Where walls are constructed below base flood elevation in Coastal High Hazard Area and Ocean Hazard Area, they shall be constructed in a manner to eliminate wave forces on the pilings.

SECTION 4105
CONSTRUCTION MATERIALS AND METHODS STANDARDS

4105.1 The requirements of Section 4105.2 through 4105.9 are applicable in the Coastal High Hazard Area, the Ocean Hazard Area, and all areas defined as 110 MPH wind zone.

4105.2 Every rafter or roof truss shall be anchored to the bearing wall plate as required by Section 802.12. At the ridges, rafters shall have a minimum 1 x 6 or 2 x 4 collar or wind beam. Every third rafter not to exceed 4 feet on centers shall be anchored vertically with minimum 1 x 6 or 2 x 4 from its midpoint to ceiling joists below.

4105.3 Wood Frame Wall Construction: Maximum stud spacing shall be 16 inches o.c. for 2 x 4's and 24 inches for 2 x 6's. See Section 4005 for wall construction requirements. See Section 4008 for uplift anchorage requirements. Wood structural panel sheathing including endwall sheathing shall extend 12 inches beyond construction joints and shall overlap girders their full depth. Panels may be installed with face grain either parallel or perpendicular to stud.

4105.4 Equal or better methods of tieing structures together and to foundations designed for a specific building by a Professional Engineer or Architect shall be accepted by the Building Inspector.

4105.5 In the Coastal High Hazard Area and the Ocean Hazard Area, all metal connectors and fasteners outside of conditioned spaces shall be hot dip galvanized steel after fabrication and meet ASTM A153. Exposed metal connectors, such as tie-down straps on porches, decks, and areas under the structure shall be a minimum of 3/16 inch thick, and shall be hot dip galvanized after fabrication and meet ASTM A123 or ASTM A153. Stainless steel light-gauge metal connectors shall be permitted in exposed or partially exposed locations. Metal connectors of approved equivalent corrosion resistant material may be accepted. See Table 4105.5.

4105.6 Building Anchorage

1. For masonry buildings, the roof structure, including rafters and joists shall be securely anchored to the wall per Section 304.7 and 702.10. All mortar used for masonry walls shall be type M or S.
2. For masonry or wood frame buildings, all sills, beams or girders which resist uplift (including interior sills, beams, girders, and joists where the perimeter is unenclosed) Shall be securely anchored to the footing per Section 4004. Footing dowel bars shall have an 8 inch hook.
3. Where wood partitions and masonry walls join, the stud abutting the masonry shall be double and bolted to the masonry with three 1/2 inch galvanized bolts.
4. Steel and wooden columns and posts, including porch columns shall be anchored with metal ties and bolts to their foundations and to the members which they support.

Table 4105.5[1]
CORROSION RESISTANCE
(Applies Only to Structures Located in Coastal High Hazard Areas and Ocean Hazard Areas)

	Exposure Level		
	OPEN (exteriors, porches, underhouse	**VENTED/ENCLOSED (attic, floor trusses, enclosed crawl spaces and stud cavity)**	**CONDITONED (heated/cooled living areas)**
Nails, staples, screws	Hot Dip galvanized	Hot dip galvanized	–
Nuts, bolts, washers, tie rods	Hot Dip galvanized	Hot Dip galvanized	–
Steel connection plates & straps (3/16" minimum thickness)	Hot Dip galvanized after fabrication	Hot Dip galvanized	–
Sheet metal connectors, wind anchors, joists hangers, steel joists and beams	Stainless Steel or Hot Dipped galvanized after fabrication	Hot dip galvanized after plate fabrication	Hot dip galvanized
Truss plates	Stainless Steel or Hot Dipped galvanized after fabrication	Hot dip galvanized after fabrication or stainless steel within 6'-0" of a gable louver or soffit vent. Otherwise in accordance with TIP-78 of the Truss Plate Institute	Standard galvanized

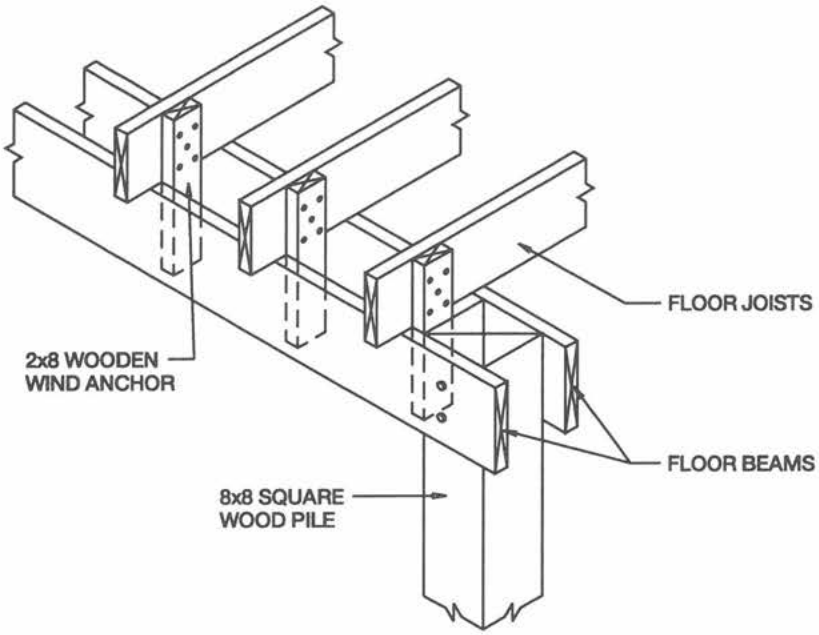
1. Applies only to structures located in Coastal High Hazard area and Ocean Hazard Area.

4105.7 Roof Coverings

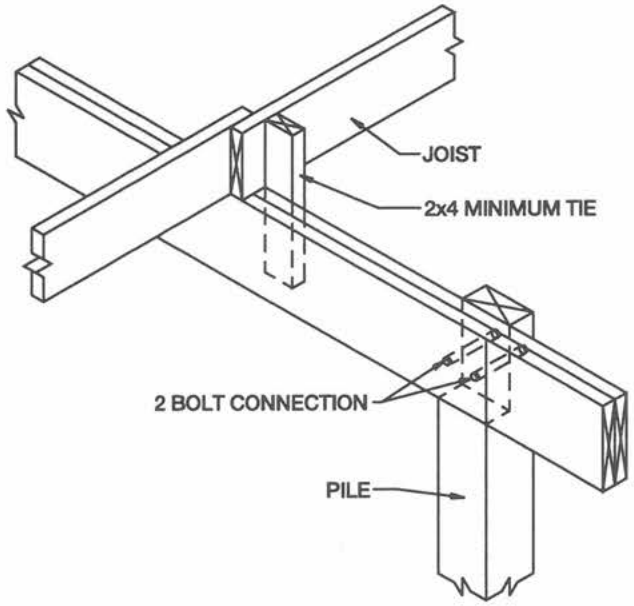
1. Attaching devices shall be hot dip galvanized after fabrication or be of other suitable corrosion resistant material.
2. All butts or tabs on roof shingles shall be securely spotted or tabbed with a plastic fibrous, asphaltic cement, or anchored by clips or locks. The use of seal-o-matic roofing may be used as the equivalent of this requirement.
3. Where two or more layers of roll or built-up roofing are applied, the deck shall be thoroughly mopped before the anchor sheet is nailed to the sheathing with sheet metal caps and nails not over 12 inches on center in each direction and 6 inches along edges and laps. Each additional sheet above the anchor sheet shall be thoroughly mopped and finished with corrosion resistant capping around edges of roof.
4. All roof covering shall be Class A or Class B Covering, or Class C asphalt covering.

4105.8 Insulation. Insulation installed in floors in buildings elevated on pilings shall be held in place with plywood with exterior glue or other material approved by the building inspector.

4105.9 Accessory Structures. Detached accessory structures and out buildings shall be bolted to their foundation or otherwise constructed so as to prevent overturning during high winds.



SPACED BEAM TIE DETAILS



SOLID BEAM TIE DETAIL

TYPICAL CONNECTIONS ON INTERIOR COLUMN LINES

FIGURE 4105.3(a)
TWO STORY WALL SECTION
(TYPICAL)

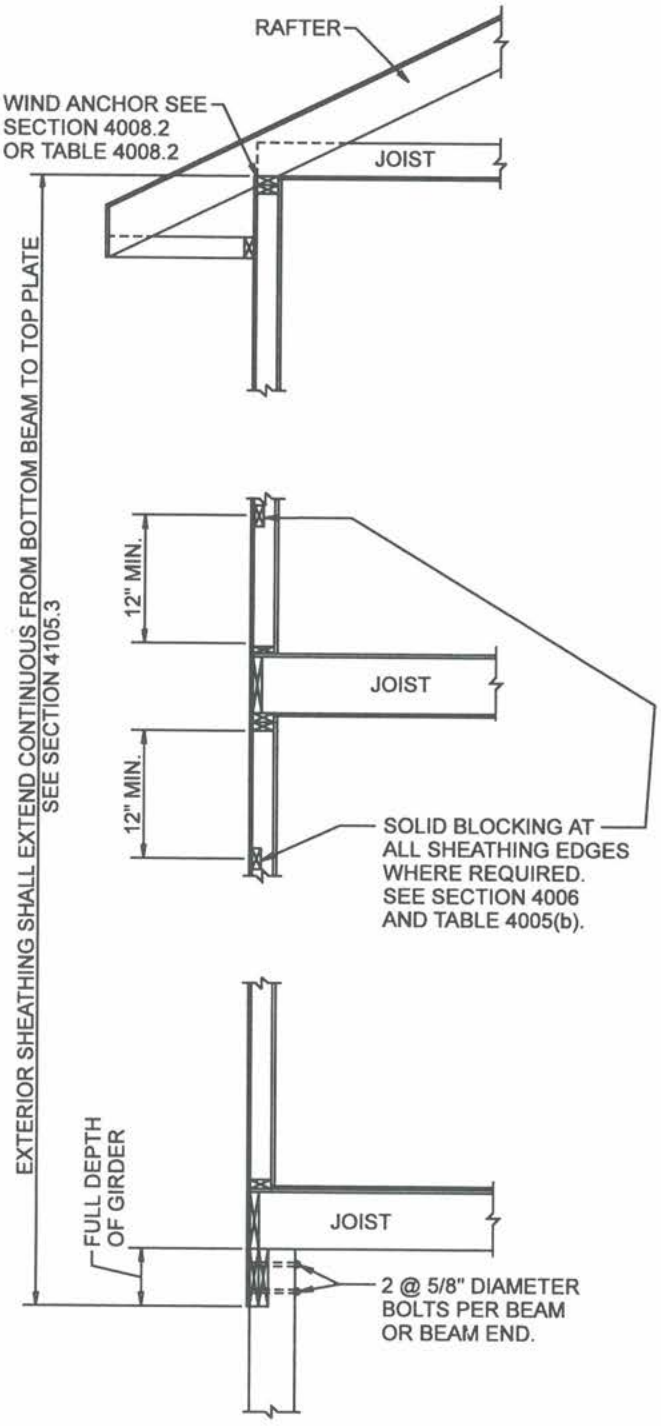


FIGURE 4105.3(b)
TWO STORY WALL SECTION
(TYPICAL)

CHAPTER 42
ELECTRICAL

SECTION 4201
GENERAL

4201 GENERAL. All electrical installations shall be in accordance with the North Carolina State Building Code, Volume IV-Electrical.

CHAPTER 43
STANDARDS

SECTION 4301
GENERAL

4701.1 Scope. 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.

SECTION 4302
REFERENCED STANDARDS

Standard Designation	Section
AA ASM 35-1980, Specification for Aluminum Sheet Metal Work in Building Construction	905.2
AAMA/NWWDA 101/I.S.2-97, Voluntary Specification for Aluminum, Vinyl (PVC), and Wood Windows and Glass Doors	608.1, 609.1
ACCA Manual D-1984, Duct Design and Residential Winter and Summer	1901.3.1
ACCA Manual J- 1986, Load Calculations for Residential Winter and Summer Air Conditioning, 7th Edition	1401.3
ACI 318-1980 (1992 Revisions), Building Code Requirements for Reinforced Concrete	404.1
ACI 318.1-1989 (1992 Revisions), Building Code Requirements for Structural Plain	404.1
ACI 530/ASCE 5/TMS 402-1991, Building Code Requirements for Masonry Structures	404.1, 604.1
AFPA NDS 1991, National Design Specification for Wood Construction Design Values for Wood Construction	802.2
AFPA - Wood Frame Construction Manual For One and Two-Family Dwellings 1995 SBC High Wind Edition	4001.1
AGA 7-90, AGA Requirements for Gas Convenience Outlets	1202, 2606.5
AHA A 135.6-1989, Hardboard Siding	Table 703.4
AHA 1 94. 1-1985, Cellulosic Fiber Board	Table 602.3a
ANSI A 108. 1-1992, Installation of Ceramic Tile with Portland Cement Mortar	702.4
ANSI A108.4-1992, Ceramic Tile Installed with Water-Resistant Organic Adhesives	702.4
ANSI A108.5-1992, Installation of Ceramic Tile with Dry-Set Portland Cement Mortar or Latex-Portland Cement Mortar	702.4
ANSI A 108.6-1992, Installation of Ceramic Tile with Chemical-Resistant, Water Cleanable Tile—Setting and Grouting Epoxy	702.4
ANSI A 108.1 1-1990, Interior Installation of Cementitious Backer Units	702.4
ANSI A 112.19.6-1990, Hydraulic Performance Water Closets and Urinals	Table 3201.1
ANSI A 1 1 2. 19.9- 1991, Nonvitreous Ceramic Plumbing Fixtures	Table 3201.1
ANSI A 1 1 8. I -1992, Dry-Set Portland Cement Mortar (for Ceramic Tile)	702.4
ANSI A118.3-1992, Standard Specifications for Chemical-Resistant, Water Cleanable Tile—Setting and Grouting Epoxy	702.4
ANSI A 1 36. 1-1992, Standard for Organic Adhesives for Installation of Ceramic Tile, Types I and II	702.4

Standard Designation	Section
ANSI A 137.1-1988, Ceramic Tile	702.
ANSI A 137.1-1988. Ceramic Tile	702.4
ANSI A208.1-1993, Wood Particleboard	503.3.1, 611.1, 803.3.1
ANSI Z21.11- 1987, Household Cooking Gas Appliances, with Addenda Z21.1a-1982 and Z21.1b-1984	2201.2, 2202.1
ANSI Z21.5.1-1982, Gas Clothes Dryers, Volume I, Type 1	2204.1
ANSI Z21.8-1984, Installation of Domestic Gas Conversion Burners	1304.1
ANSI Z21.10.1-1987, Gas Water Heaters, Volume III, Circulating and Storage, with Input Ratings above 75,000 Btu per Hour, with Addenda Z21.10.3a-1988	2307.1
ANSI Z21.11.1-1983,Vented Room Heaters,Volume I, with Addenda Z21.11.2a-1984	1603.1
ANSI Z21.15-1979, Manually Operated Gas Valves with Addenda Z21.15a-1981 and Z21.15b-1984	2606.1
ANSI Z21.17-1984, Domestic Gas Conversion Burners Installation of Domestic Gas Conversion Burners	1304.1
ANSI Z21.22-1986, Relief Valves and Automatic Gas Shutoff Devices for Hot Water Supply Systems	3301.4, 3408.5
ANSI Z21.44-1985, Gas-fired Gravity and Fan Type Direct Vent Wall Furnaces, with Addenda Z21.44a-1985	1602.1
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	1402.1
ANSI Z2 1.48-1986, Gas-fired Gravity and Fan Type Vented Wall Furnaces	1601.1
ANSI Z21.49-1986, Gas-Fired Gravity and Fan Type Vented Wall Furnaces	1602.1
ANSI Z21.50-1986, Vented Decorative Gas Appliances	2205.1
ANSI Z21.54-1987, Outdoor Cooking Gas Appliances, with Addenda Z21.54a-1983 and Z21.54b-1985	2203.1
ANSI Z21.58-1987, Outdoor Cooking Gas Appliances, with Addenda Z21.58a-1982 and Z21.58b- 1985	2203.1
ANSI Z21.64-1985, Direct Vent Central Furnaces, with Addenda Z21.64a-1986	1402.1
ANSI Z21.66-1985, Electrically Operated Automatic Vent Damper Devices for Use with Gas-fired Appliances	2102.2.2
ANSI Z97. 1- 1984, Safety Glazing Materials Used in Buildings, Performance Specifications and Methods of Test for	308.3
ANSI Z124.1-1987, Plastic Bathtub Units	Table 3201.1
ANSI Z124.2-1987, Plastic Shower Receptors and Shower Stalls	Table 3201.1
ANSI Z124.3-1986, Plastic Lavatories	Table 3201.1
ANSI Z124.4-1986, Plastic Water Closet Bowls and Tanks	Table 3201.1
ANSI Z 124.6-1990, Plastic Sinks	Table 3201.1
ANSI/AGA LC 1, AGA Requirements for Interior Natural Gas Piping Systems Using Corrugated Stainless Steel Conduit	Table 2605.1
ANSI/ASHRAE 34-1992, Number Designation and Safety Classification of Refrigerants	2401.1
ANSI/NSF 14-1990, Plastic Piping Components and Related Materials	3109.1
ANSI/UL 174-1983, Household Electric Storage Tank Water Heaters (Revised March 1988)	2307.1
ANSI/UL 196-1989. Oil Burners Safety Standard	1304.1

Standard Designation	Section
ANSI/UL 727-1980/83, Oil-fired Central Furnace	1402.1
ANSI/UL 729-1976/1980, Oil-fired Floor Furnaces	1601.1
ANSI/UL 730-1974/1980, Oil-fired Wall Furnace	1602.1
APA E30-1990, Design and Construction Guide: Residential and Commercial	803.2.3
ASCE 7-1993, Minimum Design Loads for Buildings and Other Structures	Table 301.2b
ASME B 16.18-1984, Cast Copper Alloy Solder-Joint Pressure Fittings	Table 3403.1
ASME B 16.23-1984, Cast Copper Alloy Solder-Joint Drainage Fittings	Table 3502.1
ASME/ANSI A 1 1 2.4. 1-1993, Water Heater Relief Valve Drains	3408.5.7
ASME/ANSI A 112.19.1 M- 1987, Enameled Cast Iron Plumbing Fixtures	Table 3201.1
ASME/ANSI Al 12.19.2M-1990, Vitreous China Plumbing Fixtures	Table 3201.1
ASME/ANSI Al 12.19.3M-1987, Stainless Steel Plumbing Fixtures (Designed for Residential Use)	Table 3201.1
ASME/ANSI A112.19.4M-1984, Porcelain Enameled Formed Steel Plumbing Fixtures	Table 3201.1
ASME/ANSI A112.19.5-1979, Trim for Water Closet Bowls, Tanks and Urinals	Table 3201.1
ASME/ANSI A 112.19.6-1990, Hydraulic Performance Water Closets and Urinals	Table 3201.1
ASME/ANSI A112.19.7M-1987, Whirlpool Bathtub Appliances	Table 3201.1
ASME/ANSI A112.19.8M-1987, Suction Fittings for Use in Swimming Pools, Wading Pools, Spas, Hot Tubs and Whirlpool Bathtub Appliances	Table 3201.1
ASME/ANSI A112.21.1 -1991, Floor Drains	Table 3201.1
ASSE 1051, Performance Requirements for Air Admittance Valves for Plumbing Drainage Systems, Fixtures and Branch Devices—with September 1992 Revisions	3601.4, 3601.5.6
ASSE/ANSI 1001-1988, Pipe Applied Vacuum Breakers	Table 3201.1
ASSE/ANSI 1002-1979 (1986), Water Closet Flush Tank Ball Cocks	Table 3201.1
ASSE/ANSI 1003-1981, Water Pressure Reducing Valves for Domestic Water Supply Systems	Table 3201.1
ASSE/ANSI 1006-1986, Household Dishwashing Machines	Table 3201.1
ASSE/ANSI 1007-1973 (1986), Home Laundry Equipment	Table 3201.1
ASSE/ANSI 1008-1973 (1986), Household Dispensers	Table 3201.1
ASSE/ANSI 1010-1982, Water Hammer Arrestors	Table 3201.1
ASSE/ANSI 1011-1982, Home Connection Vacuum Breakers	Table 3201.1
ASSE/ANSI 1014-1979, Handheld Showers	Table 3201.1
ASSE/ANSI 1016- 1979, Individual Shower Control Valves, Anti-Scald	Table 3201.1, 3210.4, 3215.2
ASSE/ANSI 1019-1978, Wall Hydrants, Freezeless, Automatic Raining, Anti-backflow Types	Table 3201.1
ASSE/ANSI 1023-1979, Plumbing Requirements for Hot Water Dispensers, Household Storage Type, Electrical	Table 3201.1

Standard Designation **Section**

Standard Designation	Section
ASTM B 280-92A, Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service	Table 2605.1
ASTM B 302-92, Specification for Threadless Copper Pipe	Table 2501.1, Table 2605.1
ASTM B 306-1988, Specification for Copper Drainage Tube	Table 2501.1, Table 3502.1, Table 3502.2
ASTM B 370-1988, Standard Specification for Copper Sheet and Strip for Building Construction	Table 3201.1
ASTM B 447-1989, Welded Copper Water Tube (WK, WL, WM)	Table 3403.1
ASTM B 813-1991, Specification for Liquid and Paste Fluxes for Soldering Applications of Copper and Copper Alloy Tube	Table 2501.1, 3404.2.2, 3503.3.4
ASTM B 828-1992, Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings	3404.2.2
ASTM C 5-1979, Specification for Quicklime for Structural Purposes (Reapproved 1992)	702.2
ASTM C 14-1988, Specification for Concrete Sewer, Storm Drain and Culvert Pipe	Table 3502.2
ASTM C 28- 1992, Specification for Gypsum Plasters	702.2
ASTM C 34-1990. Structural Clay Load-Bearing Wall Tile	Table 301.2a
ASTM C 35-1989a, Specification for Inorganic Aggregates for Use in Gypsum Plaster	702.2
ASTM C 36-1992, Specification for Gypsum Wallboard	702.3.1
ASTM C 37-1992, Specification for Gypsum Lath	702.2
ASTM C 55-1985, Concrete Building Brick	202, Table 301.2a
ASTM C 59- 1991, Specification for Gypsum Casting and Molding Plaster	702.2
ASTM C 6 1-1991, Specification for Gypsum Keene's Cement	702.2
ASTM C 62-1991, Building Brick (Solid Masonry Units Made from Clay or Shale)	202, Table 301.2a
ASTM C 73-1985, Sand-lime Building Brick	202, Table 301.2a
ASTM C 79-1992, Test Method for Gypsum Sheathing Board	Table 602.3a
ASTM C 90-1985, Hollow Load-Bearing Concrete Masonry Units	202, Table 301.2a
ASTM C 129-1985, Nonload-Bearing Concrete Masonry Units	202, Table 301.2a
ASTM C 145-1985, Solid Load-Bearing Concrete Masonry Units	202, Table 301.2a
ASTM C 150-1992, Specification for Portland Cement	402.2
ASTM C 208-72, Standard Specification for Insulating Board (Cellulosic Fiber) Structural and Decorative	Table 602.3a
ASTM C 216-1991, Facing Brick (Solid Masonry Units Made from Clay or Shale)	202, Table 301.2a
ASTM C 270-1989, Specification for Mortar for Unit Masonry	607.1.1
ASTM C 406-1984, Specification for Roofing Slate	904.2
ASTM C 425-1988, Specification for Compression Joints for Vitrified Clay Pipe and Fittings	Table 3502.2
ASTM C 475-1989, Specification for Joint Treatment Materials for Gypsum Wallboard Construction	702.3.1
ASTM C 476-1983, Specification for Grout for Masonry	607.1.1
ASTM C 514-1990, Specification for Nails for the Application of Gypsum Board	702.3.1

Standard Designation	Section
ASTM C 557-93, Standard Specification for Adhesives for Fastening Gypsum Wallboard to Wood Framing	702.3.1
ASTM C 578- 1987, Standard Specification for Preformed, Cellular Polystyrene Thermal Insulation	403.3
ASTM C 587-1991, Specification for Gypsum Veneer Plaster	702.2
ASTM C 588-1991, Specification for Gypsum Base for Veneer	702.2
ASTM C 595-1992, Specification for Blended Hydraulic Cement	402.2
ASTM C 630-1992, Specification for Water-Resistant Gypsum Backing Board	702.4.1
ASTM C 631-1991, Standard Specification for Bonding Compounds for Interior Plastering	702.2
ASTM C 645-88, Non-Load (Axial) Bearing Steel Studs, Runners (Track) and Rigid Furring Channels for Screw Application of Gypsum Wallboard	702.3.3
ASTM C 652-1991, Hollow Brick (Hollow Masonry Units Made from Clay or Shale)	202, Table 301.2a
ASTM C 700-1988, Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength and Perforated	Table 3502.2
ASTM C 843-1992, Specification for Application of Gypsum Veneer Base	702.2
ASTM C 844-1985, Specification for Application of Gypsum Base to Receive Gypsum Veneer Plaster (Reapproved 1990)	702.2
ASTM C 847-1988, Specification for Metal Lath (Reapproved 1992)	702.2
ASTM C 887-79a (1989), Specification for Packaged, Dry, Combined Materials for Surface Bonding Mortar	406.1
ASTM C 897-1988, Specification for Aggregate for Job-Mixed Portland Cement-Based Plaster	702.2
ASTM C 933-1980, Standard Specification for Welded Wire Lath (Reapproved 1990)	702.2
ASTM C 954-93, Specification for Steel Drill Screws for the Application of Gypsum Board or Metal Plaster Bases to Steel Studs from 0.33 inch to 0.112 inch in Thickness	702.3.5
ASTM C 955-88, Load-Bearing (Transverse and Axial) Steel Studs, Runners (Track) and Bracing or Bridging for Screw Application of Gypsum Board and Metal Plaster Bases	702.3.3
ASTM C 960-1991, Specification for Predecorated Gypsum Board	702.3.1
ASTM C 1002-1988, Specification for Drill Screws for the Application of Gypsum Board	702.3.1, 702.3.5
ASTM C 1032-1986, Specification for Woven Wire Plaster Base (Reapproved 1990)	702.2
ASTM C 1047-1985, Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base (Reapproved 1990)	702.2, 702.3.1
ASTM C 1063-1986, Specification for Installation of Lathing and Furring for Portland Cement-Based Plaster	702.2
ASTM D 312-1984, Specifications for Asphalt Used in Roofing	907.4.2
ASTM D 1248-84 (1989), Specification for Polyethylene Plastics Molding and Extrusion Materials	1901.1.2
ASTM D 1527-1989, Specification for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe, Schedules 40 and 80 (Reapproved 1982)	Table 3403.1
ASTM D 1784-1990, Specification for Rigid Poly (Vinyl Chloride) (PFC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds	1901.1.2
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ASTM D 1861-1988, Specification for Homogeneous Bituminized Fiber Drain and Sewer Pipe (Reapproved 1981)	Table 3502.2
ASTM D 2104-1989a, Specification for Polyethylene (PE) Plastic Pipe, Schedule 40	Table 3403.1
ASTM D 2235-88, Solvent Cement for ABS-DWV Pipe and Fittings	Table 3403.1, Table 3502.1, Table 3502.2
ASTM D 2239-1989, Specification for Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter	Table 3403.1
ASTM D 2241-1989, Specification for Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR-series)	Table 3403.1
ASTM D 2282-1989, Specification for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe (SDR-PR)	Table 3403.1
ASTM D 2412-1987, Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading	1901.1.2
ASTM D 2447-1989, Polyethylene (PE) Plastic Pipe Controlled OD	Table 3403.1, Table 3409.5a
ASTM D 2466-1990a, Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40	Table 3403.1
ASTM D 2467-1990, Specification for Socket-Type Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80	Table 3403. 1
ASTM D 2468-1990, Specification for Acrylonitrile-Butadiene Styrene (ABS) Plastic Pipe Fittings, Schedule 40	Table 3403.1
ASTM D 2513-91 A, Specification for Thermoplastic Gas Pressure Pipe, Tubing and Fittings	Table 2605.1
ASTM D 2564-1991, Solvent Cement for PVC-DWV Pipe and Fittings	Table 3403.1, Table 3502.1, Table 3502.2
ASTM D 2609-1990, Specification for Plastic Insert Fittings for Polyethylene (PE) Plastic Pipe	Table 3403.1
ASTM D 2661-1991, Specification for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Drain, Waste and Vent Pipe and Fittings	Table 3502.1, Table 3502.2
ASTM D 2665-1991b, Specification for Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings	Table 3502.1, Table 3502.2
ASTM D 2666-1989, Specification for Polybutylene (PB) Plastic Tubing	Table 3403.1
ASTM D 2672- 1989, Socket Bell for PVC-DWV Pipe and Fittings	Table 3403.1, Table 3502.1, Table 3502.2
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ASTM D 2846-1990a, Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Hot- and Cold-Water Distribution Systems	Table 2501.1, Table 3403.1, Table 3409.5a
ASTM D 2949-89, 3.25-inch O.D. PVC-DWV Pipe and Fittings	Table 3502.1, Table 3502.2
ASTM D 3000-1989, Standard Specification for Polybutylene (PB) Plastic Pipe (SDR-PR) Based on Outside Diameter	Table 3403.1
ASTM D 3034-1989, Type PSM/PVC Sewer Pipe and Fittings	Table 3502.2
ASTM D 3212-1989, Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals	Table 3502.2
ASTM D 3261-1990, Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing	Table 3403.1

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ASTM F 89 1-1991, Specification for Coextruded Poly (Vinyl Chloride) (PVC) Plastic Pipe with a Cellular Core	Table 3502.1, Table 3502.2
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AWPA C1-1990, Pressure Treatment (General Requirements), All Timber Products	322.1
AWPA C2-1990, Pressure Treatment, Lumber, Timber, Bridge Ties and Mine Ties	322.1
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AWPA C15-1990, Wood for Commercial-Residential Construction, Preservative Treatment by Pressure Process	322.1
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AWPA C27-1988, Plywood-Fire-Retardant Treatment by Pressure Processes	322.1
AWPA C28-1990, Standard for Preservative Treatment of Structural Glued-Laminated Members and Laminations Before Gluing of Southern Pine, Pacific Coast Douglas Fir, Hem-fir and Western Hemlock by Pressure Process	322.1
AWPA M4-1988, Care of Preservative-Treated Wood	323.3.1
AWPA P1-1989, Standard for Coal Tar Creosote for Land and Fresh Water and Marine (Coastal Water Use)	322.1
AWPA P2-1990, Standard for Cresote and Cresote Solutions	322.1
AWPA P3-1989, Standard for Cresote—Petroleum Oil Solution	322.1
AWPA P5-1990, Waterborne Preservatives	402.1.2
CAN4-S102.2-M83, Standard Method of Test for Surface Burning Characteristics of Flooring, Floor Covering and Miscellaneous Materials and Assemblies	319.2
CISPI HS74-1986, Specification for Cast Iron Soil Pipe and Fittings for Hub and Spigot Systems for Drain Waste or Vent, Sewer, Rainwater or Storm Drain Systems	Table 3502.1, Table 3502.2
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CSSB-1984, Grading and Packing Rules for Certigrade Red Cedar Shingles (Revised February 1, 1984)	908.2
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CSSB-1990, Grading Rules for Shake Hip and Ridge based on the Standards of the Cedar Shake and Shingle Bureau	908.3.3, 909.3.4
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CWC-1987. Canadian Dimension Lumber Data Book	802.2
DOC PS 1-1992, Construction and Industrial Plywood	202, Table 404.3, 503.2.1, 610.1, 803.2.1
DOC PS 2-1992, Performance Standard for Wood-based Structural-use Panels	202, Table 404.3, 503.2.1 503.2.1.2, 610.1, 803.2.1, 803.2.1.3
DOC PS 1970, American Softwood Lumber Standard (1986)	404.3.1, 502.1, 602.1, 802.1
FM 4880-1972, Factory Mutual Building Corner Fire Test	317.3
GA 253-1993, Recommended Specifications for the Application of Gypsum Sheathing	Table 602.3a
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NFiPA 259-1993, Potential Heat of Building Materials, Standard Method of Test for	317.2.5
NFiPA 501 A-92, Manufactured Home Installations, Sites and Communities	202
SBCCI SSTD 10-97 Standard for Hurricane Residential Construction	4001.1
SMACNA-1988, Installation Standards for Residential Heating and Air Conditioning Systems	1901.3.1
TPI BWT-1976, Bracing Wood Trusses: Commentary and Recommendations	502.10, 802.11
TPI QST-1989, Quality Standard for Metal Plate Connected Wood Trusses	502.10, 802.11
TPI PCT-1980, Design Specification for Metal Plate Connected Parallel Chord Wood Trusses	502.10, 802.11
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UL 55A-1983, Materials for Built-up Roof Coverings (Revised 1989)	907.2
UL 80-80, Steel Inside Tanks for Oil-Burner Fuel	2701.1
UL 103-89, Chimneys, Factory-Built Residential Type and Building Heating Appliance	1202
UL 142-93, Steel Aboveground Tanks for Flammable and Combustible Liquids	2701.1
UL 144-85, Pressure Regulating Valves for LP-Gas	2611.1
UL 181-1996, Factory-Made Air Ducts and Air Connectors	1901.2
UL 181A-1994, Closure Systems for Use with Rigid Air Ducts and Air Connectors	1901.2
UL 181B-1995, Closure Systems for Use with Flewxible Air Ducts and Air Connectors	1901.2, 1901.32
UL 441-1986, Gas Vents	1901.2, 1901.3.2
UL 443-79, Steel Auxiliary Tanks for Oil-Burner Fuel	2701.1
UL 559-1985, Heat Pumps (Revised December 1987)	1403.1
UL 641-86, Low-Temperature Venting Systems, Type L	1202, 2104.2.4

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UL 790-1983, Tests for Fire Resistance of Roof Covering Materials (Revised 1989)	901.3
UL 896-1973/1974, Oil-Burning Stoves	1603.1
UL 1040-1971, Outline of Investigation for Insulated Wall Construction	317.3
UL 1096-1986, Electric Central Air Heating Equipment (Revised January 1988)	1402.4
UL 1482-1983, Room Heaters, Solid-Fuel Type	1603.1
UL 1715-1989, Outline of Investigation of Classification of Interior Finish Material Assemblies Using a Room Fire Test	317.3
UL 1777-88, Chimney Liners (Revised November 1989)	1001.14
WWPA-1992, Western Lumber Span Tables for Floor and Ceiling Joists and Roof Rafters	802.2

SECTION 4303
ABBREVIATIONS

AA— Aluminum Association
18 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. 20046

ACI— American Concrete Institute
P.O. Box 19150
Detroit, MI 48219

AFPA— American Forest and Paper Association
1111 19th Street, NW, Suite 800
Washington D.C. 20036

AHA— American Hardboard Association
887-B Wilmette Road
Palatine, IL 60067

ANSI— American National Standards Institute
1430 Broadway
New York, NY 10018

ANSI/ASHRAE American National Standards Institute/ American Society of Heating, Refrigeration and Air-Conditioning Engineers
1791 Tullie Circle NE
Atlanta, GA 30329

ANSI/NSF American National Standards Institute/ National Sanitation Foundation
3475 Plymouth Road
P. O. Box 1468
Ann Arbor, MI 48106

ANSI/UL American National Standards Institute/ Underwriters Laboratories

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

ASME/ANSI— American Society of Mechanical Engineers
American National Standards Institute

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

CAN— National Standards of Canada designation (The number or name following the CAN designation represents the agency under whose auspices the standard is issued.)
CAN1 designates CGA,
CAN2 designates CGSB,
CAN3 designates CSA, and
CAN4 designates ULC.
350 Sparks Street,
Ottawa, Ontario
Canada K I R 7S8

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
1730 St. Laurent Boulevard
Suite 350
Ottawa, Ontario
Canada K1G 5L1

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

NCMA National Concrete Masonry Association
2302 Horse Pen Road, P.O. Box 781
Herndon, VA 22070

NFiPA National Fire Protection Association
1 Batterymarch Park
Quincy, MA 02269

NFiPA/
ANSI— National Fire Protection Association
American National Standards Institute

NWWDA— National Wood and Door Association
1400 E. Touhy Avenue, Suite G-54
Des Plaines, IL 60018

SMACNA— Sheet Metal and Air Conditioning Contractors
National Association, Inc.
4201 Lafayette Center Drive
Chantilly, VA 22021

TPI— Truss Plate Institute
583 D'Onofrio Drive
Suite 200
Madison, Wl 53719

UL— Underwriters Laboratories, Inc.
333 Pfingsten Road
Northbrook, IL 60062

APPENDIX B
ENGINEERED PROCEDURE FOR SIZING PLUMBING VENTS

Section 3601.6 of this code permits engineered vents to be sized in accordance with this appendix as an alternate to the prescriptive vent sizing included in the code. This appendix outlines an alternate procedure for sizing such vents.

Tables B101 , B201 and B301 provide an engineered method for sizing vents. Use of these tables and Figures B101 through B601 shall require a formal plan review prior to installation.

In most residential applications, individual fixtures or small fixture groups may be vented by a 1/2, 3/4, or 1 inch (12.7, 19 or 25 mm) 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 B201.

$$A_B = \sqrt{A_L} \times \Sigma A_v \qquad \text{(Formula B-1)}$$

where:

A_B = Area of branch vent.
A_L = Area of largest vent served.
A_v = Area of all other vents served.

TABLE B101
MINIMUM SIZE FOR DRY VENTS

VENTING APPLICATION	LOAD SERVED (d.f.u.)	VENT SIZE[1] (inches)
Individual fixture vent (single trap only)	3.9 or less 4.0 or more	1/2 3/4
Common vent waste stack vent or wet vent extension	3.9 or less 4.0 to 6.9 7.0 to 15.9	3/4 1 1-1/4
Soil stack vent	6.9 or less 7.0 to 15.9 16.0 to 30.0	1-1/2 1-1/4 1-1/2
Vent stack	10.9 or less 11.0 to 30.0	1-1/4 1-1/2
VENTING APPLICATION	**NUMBER OF FIXTURE VENTS SERVED**	**PIPE SIZES LARGER THAN LARGEST FIXTURE VENT SERVED**
Branch vent	Two Three (largest = 3/4 in) Three (largest = 1 in or more) Four or more	One One Usually one[2] Compute size[3]

For **SI**: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

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 1/2 or 3/4-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 B301, Combinations of Three-fixture Vents Requiring Two-pipe-size Increase in Branch Vent .

3 Compute pipe size using Table B201. Internal Cross-sectional Areas of Various Nominal Size of Pipes, and Formula B-1.

TABLE B201
INTERNAL CROSS-SECTIONAL AREAS OF VARIOUS NOMINAL SIZES OF PIPE

NOMINAL PIPE SIZE (inches)	INTERNAL CROSS-SECTIONAL AREAS*		
	Schedule 40 Pipe Metallic or Nonmetallic (square inches)	Copper Tube	
		Type M (square inch)	Type DWV (square inches)
1/2	0.304	0.254	—
3/4	0.533	0.517	—
1	0.864	0.874	—
1-1/4	1.495	—	1.317
1-1/2	2.036	—	1.865
2	3.355	—	3.272
3	7.393	—	7.235

For **SI**: 1 inch = 25.4 mm. 1 square inch = 645.16 mm.

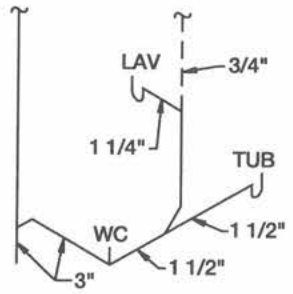
* Areas for other piping materials and wall Thickness may be obtained or calculated from the respective ASTM standards or the manufacturer's specifications.

Table B301 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.

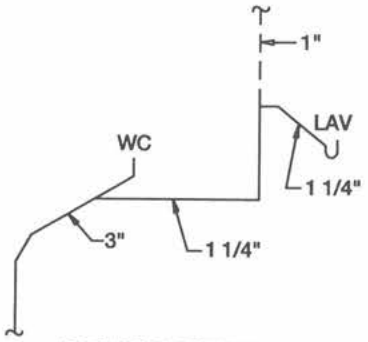
TABLE B301
COMBINATIONS OF THREE-FIXTURE VENTS REQUIRING TWO-PIPE-SIZE INCREASE IN BRANCH VENT

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

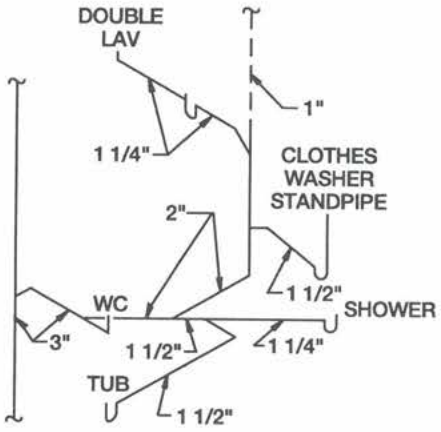
For **SI**: 1 inch = 25.4 mm.



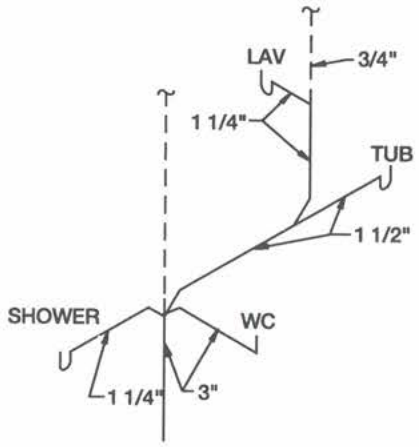
A. TYPICAL SINGLE-BATH



B. TYPICAL POWDER ROOM

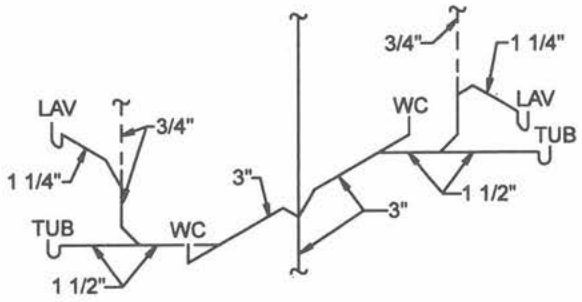


C. MORE ELABORATE
SINGLE-BATH ARRANGEMENT

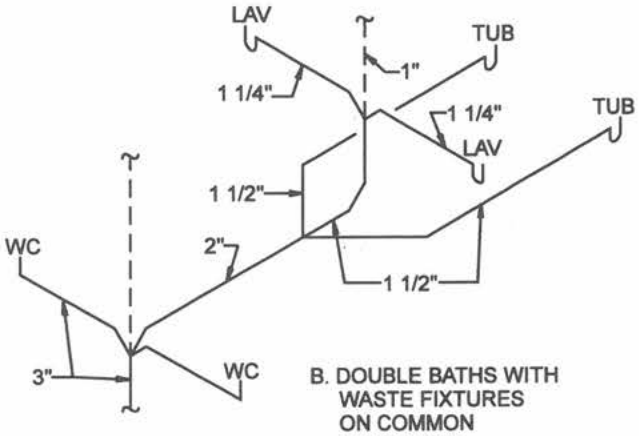


D. COMBINATION WET - AND
STACK - VENTING WITH
STACK FITTING

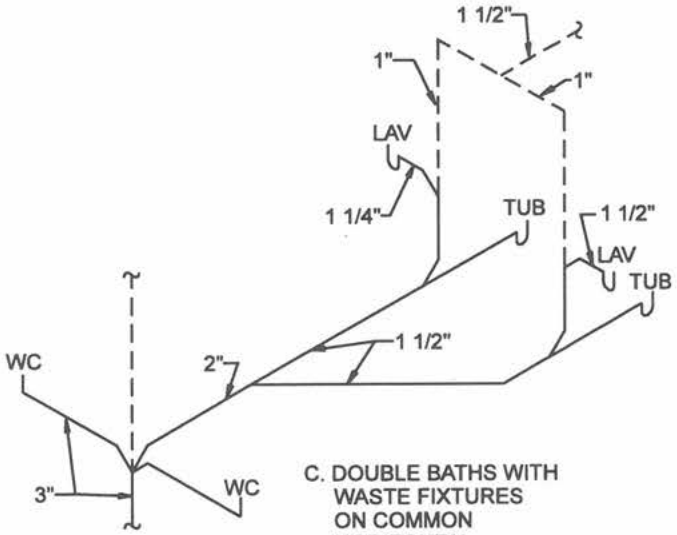
FIGURE B101
TYPICAL SINGLE-BATH WET-VENT ARRANGEMENTS



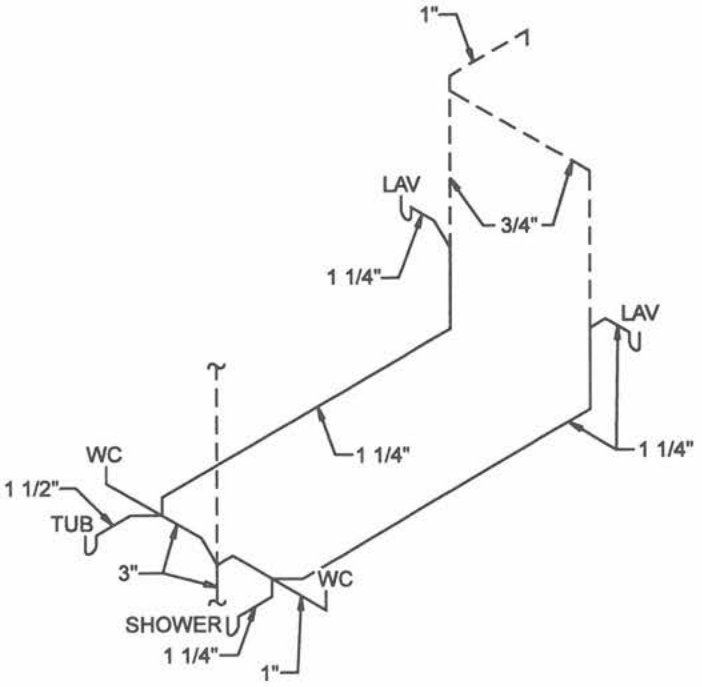
A. TYPICAL BACK-TO-BACK BATHS



B. DOUBLE BATHS WITH WASTE FIXTURES ON COMMON HORIZONTAL BRANCH, COMMON WET VENT



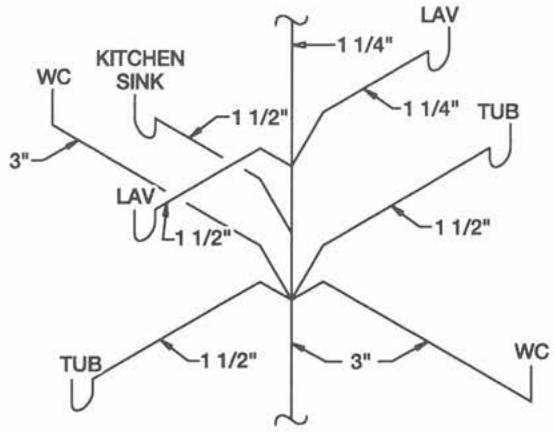
C. DOUBLE BATHS WITH WASTE FIXTURES ON COMMON HORIZONTAL BRANCH, INDIVIDUAL WET VENT



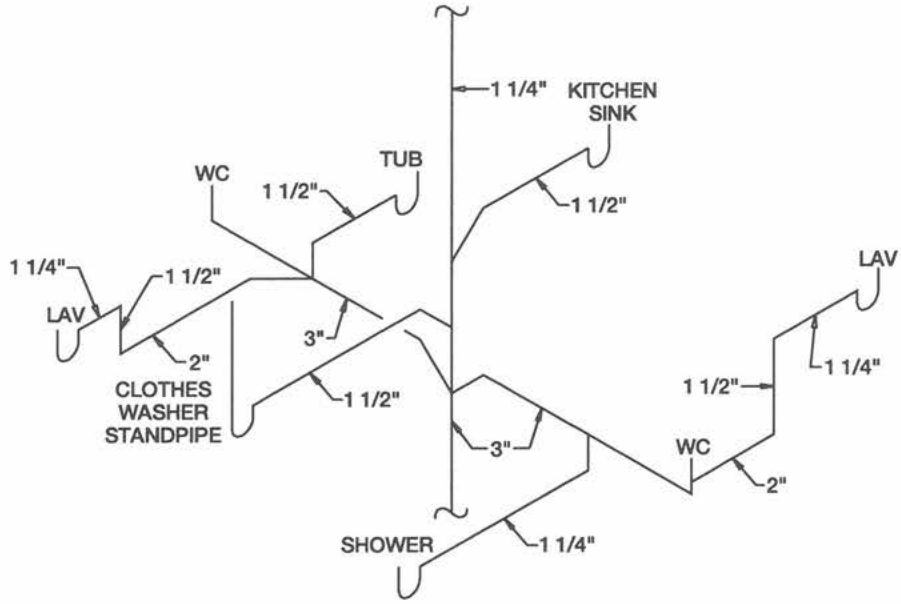
D. DOUBLE BATHS WITH LAVATORIES AND TUBS ON WET VENT, WC'S STACK VENTS

FIGURE B201
TYPICAL DOUBLE-BATH WET-VENT ARRANGEMENTS

FIGURE B301
WASTE STACK SERVING AS WET VENT FOR LAUNDRY GROUP



A. WASTE FIXTURES CONNECTED DIRECTLY TO STACK



B. WASTE FIXTURES CONNECTED TO WATER CLOSET HORIZONTAL BRANCH

FIGURE B401
TYPICAL METHODS OF CONNECTING FIXTURE DRAINS TO STACK IN STACK-VENTED SYSTEMS

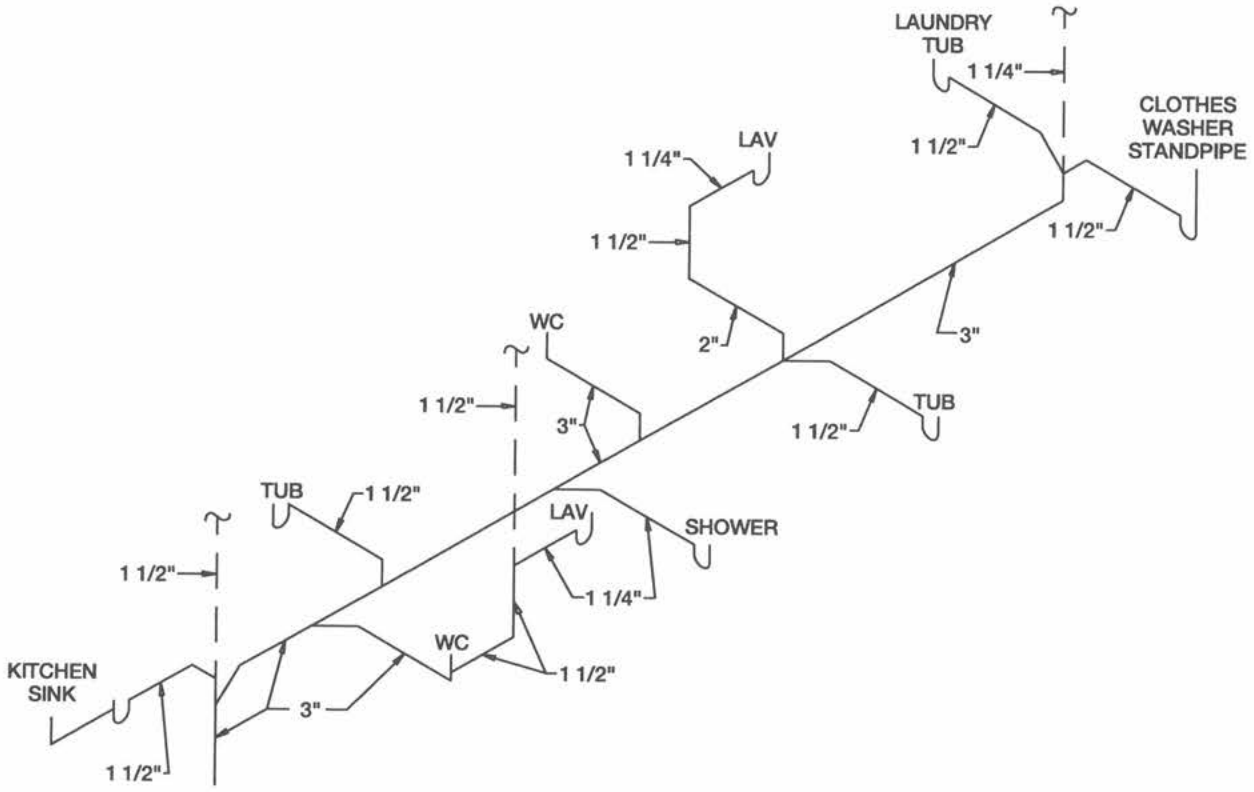


FIGURE B501
TYPICAL UNIFORMLY SIZED HORIZONTAL BRANCH SYSTEM

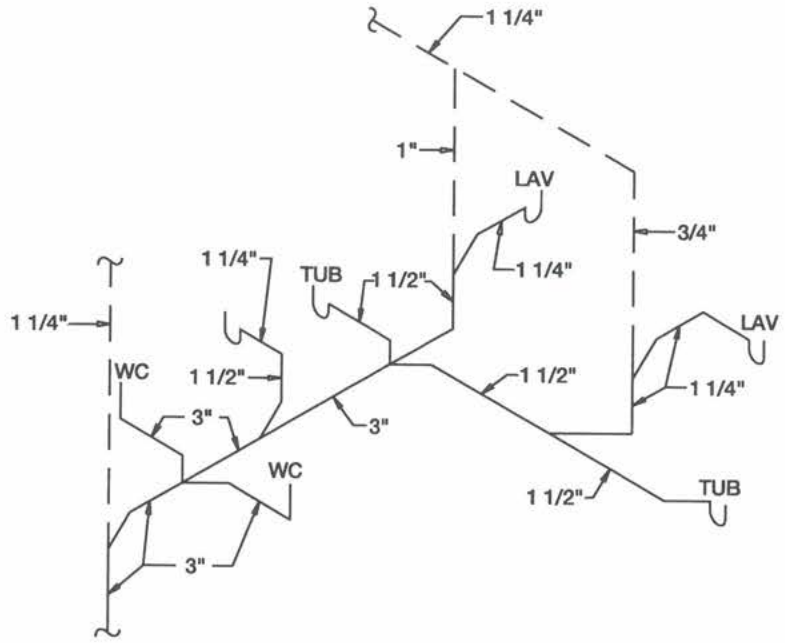


FIGURE B601
TYPICAL HORIZONTAL BRANCH SYSTEM REDUCING IN SIZE UTILIZING WET VENTING

APPENDIX C
DETAILED PROCEDURE FOR SIZING THE BUILDING WATER SUPPLY SYSTEM

SECTION C101
INTRODUCTION

This appendix presents a detailed engineering method that may be used for sizing water-service and distribution piping in single-family homes. This appendix is referenced in Section 3409.5 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 (276 kPa) and the elevation of the highest fixture above the service valve does not exceed 25 feet (7625 mm).

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 (55 kPa) for common plumbing fixtures, and as recommended by manufacturers of plumbing appliances].

SECTION C201
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 34. 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:

1. 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 Section C101, 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.
2. Calculate the equivalent length of the basic design circuit (BDC*), identify the 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 C101a and C101b. 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 34.

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 4 below).

3. 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 C101 may be used to obtain losses in water meters. The curves in

Figure C101 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 (kPa), at the main or other source, the sum of Items 3.1, 3.2, 3.3 and 3.4 below:

3.1 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 (55 kPa) may be assumed at the terminal fixture.

3.2 Friction loss, in psi, due to flow through fixture-supply branches. For this purpose, a value of 5 psi (34 kPa) may be assumed.

3.3 Elevation head loss, in psi (kPa), from main or other source up to terminal fixture. This is calculated as the product of the elevation difference, in feet (mm), times the factor 0.433 psi per foot (3.0 kPa per mm).

3.4 The sum of friction losses, in psi (kPa), 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 C101 .

4. Calculate the friction loss design factor, p, psi/l 00 feet (0.226 kPa/m), for the basic design circuit. This is obtained by dividing the pressure available for friction (see Item 3 above) by the total equivalent length of the basic design circuit (see Item 2 above) and multiplying the result by 100:

$$\Delta p = \frac{\text{psi available for friction}}{\text{total equivalent length}} \times 100 \qquad \text{(Formula C-l)}$$

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 7 below).

5. 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 C201 and Figure C201 (or Table 3409.3 in Chapter 34).

6. Size the service pipe by the use of the appropriate table in Table C301a through C301f. Enter the appropriate table with the service pipe demand rate obtained in Item 5 above, the pressure available for friction as obtained in Item 3 above and the total equivalent length of the basic design circuit obtained in Item 2 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 C401 may be used to size the service pipe.

7. Size each hot and cold building main, as well as each primary branch and riser, by the use of Table C401. Enter the portion of the table for the appropriate piping material with the appropriate demand rate obtained in Item 5 above and the friction loss design factor, Δp, obtained in Item 4 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 Tables C301a through C301f.

TABLE C101a
ALLOWANCE IN EQUIVALENT LENGTH FOR FRICTION LOSS IN VALVES AND FITTINGS[1]
(Streamline Connections, Soldered, Brazed or Solvent Cemented)

	EQUIVALENT FEET OF TUBE FOR VARIOUS SIZES (inches)					
FITTING OR VALVE	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-degree elbow	0.2	0.3	0.5	0.5	1.0	1.0
90-degree 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

For **SI:** 1 inch = 25.4 mm, 1 foot = 304.8 mm.

1 From *Copper Tube Handbook*, 404-0 (1980), by Copper Development Association Inc. In the absence of a specific recommendation from the manufacturer, listed values may be applied also to CPVC plastic piping using solvent-cemented fittings, and five times the listed values may be applied to plastic piping systems using insert-type fittings.

TABLE C101b
ALLOWANCE IN EQUIVALENT LENGTH FOR FRICTION LOSS IN VALVES AND FITTINGS
(Threaded, Galvanized Steel, Brass or Copper, Standard Wall Schedule 40)

	EQUIVALENT FEET OF TUBE FOR VARIOUS SIZES (inches)					
FITTING OR VALVE	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-degree elbow	0.5	1.0	1.2	1.5	1.8	2.4
90-degree 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

For **SI:** 1 inch = 25.4 mm, 1 foot = 304.8 mm.

1 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 C201
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)[1]	—	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 ½ baths	2.0	3.3	4.4
2 baths	2.6	3.9	5.2
2 ½ baths	2.8	4.2	5.6
3 baths	3.2	4.7	6.3
3 ½ baths	3.4	5.1	6.8
Additional l/2 bath if part of group	0.3	0.6	0.8

For **SI**: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 gpm = 0.0631 L/s.

1. 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 C101.

TABLE C301a
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 (inches)	EQUIVALENT LENGTH OF LINE (feet)[1]							
	10	20	40	60	80	100	150	200
	Flow Rate, gpm[2]							
Pressure Available for Friction[3]—5 psi								
¾	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
1¼	30.3			26.0	22.1	19.8	15.9	13.6
Pressure Available for Friction[3]—10 psi								
¾	10.9			9.8	8.5	7.5	6.0	5.1
1	19.4				17.9	15.9	12.7	10.9
1¼	30.3					28.8	23.1	19.8
Pressure Available for Friction[3]—15 psi								
¾	10.9				10.5	9.4	7.5	6.4
1	19.4						15.9	13.6
1¼	30.3						28.8	24.7
Pressure Available for Friction[3]—20 psi								
¾	10.9						8.7	7.5
1	19.4						18.6	15.9
1¼	30.3							29.0
Pressure Available for Friction[3]—25 psi								
¾	10.9							8.5
1	19.4							17.9
1¼	30.3							
Pressure Available for Friction[3]—30 psi								
¾	10.9							9.4
1	19.4							
1¼	30.3							
Pressure Available for Friction[3]—35 psi								
¾	10.9							10.1
1	19.4							
1¼	30.3							
Pressure Available for Friction[3]—40 psi								
¾	10.9							
1	19.4							
1¼	30.3							
Pressure Available for Friction[3]—45 psi								
¾	10.9							
1	19.4							
1¼	30.3							
Pressure Available for Friction[3]—50 psi								
¾	10.9							
1	19.4							
1¼	30.3							
Pressure Available for Friction[3]—60 psi								
¾	10.9							
1	19.4							
1¼	30.3							
Pressure Available for Friction[3]—70 psi								
¾	10.9							
1	19.4							
1¼	30.3							

For **SI**: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1psi=6.895KPa, 1 gpm = 0.0631 L/s, 1 fps = 0.3048 m/s.

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 C401 for hyraulic formula.

TABLE C301b
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 (inches)	EQUIVALENT LENGTH OF LINE (feet)[1]							
	10	20	40	60	80	100	150	200
	Flow Rate, gpm[2]							
Pressure Available for Friction[3]—5 psi								
¾	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
1¼	31.3			27.3	23.5	20.2	16.6	14.2
Pressure Available for Friction[3]—10 psi								
¾	12.1			11.2	9.6	8.4	6.8	5.8
1	20.6				19.5	17.1	14.0	11.6
1¼	31.3					29.1	24.2	20.2
Pressure Available for Friction[3]—15 psi								
¾	12.1					10.7	8.4	7.3
1	20.6						17.1	14.8
1¼	31.3						29.1	26.0
Pressure Available for Friction[3]—20 psi								
¾	12.1						10.7	8.4
1	20.6						20.1	17.1
1¼	31.3							29.1
Pressure Available for Friction[3]—25 psi								
¾	12.1						11.2	9.6
1	20.6							19.5
1¼	31.3							
Pressure Available for Friction[3]—30 psi								
¾	12.1							10.7
1	20.6							
1¼	31.3							
Pressure Available for Friction[3]—35 psi								
¾	12.1							11.5
1	20.6							
1¼	31.3							
Pressure Available for Friction[3]—40 psi								
¾	12.1							
1	20.6							
1¼	31.3							
Pressure Available for Friction[3]—45 psi								
¾	12.1							
1	20.6							
1¼	31.3							
Pressure Available for Friction[3]—50 psi								
¾	12.1							
1	20.6							
1¼	31.3							
Pressure Available for Friction[3]—60 psi								
¾	12.1							
1	20.6							
1¼	31.3							
Pressure Available for Friction[3]—70 psi								
¾	12.1							
1	20.6							
1¼	31.3							

For **SI**: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 psi=6.895KPa, 1 gpm = 0.0631 L/s, 1 fps = 0.3048 m/s.

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 C401 for hyraulic formula.

TABLE C301c
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 (inches)	EQUIVALENT LENGTH OF LINE (feet)[1]							
	10	20	40	60	80	100	150	200
	Flow Rate, gpm[2]							
Pressure Available for Friction[3]—5 psi								
¾	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
1¼	32.6			28.5	24.1	21.3	17.1	14.6
Pressure Available for Friction[3]—10 psi								
¾	12.9			12.2	10.4	9.2	7.4	6.3
1	21.8				20.8	18.4	14.7	12.5
1¼	32.6					30.7	25.1	21.4
Pressure Available for Friction[3]—15 psi								
¾	12.9					11.5	9.2	7.8
1	21.8						18.4	15.7
1¼	32.6						31.5	27.0
Pressure Available for Friction[3]—20 psi								
¾	12.9						10.8	9.2
1	21.8						21.6	18.4
1¼							32.6	30.7
Pressure Available for Friction[3]—25 psi								
¾	12.9						12.2	10.4
1	21.8							20.8
1¼	32.6							
Pressure Available for Friction[3]—30 psi								
¾	12.9							11.5
1	21.8							
1¼	32.6							
Pressure Available for Friction[3]—35 psi								
¾	12.9							12.5
1	21.8							
1¼	32.6							
Pressure Available for Friction[3]—40 psi								
¾	12.9							
1	21.8							
1¼	32.6							
Pressure Available for Friction[3]—45 psi								
¾	12.9							
1	21.8							
1¼	32.6							
Pressure Available for Friction[3]—50 psi								
¾	12.9							
1	21.8							
1¼	32.6							
Pressure Available for Friction[3]—60 psi								
¾	12.9							
1	21.8							
1¼	32.6							
Pressure Available for Friction[3]—70 psi								
¾	12.9							
1	21.8							
1¼	32.6							

For **SI**: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 gpm = 0.0631 L/s, 1 fps = 0.3048 m/s.

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 C401 for hyraulic formula.

TABLE C301d
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 (inches)	EQUIVALENT LENGTH OF LINE (feet)[1]							
	10	20	40	60	80	100	150	200
	Flow Rate, gpm[2]							
Pressure Available for Friction[3]—5 psi								
¾	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
1¼	46.6		42.5	34.0	29.0	25.8	20.8	17.8
Pressure Available for Friction[3]—10 psi								
¾	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
1¼	46.6				42.5	37.5	30.2	25.8
Pressure Available for Friction[3]—15 psi								
¾	16.6				13.7	12.2	9.8	8.3
1	26.9				26.0	23.1	18.4	15.8
1¼	46.6						37.5	32.2
Pressure Available for Friction[3]—20 psi								
¾	16.6				16.1	14.2	11.3	9.8
1	26.9						21.7	18.4
1¼	46.6						44.0	37.5
Pressure Available for Friction[3]—25 psi								
¾	16.6					16.1	13.0	11.1
1	26.9						24.5	21.0
1¼	46.6							42.5
Pressure Available for Friction[3]—30 psi								
¾	16.6						14.2	12.2
1	26.9							23.1
1¼	46.6							
Pressure Available for Friction[3]—35 psi								
¾	16.6						15.6	13.2
1	26.9							25.0
1¼	46.6							
Pressure Available for Friction[3]—40 psi								
¾	16.6							14.3
1	26.9							
1¼	46.6							
Pressure Available for Friction[3]—45 psi								
¾	16.6							15.2
1	26.9							
1¼	46.6							
Pressure Available for Friction[3]—50 psi								
¾	16.6							16.2
1	26.9							
1¼	46.6							
Pressure Available for Friction[3]—60 psi								
¾	16.6							
1	26.9							
1¼	46.6							
Pressure Available for Friction[3]—70 psi								
¾	16.6							
1	26.9							
1¼	46.6							

For **SI**: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1psi - 6.895 KPa, 1 gpm = 0.0631 L/s, 1 fps = 0.3048 m/s.

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 10 fps. See Table C401 for hyraulic formula.

TABLE C301e
MAXIMUM FLOW RATES, *Q*, WHICH YIELD VELOCITIES NOT EXCEEDING 12 fps AT INDICATED AVAILABLE PRESSURES
POLYETHLENE PE SCHEDULE 40 PIPE (ASTM D 2447)
CHLORINATED POLYVINYL CHLORIDE CPVC SCHEDULE 40 PIPE (ASTM F 441) WATER-SERVICE PIPE

NOMINAL PIPE SIZE (inches)	EQUIVALENT LENGTH OF LINE (feet)[1]							
	10	20	40	60	80	100	150	200
	Flow Rate, gpm[2]							
Pressure Available for Friction[3]—5 psi								
¾	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
1¼	56.6		42.5	34.0	29.0	25.8	20.8	17.8
Pressure Available for Friction[3]—10 psi								
¾	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
1¼	56.0			50.0	42.5	37.5	30.2	25.8
Pressure Available for Friction[3]—15 psi								
¾	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
1¼	56.0				53.0	47.0	37.5	32.2
Pressure Available for Friction[3]—20 psi								
¾	20.0			18.8	16.1	14.2	11.3	9.8
1	32.2				30.6	27.0	21.7	18.4
1¼	56.0					55.0	44.0	37.5
Pressure Available for Friction[3]—25 psi								
¾	20.0				18.3	16.1	13.0	11.1
1	32.2					30.4	24.5	21.0
1¼	56.0						50.0	42.5
Pressure Available for Friction[3]—30 psi								
¾	20.0					17.8	14.2	12.2
1	32.2						27.0	23.1
1¼	56.0						55.0	47.0
Pressure Available for Friction[3]—35 psi								
¾	20.0					19.5	15.6	13.2
1	32.2						29.5	25.0
1¼	56.0							51.0
Pressure Available for Friction[3]—40 psi								
¾	20.0						16.7	14.3
1	32.2						31.8	27.2
1¼	56.0							55.0
Pressure Available for Friction[3]—45 psi								
¾	20.0						17.8	15.2
1	32.2							29.0
1¼	56.0							
Pressure Available for Friction[3]—50 psi								
¾	20.0						18.1	16.1
1	32.2							30.5
1¼	56.0							
Pressure Available for Friction[3]—60 psi								
¾	20.0							18.1
1	32.2							
1¼	56.0							
Pressure Available for Friction[3]—70 psi								
¾	20.0							19.5
1	32.2							
1¼	56.0							

For **SI**: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1psi = 6.895KPa, 1 gpm = 0.0631 L/s, 1 fps = 0.3048 m/s.

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 12 fps. See Table C401 for hyraulic formula.

TABLE C301f
MAXIMUM FLOW RATES, *Q*, WHICH YIELD VELOCITIES NOT EXCEEDING 12 fps AT INDICATED AVAILABLE PRESSURES
POLYETHLENE PB SDR 11 TUBING (ASTM D 3309)
CHLORINATED POLYVINYL CHLORIDE CPVC SDR 11 TUBING (ASTM D 2846) WATER-SERVICE PIPE

NOMINAL PIPE SIZE (inches)	EQUIVALENT LENGTH OF LINE (feet)[1]							
	10	20	40	60	80	100	150	200
	Flow Rate, gpm[2]							
Pressure Available for Friction[3]—5 psi								
¾	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
1¼	37.2	36.0	24.8	19.8	17.0	15.0	12.0	10.3
Pressure Available for Friction[3]—10 psi								
¾	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
1¼	37.2		36.0	29.0	24.8	22.0	17.5	15.0
Pressure Available for Friction[3]—15 psi								
¾	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
1¼	37.2			36.0	31.0	27.5	22.0	18.7
Pressure Available for Friction[3]—20 psi								
¾	15.0			12.9	11.0	9.7	7.7	6.7
1	24.9				21.3	19.0	15.1	13.0
1¼	37.2				36.0	32.0	25.7	22.0
Pressure Available for Friction[3]—25 psi								
¾	15.0			14.5	12.3	11.0	8.8	7.6
1	24.9				24.1	21.3	17.1	14.6
1¼	37.2					36.0	29.0	24.8
Pressure Available for Friction[3]—30 psi								
¾	15.0				13.2	12.2	9.7	8.3
1	24.9					23.6	19.0	16.1
1¼	37.2						32.0	27.5
Pressure Available for Friction[3]—35 psi								
¾	15.0					13.2	10.6	9.1
1	24.9						20.6	17.6
1¼	37.2						35.0	29.6
Pressure Available for Friction[3]—40 psi								
¾	15.0						11.3	9.7
1	24.9						22.2	19.0
1¼	37.2							32.0
Pressure Available for Friction[3]—45 psi								
¾	15.0						12.2	10.4
1	24.9						23.6	20.2
1¼	37.2							34.2
Pressure Available for Friction[3]—50 psi								
¾	15.0						12.9	11.0
1	24.9							21.3
1¼	37.2							36.0
Pressure Available for Friction[3]—60 psi								
¾	15.0						14.3	12.2
1	24.9							23.7
1¼	37.2							
Pressure Available for Friction[3]—70 psi								
¾	15.0							13.3
1	24.9							
1¼	37.2							

For **SI**: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 psi= 6.895KPa, 1 gpm = 0.0631 L/s, 1 fps = 0.3048 m/s.

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 12 fps. See Table C401 for hyraulic formula.

TABLE C401
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 (inches)	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 B88														
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 B88														
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 B88														
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/A 53														
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
Polybutylene (PB) Tubing—SDR 11, ASTM D 3309 Chlorinated Polyvinyl Chloride (CPVC) Tubing—SDR 11, ASTM D 2846														
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 F 441 Polyethylene (PE) Pipe—Schedule 40, ASTM D 2104														
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

For **SI:** 1 inch = 25.4 mm, 1FOOT= 304.8 mm, 1FPS = 0.3048mm, 1 gpm = 0.0631 L/s,

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.

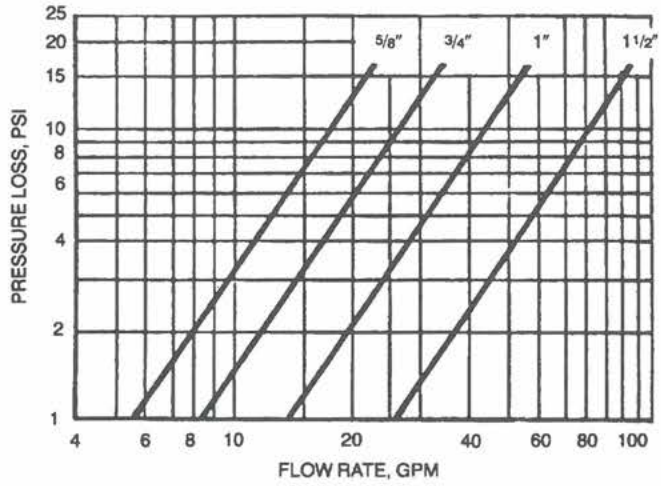
3 $Q = 4.57\ \Delta p^{0.0546} D^{2.64}$

where:

Q is in gpm.

Δp is in psi 100 feet.

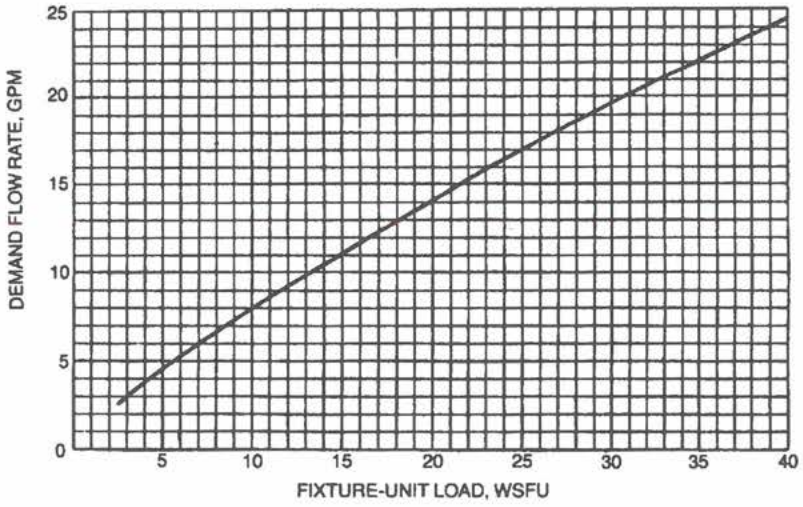
D is in inches, I.D.



For **SI:** 1 inch = 25.4 mm, 1 gpm = 0.0631 L/s, 1 psi 6.895 kPa.

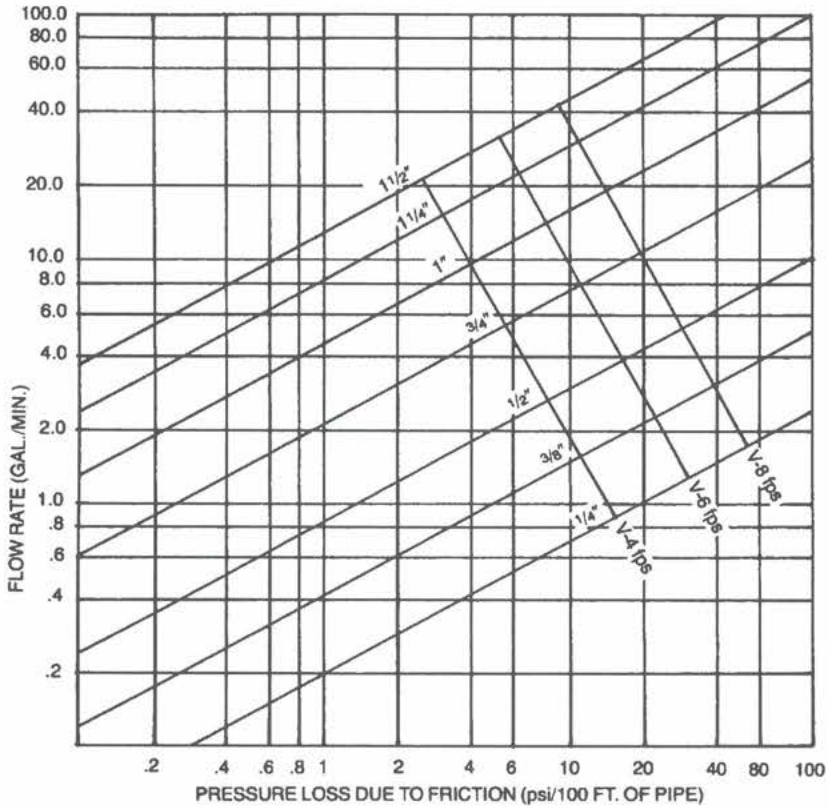
NOTE: Curves based on the assumption that pressure loss is proportional to the square of the flow rate.

FIGURE C101
PRESSURE LOSS IN COLD-WATER METERS, DISPLACEMENT TYPE (AWWA C700-77)



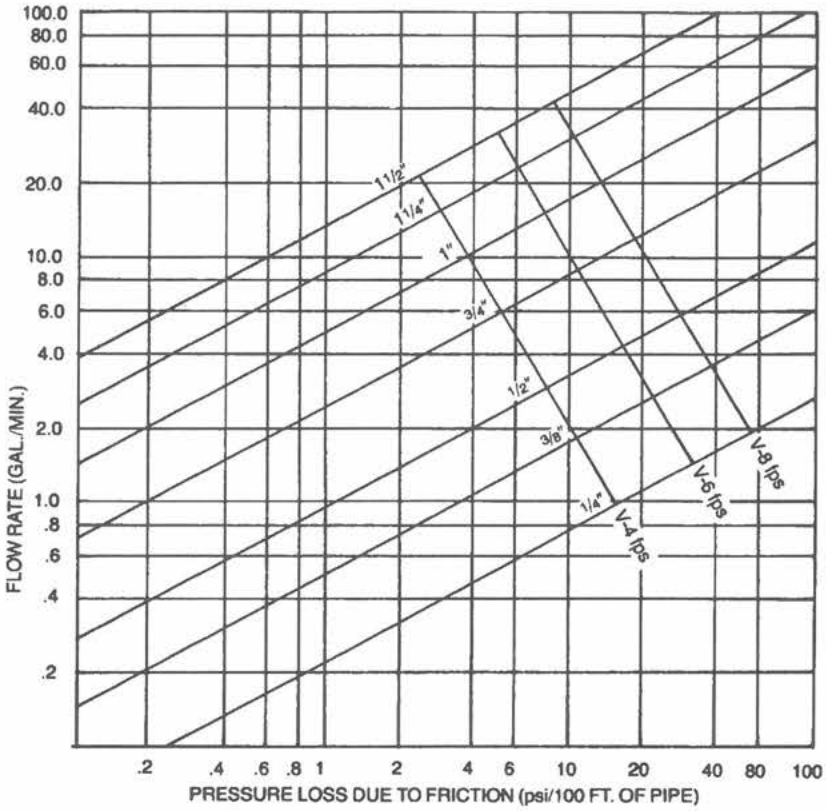
For SI: 1 gpm = 0.0631 L/s

FIGURE C201
DEMAND FLOW RATE AS A FUNCTION OF FIXTURE-UNIT LOAD



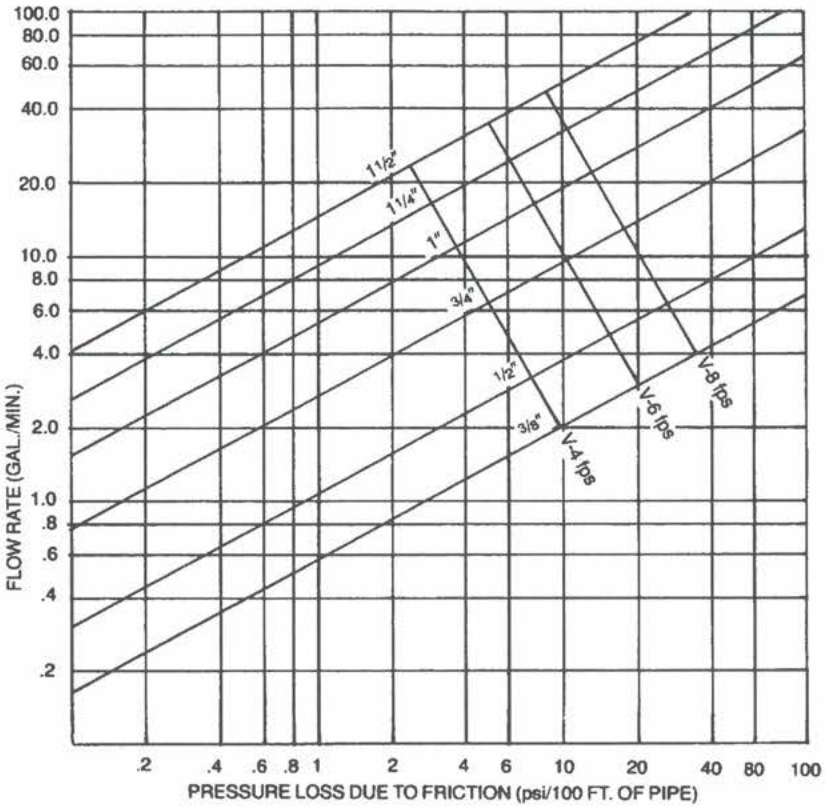
For **SI:** 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 psi = 6.895 kPa, 1 gpm = 0.0631 L/s.

FIGURE C301a
PRESSURE LOSS (FRICTION) AS A FUNCTION OF FLOW RATE
MATERIAL: COPPER WATER TUBE—TYPE K, ASTM B 88



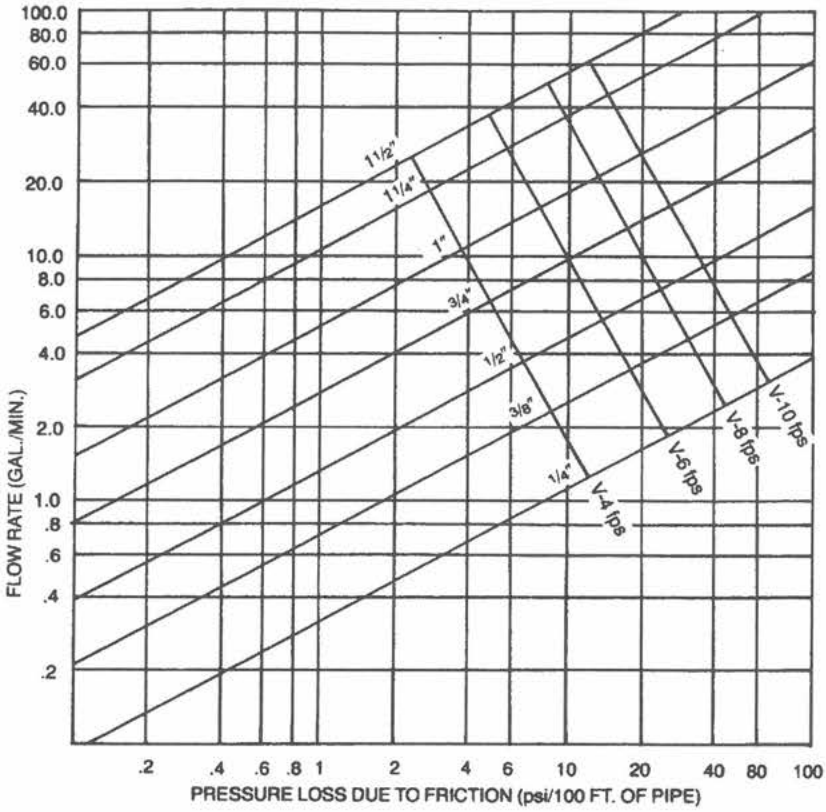
For **SI:** 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 psi = 6.895 kPa, 1 gpm = 0.0631 L/s.

FIGURE C301b
PRESSURE LOSS (FRICTION) AS A FUNCTION OF FLOW RATE
MATERIAL: COPPER WATER TUBE—TYPE L, ASTM B 88



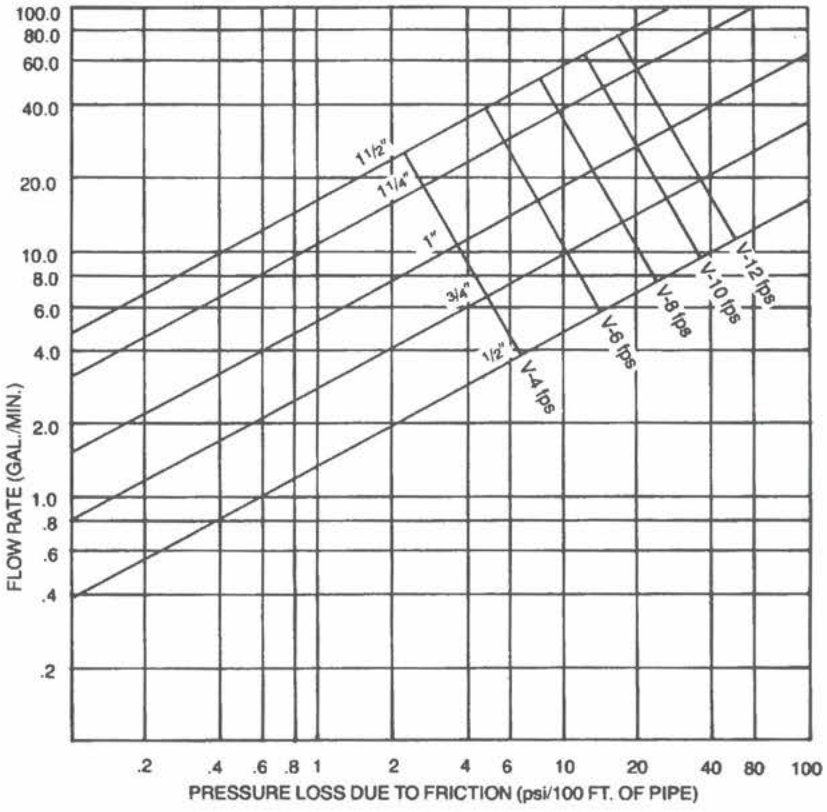
For **SI:** 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 psi = 6.895 kPa, 1 gpm = 0.0631 L/s.

FIGURE C301c
PRESSURE LOSS (FRICTION) AS A FUNCTION OF FLOW RATE
MATERIAL: COPPER WATER TUBE—TYPE M, ASTM B 88



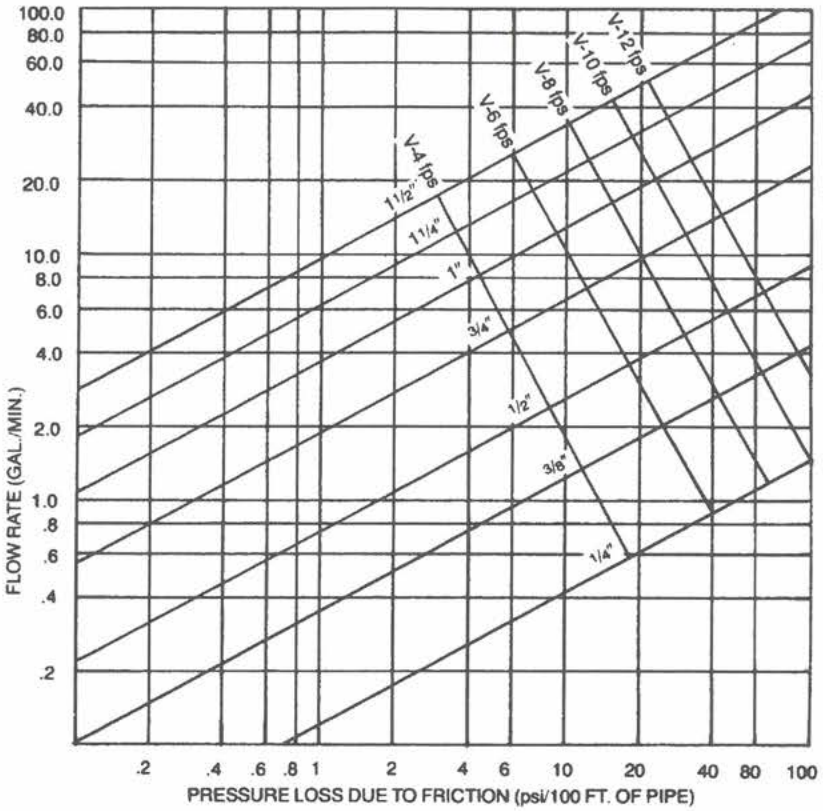
For **SI:** 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 psi = 6.1395 kPa, 1 gpm = 0.0631 L/s.

FIGURE C301d
PRESSURE LOSS (FRICTION) AS A FUNCTION OF FLOW RATE
MATERIAL: STEEL STANDARD WEIGHT PIPE ASTM A 120/A 53



For **SI:** 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 psi = 6.895 kPa, 1 gpm = 0.0631 L/s.

FIGURE C301e
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



For **SI:** 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 psi = 6.895 kPa, 1 gpm = 0 0631 L/s.

FIGURE C301f
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 D
SWIMMING POOLS, SPAS AND HOT TUBS

SECTION D101
GENERAL

The provisions of this appendix shall control the design and construction of swimming pools, spas and hot tubs installed in or on the lot of a one- and two-family dwelling.

SECTION D102
DEFINITIONS

For the purposes of these requirements, the terms used shall be defined as follows and as set forth in Chapter 2.

ABOVEGROUND/ON-GROUND POOL. See "Swimming pool."

BARRIER. A fence, wall, building wall or combination thereof which completely surrounds the swimming pool and obstructs access to the swimming pool.

HOT TUB. See "Swimming pool".

IN-GROUND POOL. See "Swimming pool".

RESIDENTIAL. That which is situated on the premises of a detached one- or two-family dwelling or a one-family town house not more than three stories in height.

SPA, NONPORTABLE. See "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.

SWIMMING POOL. Any structure intended for swimming or recreational bathing that contains water over 24 inches (610 mm) deep This includes in-ground, aboveground and onground 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 D103
SWIMMING POOLS

D103.1 In-ground pools. In-ground pools shall be designed and constructed in conformance with NSPI-5 as listed in Section D 107.

D103.2 Aboveground and on-ground pools. Aboveground and on-ground pools shall be designed and constructed in conformance with ANSI/NSPI-4 as listed in Section D107.

SECTION D104
SPAS AND HOT TUBS

D104.1 Permanently installed spas and hot tubs. Permanently installed spas and hot tubs shall be designed and constructed in conformance with ANSI/NSPI-3 as listed in Section D107.

D104.2 Portable spas and hot tubs. Portable spas and hot tubs shall be designed and constructed in conformance with ANSI/NSPI-6 as listed in D107.

SECTION D105
BARRIER REQUIREMENTS

D105.1 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.

D105.2 Outdoor swimming pool. An outdoor swimming pool, including an in-ground, aboveground 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 (1219 mm) 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 (51 mm) 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 aboveground 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 (102 mm).
2. Openings in the barrier shall not allow passage of a 4-inch-diameter (102 mm) 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 (1143 mm), 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 (44 mm) in width. Where there are decorative cutouts within vertical members, spacing within the cutouts shall not exceed 1-3/4 inches (44 mm) 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 (1143 mm) or more,

spacing between vertical members shall not exceed 4 inches (102 mm). Where there are decorative cutouts within vertical members, spacing within the cutouts shall not exceed 1¾ inches (44 mm) in width.

6. Maximum mesh size for chain link fences shall be a 1 ¼-inch (32 mm) 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 (44 mm).

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 (44 mm).

8. Access gates shall comply with the requirements of Section D105.2, 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 selfclosing 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 (1372 mm) from the bottom of the gate, the release mechanism and openings shall comply with the following:
   8.1 The release mechanism shall be located on the pool side of the gate at least 3 inches (76 mm) below the top of the gate, and
   8.2 The gate and barrier shall have no opening greater than 1/2 inch (12.7 mm) within 18 inches (457 mm) of the release mechanism.

   Where a wall of a dwelling serves as part of the barrier one of the following conditions shall be met:

9. Where a wall of a dwelling serves as pan of the barrier one of the following conditions shall be met.
   9.1 The pool shall be equipped with a powered safety cover in compliance with ASTM ES 13-89; or
   9.2 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 as 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 (1372 mm) above the threshold of the door; or
   9.3 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 Item 9.1 or 9.2 described above.

10. Where an aboveground 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:
    10.1 The ladder or steps shall be capable of being secured, locked or removed to prevent access or
    10.2 The ladder or steps shall be surrounded by a barrier which meets the requirements of Section D105.2, 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 (102 mm) sphere.

D105.3 Indoor swimming pool. All walls surrounding an indoor swimming pool shall comply with Section D105.2, Item 9.

D105.4 Prohibited locations. Barriers shall be located so as to prohibit permanent structures, equipment or similar objects from being used to climb the barriers.

D105.5 Barrier exceptions. A portable spa with a safety cover which complies with ASTM ES 13, as listed in Section D107, shall be exempt from the provisions of this appendix. Swimming pools, hot tubs and nonportable spas with safety covers shall not be exempt from the provisions of this appendix.

SECTION D106
ABBREVIATIONS

ANSI—	American National Standards Institute 11 West 42nd Street, New York, NY 10036
ASTM—	American Society for Testing and Materials 1916 Race Street, Philadelphia, PA 19103
NSPI—	National Spa and Pool Institute 2111 Eisenhower Avenue, Alexandria, VA 22314

SECTION D107
STANDARDS

ANSI/NSPI

ANSI/ NSPI-3-1992	Standard for Permanently Installed Residential Spas	D104.1
ANSI/ NSPI-4-1992	Standard for Aboveground/ Onground Residential Swimming Pools	D103.2
ANSI/ NSPI-6-1992	Standard for Residential Portable Spas	D104.2

ASTM

ASTM ES 13-89	Emergency Standard Performance Specification for Safety Covers and Labeling Requirements for All Covers for Swimming Pools, Spas and Hot Tubs	D105.5

NSPI

NSPI-5- 1987	Standard for Residential Swimming Pools.	D 103.1

APPENDIX E
FOAM PLASTIC DIAGRAMS

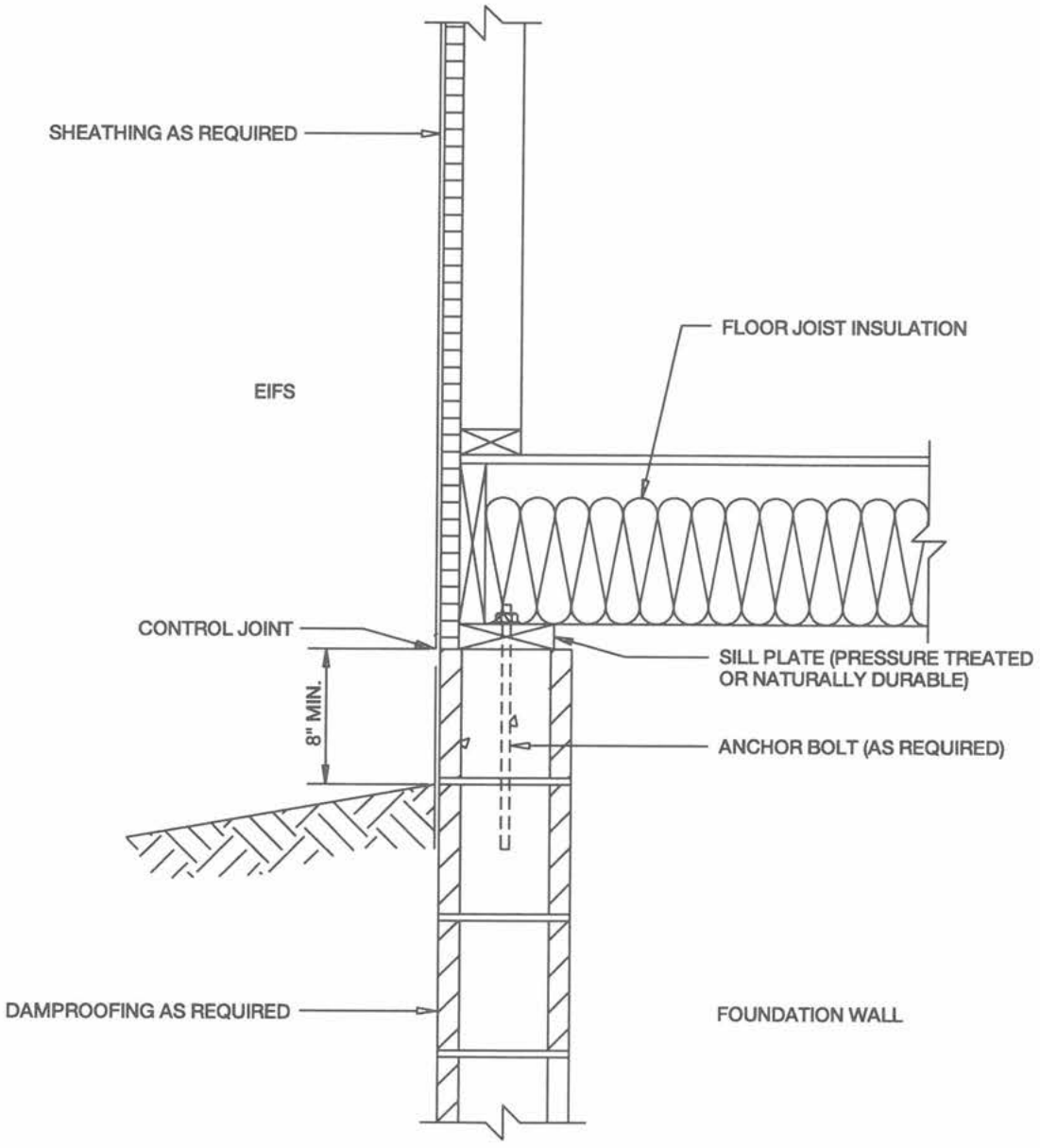


FIGURE E-1

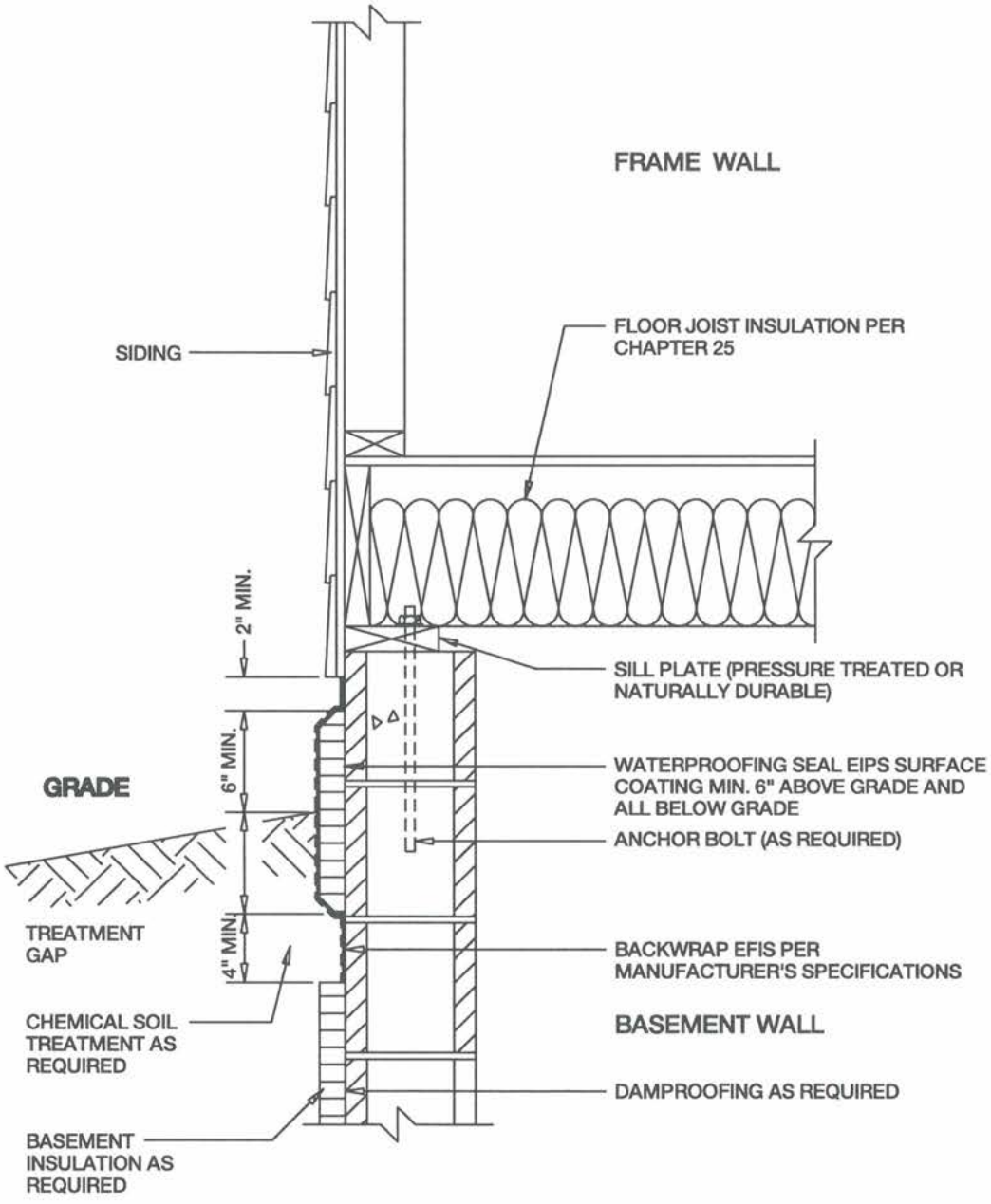
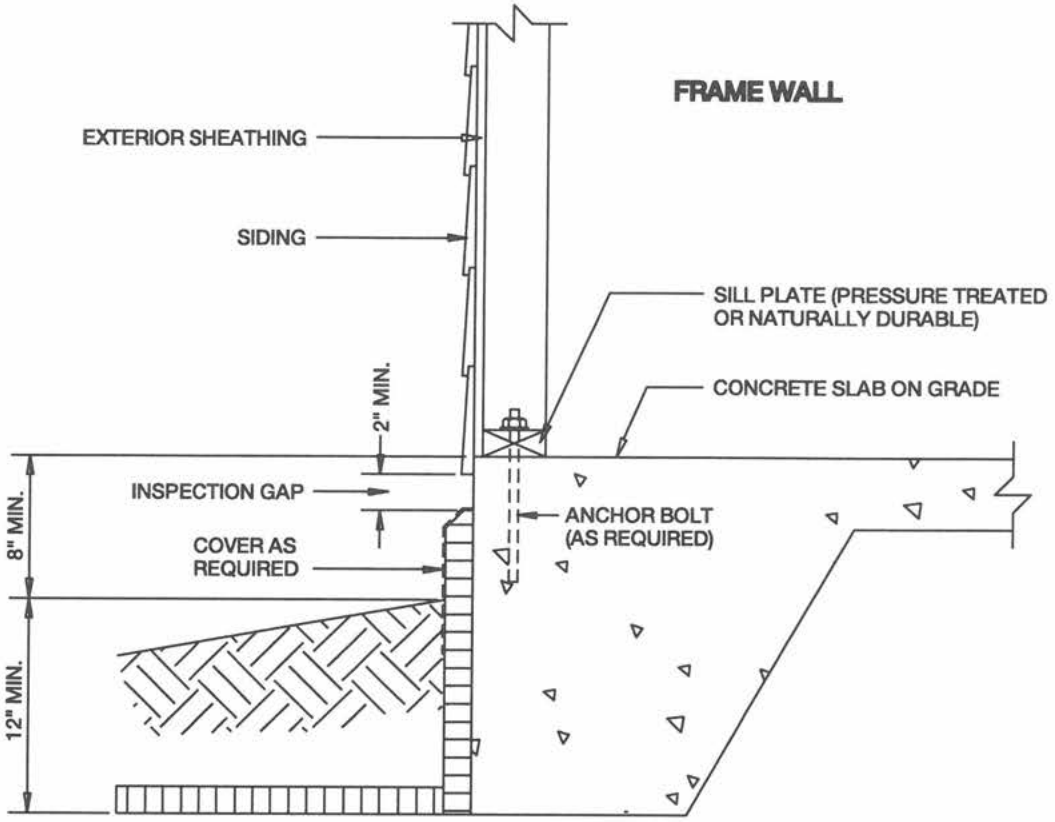

FRAME WALL
SIDING
FLOOR JOIST INSULATION PER CHAPTER 25
2" MIN.
SILL PLATE (PRESSURE TREATED OR NATURALLY DURABLE)
6" MIN.
GRADE
WATERPROOFING SEAL EIPS SURFACE COATING MIN. 6" ABOVE GRADE AND ALL BELOW GRADE
ANCHOR BOLT (AS REQUIRED)
TREATMENT GAP
4" MIN.
BACKWRAP EFIS PER MANUFACTURER'S SPECIFICATIONS
CHEMICAL SOIL TREATMENT AS REQUIRED
BASEMENT WALL
DAMPROOFING AS REQUIRED
BASEMENT INSULATION AS REQUIRED

FIGURE E-2



FOUNDATION INSULATION

24" VERTICAL DEPTH OR A COMBINATION OF VERTICAL AND HORIZONTAL DIMENSION EQUAL TO 24"

CHEMICAL PRETREATMENT OF SOIL IS REQUIRED PRIOR TO PLACING CONCRETE SLAB

FIGURE E-3

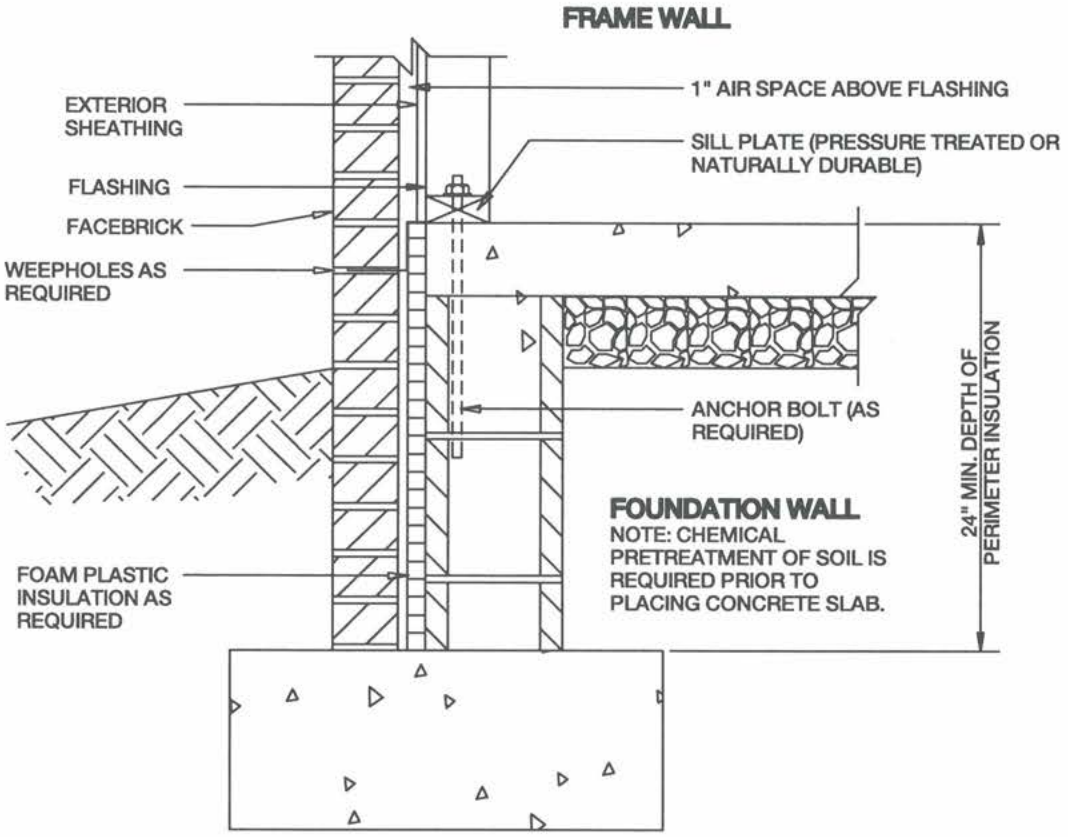

FRAME WALL
1" AIR SPACE ABOVE FLASHING
EXTERIOR SHEATHING
SILL PLATE (PRESSURE TREATED OR NATURALLY DURABLE)
FLASHING
FACEBRICK
WEEPHOLES AS REQUIRED
ANCHOR BOLT (AS REQUIRED)
24" MIN. DEPTH OF PERIMETER INSULATION
FOUNDATION WALL
NOTE: CHEMICAL PRETREATMENT OF SOIL IS REQUIRED PRIOR TO PLACING CONCRETE SLAB.
FOAM PLASTIC INSULATION AS REQUIRED

FIGURE E-4

APPENDIX F
EXTERIOR INSULATION HAND FINISH SYSTEMS (EIFS)

EXTERIOR INSULATION AND FINISH SYSTEMS (EIFS)
(Effective Date - March 12, 1996)

These recommendations apply only to EIFS designed as a barrier system which does not provide for drainage of water to the exterior and which is applied to Type VI Construction.

H-1. General. Exterior Insulation and Finish Systems (EIFS) are non-load bearing barrier wall exterior cladding systems generally consisting of an insulation board, an adhesive and/or mechanical attachment of the insulation board to the substrate, glass fiber reinforcing mesh, a base coat on the face of the insulation board that functions as a weather barrier and a textured protective finish coat.

H-2. Standards. The EIFS shall meet or exceed the following standards. Tests to certify compliance with these standards must be performed by a nationally recognized independent testing agency or evaluation service. Tests may be performed by the EIFS manufacturer if the test specimens and procedures are certified by a nationally recognized testing agency. Testing agencies shall provide unannounced follow-up inspections at least every six months to insure that system components continue to meet performance standards. Any changes in components or composition of components from the original compliance report will require a re-evaluation.

Test	Method	Acceptance Criteria
A. Durability		
1. System Performance		
a. Abrasion Resistance	ASTM D 968	No cracking, checking or loss of film integrity at 528 quarts (500 liters) of sand.
b. Accelerated Weathering	ASTM G 23 or G 53	No deleterious effects* after 2000-hours when viewed under 5x magnification.
c. Freeze/Thaw Resistance	Modified ASTM C 67	50 cycles. No deleterious effects.*
d. Mildew Resistance	ASTM D 3273 or Mil.Std. 810B, Method 108	No growth supported during 42-day exposure period.
e. Salt Spray Resistance	ASTM B 117	No deleterious effects* at 300 hour exposure.
f. Water Penetration	ASTM E 331	No water penetration.
g. Water Resistance	ASTM D 2247	No deleterious effects* at 14-day exposure.
*No deleterious effects: no cracking, checking, crazing, erosion, rusting, blistering, peeling or delamination.		
B. Fire Performance		
1. System Performance		
a. Fire Endurance	ASTM E 119	No effect on fire resistance rating of wall assembly.
b. Full-Scale Diversified	ASTM E 108 (Modified)	No significant Fire Test contribution to vertical or horizontal flame spread.
c. Radiant Heat Exposure	1996 N. C. State Building Code, Section 2603	No ignition at 20 minutes.

2. Component Performance		
a. Surface Burning	ASTM E 84	Adhesive, insulation board, reinforced base coat and finish coat shall each separately have a flame spread of 25 or less, and smoke developed of 450 or less.
C. Structural Performance		
1 System Performance		
a. Impact Resistance	ASTM E 695	No cracking or denting with 30-lb. (14 kg) impact mass at 6 feet.
b. Wind Load	ASTM E 330	Withstand negative and positive wind loads required by applicable building code.
D. Components		
1. Water Resistant Glass Mat Gypsum Sheathing	ASTM C-1177	
2. Gypsum Sheathing	ASTM C-79	Mechanically applied systems only
3. Insulation Board	ASTM C-578	0.95 #/cf minimum density and maximum absorption of 2.5% by volume.
4. Portland Cement	ASTM C-150	
5. Sealants	ASTM C-920	Type M or S Grade NS
6. Sealants	ASTM C-719	Movement capability
7. Sealants	ASTM C-1193	Installation guide

The ASTM E-119 and E-108 tests are only required in construction required to have a fire resistance rating. Each EIFS system shall have a current compliance report issued by one of the model code organizations.

H-3 Design Limitations. The maximum allowable deflection of structural wall components must be specified and is limited to a maximum L/240 of span except where more restrictive requirements prevail such as a type PM system which requires L/360. The design wind load required by the code shall not exceed the wall systems allowable wind load as stated in the manufacturer's compliance report. Structural tests are required to determine allowable positive and negative wind pressures that may be imposed on the EIFS.

Expansion joints are required in the system where they exist in the substrate, where the system adjoins dissimilar construction, and at floor lines in multilevel wood frame construction. Supplementary control joints are required in wall areas. Wall areas defined by the placement of control joints shall not exceed 150-sq. ft. (13.9m2) when a type PM system is used.

H-4 Installation Requirements.

H-4.1 Substrate (Sheathing). Exterior type plywood, water-resistent glass mat gypsum sheathing, complying with ASTM C 1177, or equivalent material listed in the manufacturer's compliance report is acceptable for adhesively applied applications. Gypsum sheathing meeting the requirements of ASTM C 79 and OSB type sheathing shall be used only with mechanically applied systems with asphalt-saturated felt cover. Substrates (sheathing) such as concrete, masonry, or other non-moisture sensitive substrates are also acceptable for adhesively applied systems.

The substrate shall be free of planar irregularities greater than 1/4 inch in 8 feet and shall be sound and free of foreign substances. The substrate surface shall be determined by the applicator to be sound, free of release agents or other residues and in all other ways suitable for the application of the EIFS. A moisture meter shall be used to determine if the surface is dry (19% moisture or less). Any areas of moisture damage shall be replaced. The substrate surface shall be free of paints, coatings, sealers, algae, chalkiness, dirt, dust, oil, fungus, grease, mildew or other foreign substances.

H-4.2 Insulation Board. Insulation board shall be polystyrene board meeting ASTM C-578 and the manufacturer's current published specifications. The board shall have a minimum density of 0.95 pounds per cubic foot and a maximum absorption of 2.5 percent by volume when tested in accordance with the provisions of ASTM C-272. The thickness of the board

shall be in accordance with the EIFS compliance report but not less than 1" in thickness for adhesively applied systems and 1-1/2" in thickness for mechanically applied systems. The maximum size of the insulation board allowable shall be in accordance with the EIFS compliance report. Insulation boards shall be delivered in labeled plastic bags or other protective cover with the physical properties of the board identified on the package . Each board shall be clearly marked with the brand name. All boards shall be wire cut with edges square. Boards shall be stored flat in a dry area and shall be protected from direct sunlight during storage and after installation. The insulation board shall not be used in contact with chimneys or other surfaces which could heat the board to a temperature greater than 150° F.

Prior to applying the insulation boards to the substrate, a strip of reinforcing mesh shall be applied to the substrate. This mesh will eventually wrap around the end of the insulation a minimum of 2-1/2" on the face of the board. This procedure, known as "backwrapping" must be used wherever the insulation

When an adhesive is used to adhere the insulation board to the substrate, the adhesive shall be applied with a notched trowel approved by the EIFS manufacturer resulting in a minimum of 50% contact area between the adhesive and substrate. Apply notched trowel pattern in vertical direction.

Ribbon and dab adhesive applications consisting of a 2" wide band of adhesive 3/8" in thickness applied to the perimeter of the insulation board and 4" round dabs spaced at 8" on center resulting in a minimum of 33 percent contact area is allowed only when adhering to a non-moisture sensitive substrate or when permitted by the EIFS compliance report.

Installations may be a combination of mechanical fasteners and adhesive. Mechanical fasteners shall be of corrosion resistant materials and shall have the necessary pull out tensile and shear strength when installed to resist the design loads imposed on the system.

Mechanically fastened systems that are installed in areas with wind speed ratings in excess of 90 mph require applying the fastener through the initial layer of reinforced base coat, adding a 4" x 4" piece of reinforcing mesh over the fastener head, and applying an additional layer of base coat over the surface. In general, one fastener per 1.25 square feet is required for areas with basic wind speeds in excess of 90 mph or equivalent fastening system detailed in EIFS manufacturer's compliance report.

When applying the insulation boards, always start from a level base line. Excess adhesive shall be removed from the edges of the board. Boards shall be installed by sliding them into place and butted tightly together. Any gaps greater than 1/16" shall be filled with insulation and not adhesive. Pressure shall be applied to the entire surface of the board. The board should be checked occasionally to insure proper contact with the substrate. Proper contact is when a piece of board is removed and a similar amount of adhesive is adhered to both the substrate and the board. When using mechanical fasteners, the fastening pattern shall be according to the manufacturer's written instructions, but in no case shall the spacing be less than one fastener per 2 square feet. Mechanical fasteners must be specifically described by the EIFS manufacturer to include type, shank diameter, length, head diameter and corrosion resistant treatment. Expansion joints, weep screeds, corner reinforcement, trim, etc. must be specifically described by the EIFS manufacturer including any corrosion-resistance treatment.

The insulation boards shall be installed in a running board pattern, with staggered vertical joints and interlocking insulation boards on the inside and outside corners. Board joints shall be offset from sheathing joints and corners of openings. Insulation boards applied with adhesive shall be allowed to remain undisturbed for 24 hours prior to proceeding with the installation of the base coat. Cool or damp conditions may extend the drying time.

H-4.3 Base Coat and Reinforcing Mesh. Prior to applying the base coat, the insulation board must be rasped so that the entire surface is level and uniform. After preparation, the wall must be protected from sun and water damage. Rerasp if ultraviolet damage occurs between the initial insulation board preparation and the applications of the base coat.

The base coat shall be a cementitious mixture of the manufacturer's base or ground coat mixed with portlant cement, complying with ASTM C 150 in the proportions listed in the compliance report, or a non-cementitious base coat with or without fibers also listed in the manufacturer's compliance report or accepted by the manufacturer as an equal to the more common cementitious base coat.

The base coat shall be compatible with the insulation board and reinforcing mesh. The reinforcing mesh shall be alkali resistant and have a minimum tensile strength of 200 lbs. per linear inch in either direction and retain at least 40 percent of its original strength when tested for 90 days in a mixture of 25 percent cement and 75 percent water (by weight). The manufacturer's description shall include the type, weight, thread count, strength, weave and treatments for compatibility with coatings. The base coat shall be of a thickness required by the EIFS compliance report and shall be mixed in accordance with the manufacturer's written instructions.

After applying the base coat to the insulation board, immediately embed the mesh in the base coat by troweling from the center to the edges of the mesh to avoid wrinkles. Trowel off any excess base coat from the surface. The mesh shall be embedded so that no mesh color or pattern is visible. When embedding the mesh into the base coat,work vertically or

horizontally in 40 inch strips. Overlap the edges of the mesh a minimum of 2-1/2" or butt the edges together in accordance with the manufacturer's instructions. After the mesh is embedded, an additional coat shall be applied to achieve the uniform thickness specified by the manufacturer.

In high impact areas a layer of high impact mesh of 14 oz/yd^2 minimum shall be applied first with joints butted and no mesh color visible. After this layer has dried, a standard mesh described above shall be applied.

Additional protection at doors and windows shall be provided by applying butterflies or small strips of mesh diagonally at the sills and headers prior to application of field mesh. All inside and outside corners shall have two layers of mesh applied.

H-4.4 Finish Coat. The base coat must be allowed to dry a minimum of 24 hours prior to the application of the finish coat. Surface irregularities in the base coat such as trowel marks, board lines, etc. shall be corrected. A primer recommended and installed in accordance with the manufacturer's instructions shall be applied except in cases of fine textured (sand blast) sprayed applied applications. The finish coat shall be mixed and applied to a thickness in accordance with the manufacturer's written instructions. The application must be performed by sufficient workers to finish entire sections of a wall area at one time uninterrupted. The finish coat shall be applied using only stainless steel or plastic trowels. Applicators shall work in pairs with the first applying the finish and the second floating the finish to the desired texture. Finish coat shall not be applied in direct sunlight. Follow or precede the sun around a building.

H-4.5 Windows, Doors, Flashing, Closures, etc. Windows and doors shall be tested and labeled to indicate compliance with the requirements of the following specifications:

Aluminum, Polyvinyl Chloride	AAMA (ANSI) 101
Wood	ANSI/NWWDA I.S.-2

Windows and doors shall be self-flashing, including corners, unless otherwise specified and detailed by the EIFS manufacturers. The EIFS manufacturers installation instructions shall include illustrated details of the flashing and/or sealing around heads, sills and jambs of windows and doors of a type which may be used with the system and at the top of exposed walls.

Approved corrosion-resistive flashing shall be provided at the top and sides of all exterior window and door openings in such a manner to be leakproof. Pan flashing shall be installed at all exterior window sills and door thresholds such that the flashing diverts water to the outside face of the EIFS. Similar flashings shall be installed at EIFS intersections with parapets, facias, gutters, soffits, wood trim, porches, decks, stairs, guardrails, handrails, and plumbing and electrical penetrations.

Windows shall meet minimum water penetration requirements for grade of window indicated on the certification label when tested in accordance with the required test method.

A. ASTM E 547-86, Water Leakage, penetration of water into the plane of the innermost face of the test specimen under specified conditions of air pressure difference across the specimen. In tests of windows and doors, it also occurs whenever water penetrates through the frame of the test specimen during the specified test period. Windows shall be tested with brick moulding or other trim in place. Leakage behind any trim will be considered failure when considering installation with EIFS. If not tested with the trim, the EIFS manufacturer shall specify the specific window(s) by manufacturer and model number and include a flashing detail.

B. NWWDA I.S.2-93 requires water penetration tests in accordance with ASTM E 547-86. NWWDA I.S.2-93 further states that "Water penetration levels are expressed in pounds per square foot (psf) of static test pressure at which there is no water leakage through the window into the wall cavity or the room when tested according to ASTM E 547. Failute also occurs whenever water penetrates through the frame of the test specimen during the specified test period.

C. Water test pressure requirements are typically 2.86 pfs minimum or 10% of the structural test pressure.

Chimneys shall be provided with crickets when the chimney does not intersect the ridgeline. The EIFS system shall be terminated a minimum of 3" above the metal step flashing. The intersection of the cricket and the chimney shall be flashed and counterflashed in the same manner as normal roof-chimney intersections.

The EIFS manufacturer's compliance report and/or supplement to the compliance report, shall include illustrated details of the following:

1. Closures and flashing at terminations such as eaves, sills and other exterior wall coverings.
2. Typical conditions within the field of the wall covering, showing substrates, control joints, etc.
3. Parapet at top and termination on backside.
4. Flashing and/or sealing at all wall penetrations.
5. Other details deemed necessary to prohibit water intrusion into the wall cavity including details for sealing between the exterior trim and window frame.

H-4.6 Sealants (Caulk). Since EIFS are barrier wall systems, sealants and caulk play a vital role in maintaining an effective barrier against air and water infiltration into the wall. If water is allowed to enter behind the EIFS, it can do damage to the substrate and framing. Whenever the EIFS or the insulation board meets another material such as door, frame, window

frame, roof, pipes, wires, meter boxes, faucets, etc. the area shall be protected from moisture intrusion with a product or method specified by the manufacturer.

A properly installed sealant provides a leak proof joint between two materials. A three point bond is not allowed. When a sealant bonds to a third surface, such as the substrate at the joint between a window frame and the insulation board, the sealant will fail. To prevent third surface bonding, a backup material shall be pushed into the joint. Backup material shall be approved by the sealant manufacturer and shall be either a closed cell polyethylene rod, extruded polyolefin foam made of a non-absorbing outer skin or a bond-breaker tape.

Sealants shall comply with ASTM C 920, type M or S, Grade NS and the particular sealant manufacturer must be acceptable to the EIFS manufacturer. The movement capability shall be 50 percent + when tested under the provisions of ASTM C 719. Sealants shall be installed in accordance with ASTM C 1193 Standard Guide for Use of Joint Sealants.

All joints shall be made so that the sealant material may be removed and replaced. The minimum sealant joint width shall be 1/2 inch or 4 times the anticipated movement, whichever is greater. Minimum expansion of sealant joint width shall be 3/4" or 4 times the anticipated movement, whichever is greater. The minimum joint depth and width shall be in accordance with the sealant manufacturer's recommendations and the provisions of ASTM C-1193. At all areas requiring sealant joints, the insulation board shall be held back to allow for the reinforced base coat and any required coatings to form a sealant joint of the required dimension. Fillet joints shall not be used unless required by a particular window trim being used. In case of fillet joints, a bond breaker tape or triangular backer material shall be used to prevent three-sided bonding. All insulation board edges shall be back wrapped or protected in accordance with the EIFS manufacturer. This includes all penetrations such as holes for piping and wiring. Sealant shall not come into direct contact with the insulation board or reinforcing mesh. Joints to be sealed shall be clean, dry and free of dust or other foreign materials and primed. The sealant must be applied to the base coat and not to the finish coat. Sealants may be applied to prepared, primed base coat when the moisture level reaches 70 percent of the original moisture level or a minimum of 72 hours or as specified by the sealant manufacturer whichever is longer. Open joints shall be protected from water intrusion by installing a backer-rod or temporary covering. Tops of walls must be immediately covered with the final trim or temporarily protected to prevent water intrusion.

Apply sealant with a gun having a proper size nozzle using sufficient pressure to fill all voids and joints solid to the backup material. The surface of the sealant shall be a full smooth head, free of ridges, wrinkles, sags, air pockets and embedded impurities. After all joints have been completely filled, they shall be neatly tooled to force sealant into complete contact with joint surfaces, to eliminate air pockets or voids and provide a smooth neat appearance. Protect adjacent surfaces from excess sealant material. Use masking tape where required to prevent contact of sealant with EIFS surfaces.

The sealant contractor shall be knowledgeable in the proper installation of sealants on buildings that utilize EIFS type cladding. The sealant contractor shall have demonstrated the ability to install the sealant on projects of similar size and complexity and shall provide a list of completed projects. The sealant contractor shall provide the proper equipment, manpower and supervision to install the sealant properly. An installation card shall be completed by the sealant contractor at the completion of each project and shall be provided to the certified contractor. The card states that the sealant installation complies with the EIFS Evaluation Report, the Sealant Manufacturer's Installation Methods and Procedures and ASTM C-1193, Standard Guide for Use of Sealants.

H-4.7 Special Installation Requirements. The ambient temperature shall be 40° F or greater and rising at the time of application, but not greater than 100° F and shall remain in this range for a minimum of 24 hours. Other temperatures may exist when covered by the compliance report. No additives or materials of any kind, such as binder, antifreeze agents, accelerators, fillers, etc. except specified amounts of clean water, shall be allowed unless specifically approved in writing by the manufacturer. EIFS materials shall be delivered at the job site in their original sealed containers bearing the manufacturer's name and identification of the product. All materials shall be purchased from a single source or a source approved by the EIFS manufacturer. Use of materials and systems without compliance reports or mixing of one manufacturer's product with one or more other manufacturer's system is prohibited. All products in pails shall be stored away from direct sunlight, shall be protected from freezing and temperatures in excess of 90° F. Products in bags shall be stored off the ground under a cover.

H-5 Applicator. The installation of EIFS shall be performed only by an applicator who has been trained by the EIFS material manufacturer or who has been trained and certified by an organization accepted by the manufacturer and carries a current certificate of qualification by the manufacturer and identification card issued by the manufacturer. The card shall be renewed every four (4) years. During application at least one certified applicator with proper identification card shall be on the job site at all times. Through the issuance of a certificate and identification card, the manufacturer is certifying that the applicator either through product seminars or by field training is familiar and confident with the materials they will install, is familiar with the conditions of the compliance report, and the manufacturer's installation instructions, and with the provisions of this code. The contractor when securing a permit shall provide a copy of the manufacturer's installation instructions and compliance report to the inspector. When requested by the building inspector or owner, the applicator shall provide a list of projects he has completed. The contractor shall provide to the building official at the end of each project an EIFS installation card along with the sealant installation card completed by the sealant contractor.

H-6 Warranty. The manufacturer shall warrant their EIFS including any caulks and sealants for twenty (20) years against faulty performance. The warranty shall include correction of delamination, chipping, denting, peeling, blistering, flaking, bulging, unsightly discoloration, or other serious deterioration of the system such as the intrusion of water through the wall or failure of the systems surface materials. Should any of these defects occur, the manufacturer shall make a prorata allowance for replacement or pay the owner the amount of the allowance. The manufacturer shall not be liable for damages or defects resulting from misuse, natural catastrophes or other causes beyond the control of the manufacturer.

The contractor shall provide a statement or EIFS and Sealant Certification Form to the owner that the product has been installed in compliance with this code, manufacturer's installation instructions and the compliance report.

H-7 Maintenance. The manufacturer shall provide maintenance recommendations necessary for compliance with the warranty. Recommendations for periodic inspections necessary to maintain the durability and integrity of the EIFS shall also be provided.

EIFS CERTIFICATION

Date Completed _____

Project Location _____
_____
_____
_____

EIFS Manufacturer's Name _____

Compliance Report
Materials
Substrate Type _____
Adhesive and/or Fasteners _____
Reinforcing Fabric _____
Base Coat _____
Finish _____

This is to certify that the EIFS materials noted above were installed on this project in accordance with the EIFS Manufacturer's Installation Requirements, Compliance Report and North Carolina State Building Code.

Name and Address of Contractor _____

Signature of Responsible Officer _____
Typed Name of Officer _____
Title _____
Telephone Number _____
Must be submitted with Sealant Certification to building official.

Sealant Certification

Date Completed _____

Project Location _____

Materials
Primer(s) _____
Bond Breakers _____
Sealant Materials _____

This is to certify that sealant materials noted were installed on this project in accordance with ASTM C-920, ASTM-C-1193, the sealant manufacturer's installation instructions, the EIFS manufacturer's installation methods and procedures and the manufacturer's evaluation report.

Name of Sealant Contractor
Address _____
_____
_____
Signature of Responsible Officer _____
Typed Name of Officer _____
Title _____
Telephone Number _____

Must be submitted to EIFS contractor.

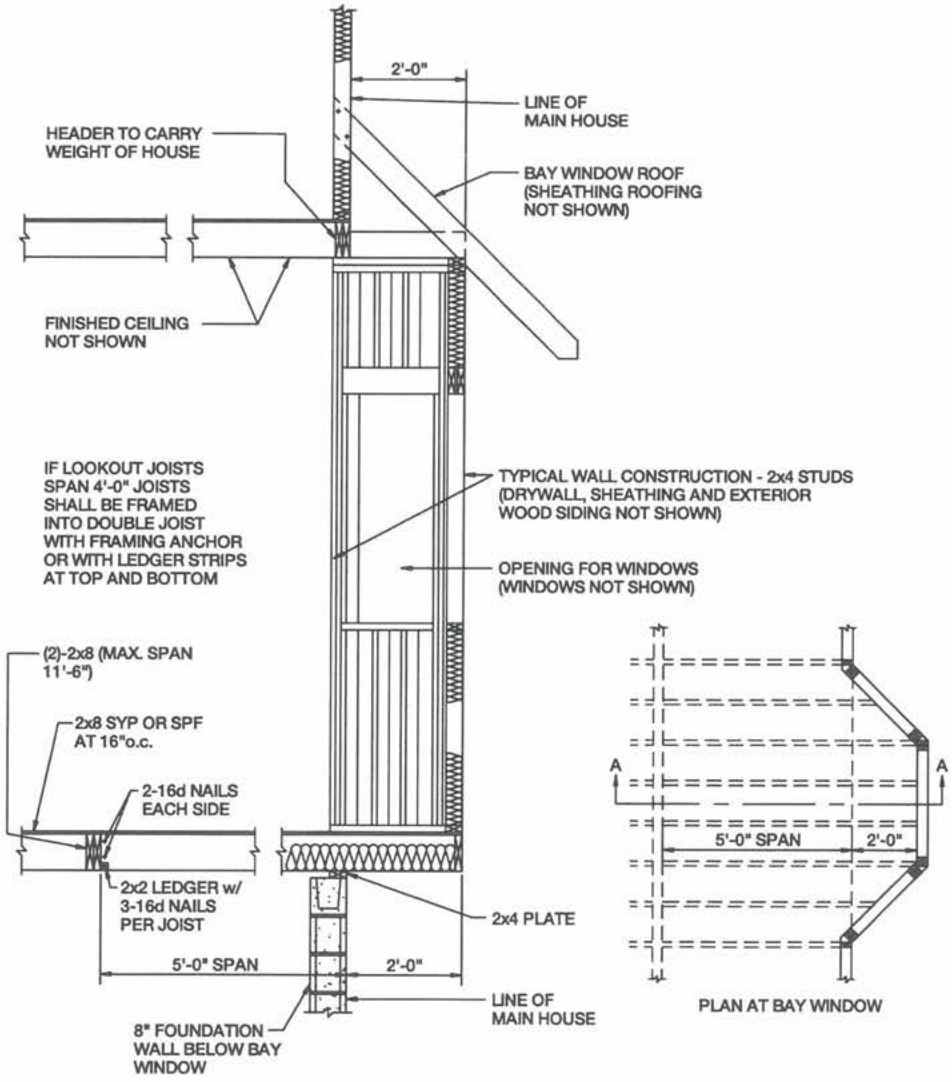
APPENDIX G
CANTILEVER FLOOR SECTIONS

G-1 SECOND FLOOR SECTIONS:

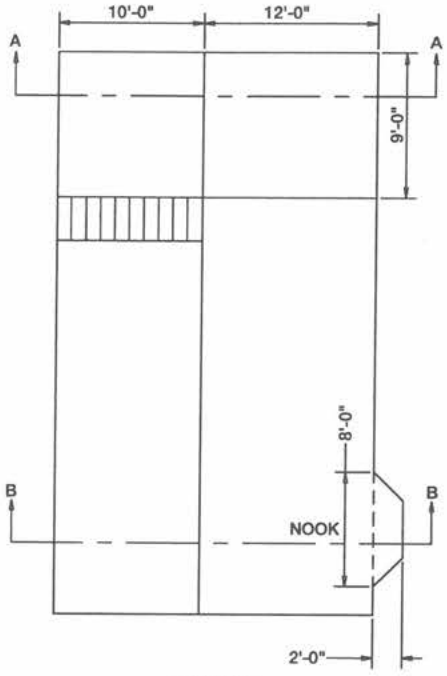
Where second story is framed out over the wall below and the second floor joists run parallel to the supporting wall, the supporting members of the overhang shall carry back at least 30 inches and frame into doubled floor joists. The maximum projection of the overhanging shall be 15 inches. Where framing is at right angle to the supporting wall, the joists shall extend continuous in one piece to form the overhang.

NOTE: This construction shall also apply to all projections carrying floor and roof loads which are not supported directly by a foundation unless adequate structural calculations are furnished to support such design.

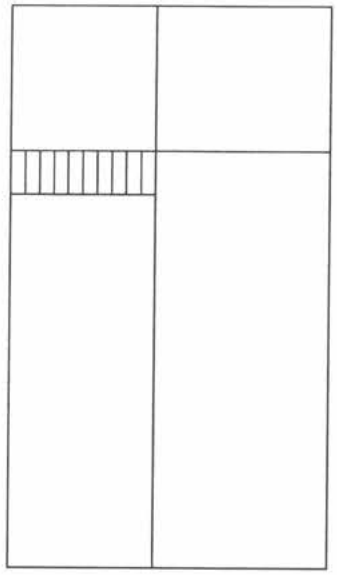
G-2 BAY WINDOWS:



APPENDIX H
BASIC LOAD ESTIMATING

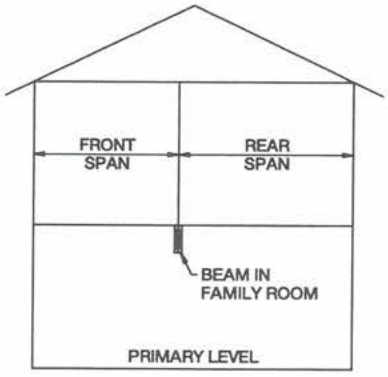


1st FLOOR

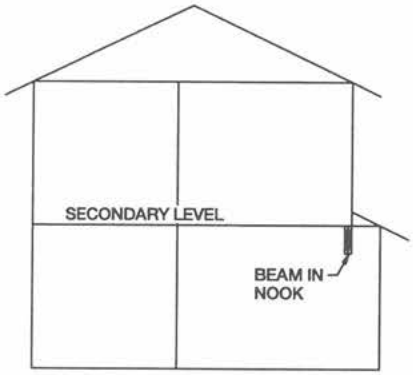


2nd FLOOR

PLAN VIEW



SECTION A-A



SECTION B-B

ASSUMPTIONS:

Loads from Appendix A

Secondary floor level is 30# L.L. + 10# D.L. = 40#/sq ft
Attic level is 20# live load + 10# dead load = 30#/sq ft
Nook ceiling is 10# dead load = 10#/sq ft

Wall load from Appendix A

Studs @ 16", 1/2" gypsum = 8#/sq ft

Roof load from Appendix A

20# live load + 10# dead load = 30#/sq ft

EXAMPLE OF LOAD ESTIMATING LOAD ON BEAM IN FAMILY ROOM

Loads in Section A - A as follows: TOTAL LOADS

2nd floor load = $\frac{\text{front span}}{2}$ + $\frac{\text{rear span}}{2}$ x 2nd floor (dead load + load) = LOAD/linear foot

= $\frac{10}{2}$ + $\frac{12}{2}$ x 40 = 11 x 40 = 440#/1ft 2nd floor = 440#/1ft

Interior wall load = 8#/sq ft x 8 ft. (Ceiling height) = 64#/1ft Interior wall = 64#/1ft

Attic load = $\frac{\text{front span}}{2}$ + $\frac{\text{rear span}}{2}$ x attic (dead load + live load) =

= $\frac{10}{2}$ + $\frac{12}{2}$ x 30 = 11 x 30 = 330#/linear ft Attic = 330#/1ft

Roof load: No roof load is transmitted to the beam in the family room. Roof = 0

TOTAL LOAD ON BEAM IN FAMILY ROOM = 834#/1ft

BEAM SPAN IN FAMILY ROOM IS 9 FEET AND TOTAL ESTIMATED LOAD IS 834#/LINEAR FOOT:

BY USING TABLE NO. H-1, THE REQUIRED BEAM is 4 @ 2" x 12" Southern Pine

OR

BY USING TABLE NO. H-2, THE REQUIRED MINIMUM FLITCH BEAM IS
2 @ 2" X 8" WITH 1/2" X 7" STEEL PLATE BOLTED WITH 1/2" BOLTS SPACED AT 2' ON CENTER.

EXAMPLE OF LOAD ESTIMATING ON BEAM IN NOOK AREA

Loads in Section B - B as follows TOTAL LOADS

2nd floor load = $\frac{\text{joist span}}{2}$ x 2nd floor (dead load + live load) = $\frac{12}{2}$ x 40 = 240#/1ft

Wall load = 64#/1ft Wall load = 64#/1ft

Attic floor load = $\frac{\text{joist span}}{2}$ x Attic (dead load + live load) = $\frac{12}{2}$ x 30 = 180#/1ft

Roof load = [rafter span + overhang] x Roof (live load + dead load) =

= [12 + 1] x 30 = 390#/1ft (nook span) Roof load = 390#/1ft (nook span)

Nook roof load = $\frac{\text{nook span}}{2}$ x roof load (live + dead) + $\frac{\text{nook span}}{2}$ x ceiling dead load =

= $\frac{2}{2}$ x 30 + $\frac{2}{2}$ x 10 = 40#/1ft Nook = 40#/1ft

TOTAL LOAD ON BEAM IN NOOK = 914#/1ft

BEAM SPAN IN NOOK IS 8 FEET AND TOTAL ESTIMATED LOAD IS
914#/LINEAR FOOT:

BY USING TABLE NO. H-1, THE REQUIRED BEAM IS 4 @ 2" X 12" Southern Pine, or

4 @ 2" x 12" Spruce-Pine-Fir

OR

BY USING TABLE NO. H-2, THE REQUIRED MINIMUM FLITCH IS 2 @ 2" x 8" WITH 3/8" X 7" STEEL PLATE BOLTED WITH 1/2" BOLTS SPACED AT 2' ON CENTER.

TABLE No. H-1

WOOD BEAMS AND GIRDERS (19%) #2 GRADE, ALLOWABLE LOADS IN POUNDS PER LINEAR FOOT SIMPLE SPAN, DEFLECTION = L/360, LOAD DURATION FACTOR 1.0, ADEQUATE BEARING AND LATERAL SUPPORT MUST BE PROVIDED

2 X 8 (1-1/2 X 7-1/4) SPECIES	SPRUCE-PINE-FIR[1]			SOUTHERN PINE		
SPAN[2]	NUMBER OF MEMBERS			NUMBER OF MEMBERS		
(feet)	2	3	4	2	3	4
3	1133	1700	2266	1457	2186	2914
4	727	1091	1454	935	1403	1870
5	535	803	1070	688	1032	1376
6	424	636	848	538	807	1076
7	350	525	700	400	600	800
8	270	405	540	309	464	618
9	215	323	430	246	369	492
10	175	263	350	200	300	400
12	107	161	214	123	185	246
14	68	102	136	78	117	156

2 x 10 (1-1/2 x 9-1/4) SPECIES	SPRUCE-PINE-FIR[1]			SOUTHERN PINE		
SPAN[2]	NUMBER OF MEMBERS			NUMBER OF MEMBERS		
(feet)	2	3	4	2	3	4
3	1776	2664	3552	2283	3425	4566
4	1054	1581	2108	1355	2033	2710
5	749	1124	1498	963	1445	1926
6	581	872	1162	747	1121	1494
7	475	713	950	570	855	1140
8	401	602	802	440	660	880
9	321	482	642	350	525	700
10	261	392	522	285	428	570
12	183	275	366	200	300	400
14	135	203	270	147	221	294

2 x 12 (1-1/2 x 11-1/4) SPECIES	SPRUCE-PINE-FIR[1]			SOUTHERN PINE		
SPAN[2]	NUMBER OF MEMBERS			NUMBER OF MEMBERS		
(feet)	2	3	4	2	3	4
3	2800	4200	5600	3600	5400	7200
4	1482	2223	2964	1906	2859	3812
5	1008	1512	2016	1296	1944	2592
6	764	1146	1528	982	1473	1964
7	615	923	1230	783	1175	1566
8	514	771	1028	604	906	1208
9	431	647	862	481	722	962
10	351	527	702	392	588	784
12	246	369	492	274	411	548
14	182	273	364	203	305	406

1. SPRUCE-PINE-FIR NOT SPRUCE-PINE-FIR (SOUTHERN) IS USED IN THIS TABLE
2. SPAN IS CLEAR SPAN – EFFECTIVE SPAN FOR BENDING AND DEFLECTION IS CLEAR SPAN PLUS 3"

TABLE No. H-2
FLITCH PLATE BEAMS-DESIGN VALUES & ASSUMPTIONS

Steel- Fb = 24000(psi) E = 29000000(psi)
Wood- Fb = 1200(psi) E = 1600000(psi)
Deflection- 1/360 of Span
(Top of Beam Laterally Supported)

2 - 2 x 6 — ALLOWABLE LOAD (Pounds/Ft)

1 PLATE Bm Wgt(lbs/ft)		8	10	13	15	17	21
Span (ft)	Plate	1/4 x 5	3/8 x 5	1/2 x 5	5/8 x 5	3/4 x 5	1 x 5
6.00		756	965	1175	1385	1595	2014
7.00		555	709	863	1018	1172	1480
8.00		411 *	520 *	638 *	739 *	848 *	1067*
9.00		289 *	365 *	442 *	519 *	596 *	749 *
10.00		210 *	266 *	322 *	378 *	434 *	546 *
11.00		158 *	200 *	242 *	284 *	326 *	410 *
12.00		122 *	154 *	187 *	219 *	251 *	316 *

* Denotes Load Controlled by Deflection

2 - 2 x 8 — ALLOWABLE LOAD (Pounds/Ft)

1 PLATE Bm Wgt(lbs/ft)		11	14	17	20	23	29
Span (ft)	Plate	1/4 x 7	3/8 x 7	1/2 x 7	5/8 x 7	3/4 x 7	1 x 7
6.00		1406	1818	2229	2640	3051	3873
7.00		1033	1335	1637	1939	2242	2846
8.00		791	1022	1254	1485	1716	2179
9.00		625	808	991	1173	1356	1722
10.00		506	654	802	950	1098	1394
11.00		400 *	516 *	631 *	746 *	862 *	1092 *
12.00		308 *	397 *	486 *	575 *	664 *	841 *
13.00		243 *	312 *	382 *	452 *	522 *	662 *
14.00		194 *	250 *	306 *	362 *	418 *	530 *
15.00		158 *	203 *	249 *	294 *	340 *	431 *
16.00		130 *	168 *	205 *	243 *	280 *	355 *

* Denotes Load Controlled by Deflection

2 - 2 x 10 — ALLOWABLE LOAD (Pounds/Ft)

1 PLATE Bm Wgt(lbs/ft)		14	18	22	26	30	37
Span (ft)	Plate	1/4 x 9	3/8 x 9	1/2 x 9	5/8 x 9	3/4 x 9	1 x 9
6.00		2310	2990	3669	4349	5029	6388
7.00		1697	2197	2696	3195	3695	4693
8.00		1299	1682	2064	2446	2829	3593
9.00		1027	1329	1631	1933	2235	2839
10.00		832	1076	1321	1566	1810	2300
11.00		687	890	1092	1294	1496	1901
12.00		576	747	917	1087	1257	1597
13.00		492	637	782	926	1071	1361
14.00		409 *	528 *	647 *	765 *	884 *	1122 *
15.00		332 *	429 *	526 *	622 *	719 *	912 *
16.00		274 *	353 *	433 *	513 *	592 *	752 *
17.00		228 *	295 *	361 *	427 *	494 *	627 *
18.00		192 *	248 *	304 *	360 *	416 *	528 *
19.00		164 *	211 *	259 *	306 *	354 *	449 *
20.00		140 *	181 *	222 *	263 *	303 *	385 *

* Denotes Load Controlled by Deflection

2 - 2 x 12 — ALLOWABLE LOAD (Pounds/Ft)

1 PLATE Bm Wgt(lbs/ft)		18	22	27	32	36	46
Span (ft)	Plate	1/4 x 11	3/8 x 11	1/2 x 11	5/8 x 11	3/4 x 11	1 x 11
6.00		3437	4452	5468	6483	7498	9529
7.00		2525	3271	4017	4763	5509	7001
8.00		1933	2504	3076	3647	4218	5360
9.00		1528	1979	2430	2881	3333	4235
10.00		1237	1603	1968	2334	2699	3430
11.00		1023	1325	1627	1929	2231	2835
12.00		859	1113	1367	1621	1875	2382
13.00		732	948	1165	1381	1597	2030
14.00		631	818	1004	1191	1377	1750
15.00		550	712	875	1037	1200	1525
16.00		483	626	769	912	1054	1340
17.00		414 *	535 *	657 *	778 *	899	1142 *
18.00		349 *	451 *	553 *	655 *	757	962 *
19.00		297 *	384 *	470 *	557 *	644	818 *
20.00		254 *	329 *	403 *	478 *	552	701 *
21.00		220 *	284 *	348 *	413 *	477	606 *
22.00		191 *	247 *	303 *	359 *	415	527 *
23.00		167 *	216 *	265 *	314 *	363 *	461 *
24.00		147 *	190 *	233 *	276 *	320	406 *

* Denotes Load Controlled by Deflection.

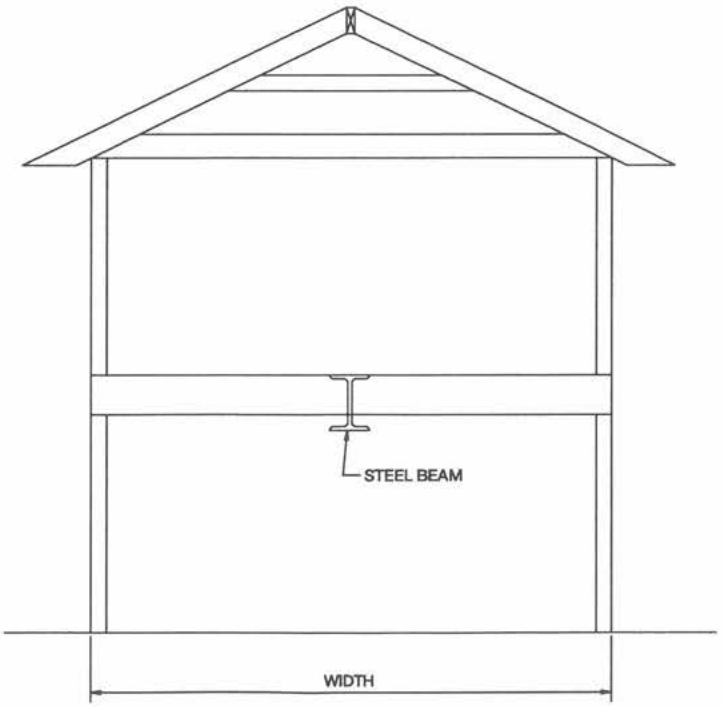
APPENDIX I

TABLE I-1
STEEL W BEAM SPAN CHART
WEIGHT OF BEAM X HEIGHT (AISC A36)
STEEL BEAM LOCATED IN MIDDLE HALF OF GARAGE

WIDTH (FEET) BEAM SPAN (FEET)	22	N	24	N	26	N	28	N	30	N
	W8 X 31		W8 X 35		W8 X 35		W8 X 40		W8 X 40	
22	W10 X 22	4	W10 X 22	4	W10 X 22	4	W10 X 26	4	W10 X 26	4
	W12 X 19		W12 X 19		W12 X 19		W12 X 19		W12 X 22	
	W8 X 40		W8 X 48		W8 X 48		W8 X 48		W8 X 48	
24	W10 X 26	4	W10 X 30	4	W10 X 30	4	W10 X 30	5	W10 X 39	5
	W12 X 22		W12 X 22		W12 X 22		W12 X 26		W12 X 26	
	W14 X 22		W14 X 22		W14 X 26		W14 X 26		W14 X 26	
26	W10 X 39	4	W10 X 39	4	W10 X 39	5	W10 X 39	5	W10 X 45	5
	W12 X 26		W12 X 26		W12 X 26		W12 X 26		W12 X 30	
	W14 X 26		W14 X 26		W14 X 26		W14 X 30		W14 X 30	
28	W10 X 45	4	W10 X 45	4	W10 X 45	5	W10 X 49	5	W10 X 54	5
	W12 X 30		W12 X 30		W12 X 30		W12 X 35		W12 X 35	

NOTES:

1. Beam must be anchored at each end with a minimum of 4 - 16d nails and latterally supported.
2. N = Number of 2 x 4 studs (# 2 SPF) required in stud column at each end of beam span.
3. Stud column shall be nailed with 2 - 12d nails @ 12" o.c. for each stud.
4. Stud column shall not exceed 11' 0" in height.
5. Floor system shall be tied together using minimum of 7/16" structural sheathing.
6. Beam designed for 40 psf live load.
7. Wood columns designed for 30 psf live load.



APPENDIX J
PRESCRIPTIVE COMPLIANCE WORKSHEET

This worksheet(s) shall be provided on all one and two family dwellings and/or room additions. Trade-off calculations for any component shall be attached with this sheet showing a BTU-for-BTU evaluation. Trade off calculations may be performed by satisfying the requirements of the 1995 MEC Check Version 2.0-1995 except that high efficiency equipment may not be traded off against envelope components. A worksheet shall be provided for each different assembly. The entries in this Appendix do not include all products. Alternate materials (other) can be qualified in accordance with Section 108.

PRESCRIPTIVE COMPLIANCE FOR CEILING

COMPONENT	PRODUCTS	R-VALUE BETWEEN FRAMING	TO BE USED
Inside Air Film	(to be included for all situations)	0.61	not counted
Interior Finish	1/2" Drywall	0.45	
	5/8" Drywall	0.56	not counted
	(Other)		
Mineral Fiber or	R-19 Batts	19.00	
loose fill or	R-22 Batts	22.00	
cellulose	R-30 Batts	30.00	
	R-38 Batts	38.00	
	(Other)		
Insulation	1" Expanded Polystyrene Foam	3.80	
Sheathing on	1" Extruded Polystyrene Foam	5.00	
Inside of Rafter	1" Polyurethane	7.20	
	1" Polyisocyanurate	7.20	
	(Other)		
Outside Air Film	(to be included for all situations)	0.17	not counted
R-Value Between Framing of Ceiling	Zones 6,7,8,&9	must be R30 or more: _____	
	Zones 11	must be R38 or more: _____	

Trade-off calculations (Section 3901.7) must be attached for cathedral ceilings of less than R-30 for Zones 6,7,8,& 9 or R-38 for Zone 11. Use of skylights will require trade off calculations.

PRESCRIPTIVE COMPLIANCE FOR FLOOR

COMPONENT	PRODUCTS	R-VALUE BETWEEN FRAMING	TO BE USED
Inside Air Film	(to be included for all situations)	0.61	not counted
Mineral Fiber	R-19 batts	19.00	
flooring	(sub-floor + finished floor value)		not counted
Outside Air Film	(to be included for all situations)	0.17	not counted
R-Value Between Framing of Floor	Zones 6,7,8,9, and 11, must be 19 or more: _____		

SLAB-ON-GRADE must have R-5 perimeter insulation extending a total linear distance of at least 24". Slab insulation must extend 1) down from the top of the slab, or 2) down from the top of the slab to the bottom of the slab and then horizontally underneath the slab, or 3) down from the top of the slab and then horizontally away from the slab, with pavement or at least 10 inches of soil covering the horizontal insulation.

A heated slab requires a minimum R-7 perimeter insulation.

PRESCRIPTIVE COMPLIANCE FOR OPAQUE WALL

COMPONENT	PRODUCTS	R-VALUE BETWEEN FRAMING	TO BE USED
Inside Air Film	(to be included for all situations)	0.68	not counted
Interior Finish	1/2" Drywall	0.45	
	5/8" Drywall	0.56	not counted
	Interior Paneling	0.25	
	(other)		
Mineral Fiber w/ Vapor Retarder	R-11 Batts	11.00	
	R-13 Batts	13.00	
	R-15 Batts	15.00	
	R-19 Batts (compressed to 5 1/2")	18.00	
	R-21 Batts	21.00	
Loose Fill	Cellulose fiber insulation (3.5 pcf x 3 1/2")	12.00	
	(other)		
Sheathing*	1/2" Reg. Density fiber insulation board	1.32	
	1/2" Inter. Density fiber insulation board	1.22	
	25/32" Reg. Density fiber insulation board	2.06	
	3/8" Plywood/OSB	0.47	
	1/2" Plywood/OSB	0.62	
	5/8" Plywood/OSB	0.77	
	3/4" Plywood/OSB	0.93	
	1/2" Expanded Polystryene Foam	1.90	
	3/4" Expanded Polystyrene Foam	2.85	
	1" Expanded Polystyrene Foam	3.80	
	1/2" Extruded Polystyrene Foam	2.50	
	3/4" Extruded Polystyrene	3.75	
	1" Extruded Polystryene Foam	5.00	
	3/4" Polyurethane with impermeable facing	5.40	
	1" Urethane	7.20	
	3/4" Urethane	5.40	
	(other)		
Exterior Finish	1/2" Hardboard	0.67	
	3/8" Plywood	0.47	
	Alum., Vinyl, or Steel siding (hollow-backed)	0.62	not counted
	1/2" Beveled, 8" lapped siding	0.81	
	3/4" Beveled, 10" lapped siding	1.05	
	4" Face Brick Veneer + air space	1.38	
	(other)		
Outside Air Film	(to be included for all situations)	0.17	not counted

Value Between Framing of Opaque Wall Zones 6,7,8, or 9 must be 14 or more: _____
Zones 11 must be 16 or more: _____
or complies with Section 3902 Exception 1 2 3

*Sheathing is not counted if it is the exterior finish.

In determining wall insulation compliance with Table 3905, wood structural sheathing may be substituted for fiberboard sheathing or other insulated sheathing of R1.3 or greater at corners of walls and every 25 feet of wall length as required for structural wall bracing per Table 602.9 without requiring a trade off calculation for:

(1) Zones 6,7,8, and 9 when using an R13 insulation batt in the wall cavity, or
(2) Zone 11 when using an R15 insulation batt in the wall cavity.

PRESCRIPTIVE COMPLIANCE FOR UNGLAZED DOOR, GLASS, DOOR, & WINDOW UNITS

1. $A_{gross\ wall}$: Gross Area of Exterior Wall Enclosing Conditioned Space (includes the nominal area of all doors and windows in these walls):_____ft²

Note: The wall between an unconditioned garage and a conditioned space is counted because it is part of the building's thermal envelope. The exterior wall separating the unconditioned garage from the outdoors would not be counted.

2. Total area of windows and doors separating conditioned space from unconditioned space or the outdoors.:

a. Nominal area of unglazed doors	_____ft²
b. Nominal area of doors with glazing	_____ft²
c. Nominal area of windows	ft²
Total nominal area of windows and doors	_____ft²

3. Percent (%) window and door openings =

$$\frac{\text{Total Nominal Area of Windows and Doors (See 2)}}{A_{gross\ wall}\ \text{(See 1)}} \times 100 = \qquad \times 100 = \_\_\_\_\_\%$$

4. Identify your Thermal Zone. Zone _____
(Refer to Figure 3901.)

5. Identify your window unit types and U values.
Enter a check mark in the column for your types.

CHECK IF APPLICABLE	WINDOW TYPE	DEFAULT U VALUE OR ENTER ACTUAL U VALUE
	Double glazed metal frame with thermal break	0.67 or _____
	Double glazed wood vinyl	0.56 or _____
	Double glazed wood vinyl with low emissivity coating	0.52 or _____
	Triple glazed wood vinyl with low emissivity coating and inert gas fill in spaces	0.35 or _____
	Other	_____

Single glazing in windows and doors can not exceed 1 percent of the gross wall area.

1 % of gross exterior wall area = $\frac{A_{gross\ wall}\ \text{(See 1)}}{100} = \qquad \frac{\text{Ft}^2}{100} = \_\_\_\_\_\ \text{Ft}^2$

Actual area of single glazing= _____Ft²
If single glazing area exceeds 1% of gross exterior wall area, trade off calculations are required.

6. Identify the largest U value from Window Unit Types (See 5) and its corresponding column in the Table below. Identify your Thermal Zone (See 4) for entering correct line of Table. The intersection of your Thermal Zone line with your window U value column entry identifies percent (%) window and door opening allowed compared to gross wall area.

Enter % from table:_____

	%WINDOW & DOOR OPENINGS ALLOWED			
ZONE	METAL/THERMAL BREAK U=0.67	WOOD VINYL U=0.56	WOOD WITH LOW U=0.52	WOOD VINYL LOW-E -INERT GAS HIGH PERFORMANCE U=0.35
6	17	21	23	33
7	15	18	20	28
8	14	16	18	25
9	13	15	16	23
11	9	13	14	17

Enter % of actual area of windows and doors from 3: ____

If % from Table is less than % from 3, then trade-off calculations are required. Recommend use of MEC check 1995 version 2.0. If % from Table is equal to or greater than % from 3, then the prescriptive requirement is met for window and door openings.

APPENDIX K
RECOMMENDED CONSTRUCTION PRACTICE FOR SLAB ON GRADE

Concrete slabs should be constructed with control joints having a depth of at least one-fourth the slab thickness. Control joints should be created as soon as possible after concrete placement. If control joints are saw cut they should be sawed as soon as the concrete is hard enough not to be torn or damaged by the blade but before random cracks can form in the concrete slab. Slabs should be strengthened at offsets, penetrations, and discontinuities, or isolation joints shall be provided at these points. Strengthening should be done by doubling the slab thickness, adding reinforcing steel, or other methods agreed to by the inspector. Joints should be spaced in accordance with the following:

(Plain Concrete)

Plain concrete slabs in conditioned space shall have joints as shown in Table No. K-l.

Plain concrete slabs in unconditioned space shall have joints at 10 ft. centers in each direction.

(Concrete Slabs Reinforced with Welded Wire Fabric or Reinforcing Steel.)

Minimum slab thickness shall be 4 inches: reinforcing and joints shall be as shown in Table No. K-l. Joints in unconditioned spaces, such as garages and patios, shall be spaced at 2/3 's of the spacing shown in Table No. K-l. 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. Reinforcing shall be cut at each control joint.

(Concrete Slabs Using Shrinkage Compensating Concrete or Admixtures.)

Joint spacing shall be based on design using engineering principles. Load tickets shall identify the products and the amount used. Copies of the design with specific requirements concerning placement and materials as well as the professional's seal shall be submitted to the inspector and posted with the building permit at the job site (for floor inspections.

(Concrete Slabs Using Steel or Synthetic Fibers.)

Joint spacing shall be as shown in Table No. K-l for plain concrete unless welded wire fabric is used in addition to the fibers. If welded wire mesh is used joint spacing may be as shown in Table No. K-l for the appropriate size wire mesh and slab thickness.

Table No. K-1
CONTROL JOINT SPACING FOR SLABS[1] ON GRADE IN CONDITIONED SPACES

MAXIMUM DIMENSION OF SLAB OR DISTANCE BETWEEN CONTROL JOINTS (Feet)						WWF WIRE SPACING (INCHES)	WWF WIRE SIZE DESIGNATION
SLAB THICKNESS (Inches)							
3.5	4.0	4.5	5.0	5.5	6.0		
10	15	15	15	15	15		Plain Concrete
NA[2]	26	23	21	19	17	6 X 6	Wl.4 X Wl.4
NA[2]	37	33	29	27	24	6 X 6	W2.0 X W2.0
NA[2]	53	47	43	39	35	6 X 6	W2.9 X W2.9

1. Joint spacing using WWF (Welded Wire Fabric) is based on a yield strength of 65,000 psi. These may be adjusted by multiplying by the ratio of provided yield strength to 65,000 psi .

2. NA under 3.5 inch thick slab indicates that reinforcing steel should not be used in this slab thickness.

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Y