North Carolina State Building Code

Volume VII – RESIDENTIAL

1993 EDITION

1996 Revisions

TO THE

1992 CABO One and Two Family Dwelling Code with North Carolina Amendments

(Revisions Adopted Through
June 13, 1995
Effective January 1, 1996)

North Carolina Building Code Council
and
North Carolina Department of Insurance
Post Office Box 26387
Raleigh, North Carolina 27611

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September 14, 1993
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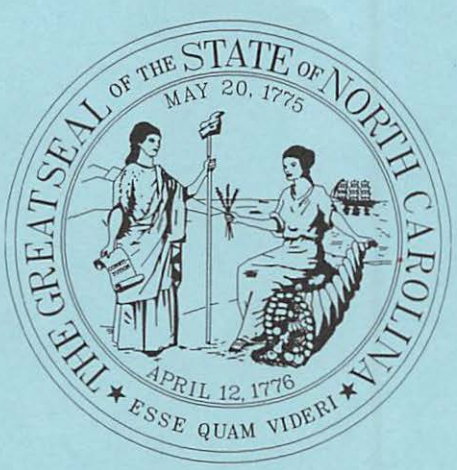

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Supplement

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TO THE

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1992 EDITION

SECOND PRINTING

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4051West Flossmoor Road
Country Club Hills, Illinois 60478-5795

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

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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
ADMINISTRATIVE

SECTION R-101—TITLE

These provisions shall be known as the North Carolina State Building Code, Volume VII - Residential, may be cited as such, and will be referred to herein as "this code."

SECTION R-102 — PURPOSE

The purpose of this Code is to provide for the public safety, health and general welfare by providing for the administration and enforcement of this Code, as adopted by the Building Code Council and enforced by State and local code enforcement officials (CEOs). [G.S. 143-138(c)]

In this Code, the building, plumbing, mechanical, electrical, and gas systems shall be referred to as "service systems." Where the word building is used in this Code, the provisions shall also be applicable to the word "structure."

SECTION R-103 — SCOPE

The provisions of this Code shall apply to the construction, alteration, repair, equipment, location, maintenance, movement to another site, removal and demolition of every one or two family dwelling and townhouse. Appurtenances connected or attached to such dwellings, and structures shall also follow the provisions of this Code. 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 masory 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 R-309, 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.

Manufactured homes labeled with a HUD label are exempt from the provisions of this Code.

SECTION R-104 — AUTHORITY

The CEO is hereby authorized and directed to administer and enforce all of the provisions of this Code. The CEO is further authorized to render interpretations of this Code, which are consistent with the spirit and intent of this Code.

SECTION R-105 — ENTRY

Whenever necessary to make an inspection under a permit issued, the CEO shall have the right to enter the building or premises. Whenever the CEO has reasonable cause to believe that there exists any condition or Code violation which makes a building or premises unsafe, dangerous or hazardous, the CEO may enter such building or premises. The CEO shall present proper credentials and request entry provided such building or premises is occupied. If such building or premises is unoccupied, the CEO 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 CEO shall have recourse to every remedy provided by law to secure entry. [G.S. 153A-360, 153A-364, 160A-420, 160A-424]

When the CEO 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. [G.S. 15-27.2]

SECTION R-106 — VIOLATIONS AND PENALTIES

Any person, firm, corporation or agent who shall violate a provision of this Code shall be guilty of a misdemeanor. Each such person shall be considered guilty of a separate offense for each and every portion thereof during which any violation is committed or continued, for a period of 30 days. Upon conviction of any such violation such person shall be liable to a fine not to exceed fifty dollars ($50.00) for each offense. [G.S. 143-138(h)]

In case any building or structure is constructed or its purpose altered so that it becomes in violation of the technical codes, the local CEO may institute any appropriate action or proceedings including civil remedies to:

(1) prevent such unlawful erection, construction or reconstruction or alteration of purpose

(2) restrain, correct, or abate such violation, or

(3) prevent the occupancy or use of said building, structure or land until such violation is corrected.

SECTION R-107 — RIGHT OF APPEAL

R-107.1 General: Any person may appeal an order, decision, or determination of a CEO pertaining to the code or any state building law by filing written notice to the Commissioner or Insurance or his designee within ten (10) days after the order, decision, or determination. A copy of the appeal shall be furnished to each party. A written technical interpretation shall be provided as specified in R-107.2. [G.S. 153A-374, 160A-434]

R-107.2 Administration by the North Carolina Department of Insurance: The Commissioner of Insurance through the Engineering Division shall have general supervision of the administration and enforcement of this code. The Engineering Division shall serve as staff for the Building Code Council and the Code Officials Qualification Board. The Engineering Division shall work in cooperation with local CEOs and provide general supervision in the administration and interpretation of this code.

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 CEO 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 R-107.4. Formal interpretations determined to be of a general nature shall be distributed on a regular basis as specified in R-116. [G.S. 143-140]

R-107.3 Stop Work Orders: 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 R-107.5. [G.S. 153A-361, 160A-421]

R-107.4 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.

R-107.5 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. [G.S. 143-141(d)]

SECTION R-108 — ALTERNATE MATERIALS AND SYSTEMS

R-108.1 General: The provisions of this code are not intended to prevent the use of any alternate material or method of construction, provided any such alternate has been reviewed and approved by the CEO at his sole discretion. The CEO shall approve any such alternate, provided he finds that the alternate, for the purpose intended, is at least the equivalent of that prescribed in the code in quality, strength, effectiveness, fire resistance, durability or safety. The CEO shall require that sufficient evidence or proof be submitted to substantiate any claim made regarding the alternate.

R-108.2 Tests: The inspection department may require tests, test reports or specific analysis as proof of compliance. This work shall be performed at the expense of the owner, or his agent, by an approved testing laboratory or other approved agency or design professional. The CEO 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.

SECTION R-109 — PERMIT

R-109.1 Permit Required: A permit shall be obtained before beginning construction, alteration or repairs, other than ordinary repairs, using application froms furnished by the CEO.

Exception: Permits shall not be required on ***a single family dwelling*** for any work costing five thousand dollars ($5,000) or less unless the work involves:

(1) the addition, repair, or replacement of load bearing structures.

(2) the addition or change in the design of a plumbing system;

(3) the addition, replacement or change in the design of a heating or air conditioning system;

(4) the addition, replacement or change in the design of an electrical system;

(5) the use of materials not permitted by this code; or

(6) the addition of roofing, excluding replacement of like grade of fire resistance.

R-109.2 Work Authorized: Work shall not deviate substantially from that described on the permit documents.

R-109.3 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: [G.S. 153A-357, 160A-417]

(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.

R-109.4 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. [G.S. 87-14,87-21(e), 87-43.1, 153A-134, 153A-357, 160A-194, 160A-417]

R-109.5 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. [G.S. 153A-352, 160A-412]

R-109.6 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. [G.S. 153A-354, 160A-414]

R-109.7 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. [G.S. 153A-354, 160A-414]

R-109.8 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. [G.S. 153A-354, 160A-414]

R-109.9 Expiration: A permit shall expire six (6) months, or any lesser time fixed by local ordinances, after the date of issuance if the work authorized by the permit has not been commenced. If after commencement, the work is discontinued for a period of twelve (12) months, the permit shall expire. Work authorized by any permit that has expired shall not continue until a new permit has been secured. [G.S. 153A-358, 160A-418]

R-109.10 Revocation of Permits:

R-109.10.1 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. [G.S. 153A-362, 160A-422]

R-109.10.2 Violation of Code Provisions: The CEO may revoke a permit upon determination that the work for which the permit was issued is in violation of, or not in conformity with, the provisions of this code. [G.S. 153A-362, 160A-422]

SECTION R-110 — PLANS

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 CEO 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 CEO to issue permits for minor construction and/or repair work without plans.

NOTE: House Bill 2015 ratified on July 13, 1994 amended GS 153A-357(a) and GS 160A-417(a) to not require city or county inspection departments to review and approve residential plans submitted pursuant to the North Carolina State Building Code, Volume VII-Residential. This Bill does not relieve the requirement for plans to be submitted but clarified that review of the plans will be done by the local government as it deems necessary.

SECTION R-111 — ADMINISTRATION AND INSPECTION

R-111.1 Administration by Local CEOs: The initial responsibility for administration and enforcement of this code has been allocated to local CEOs under the supervision of State officials as designated within R-107.2. [G.S. 143-139(b)]

R-111.1.1 Jurisdiction: A municipal inspection department shall have jurisdiction over all areas within the city limits, all extraterritorial areas

which the city has jurisdiction pursurant to state laws, and over any areas in which the municipality has contracted with another unit of government to perform code enforcement. A county inspection department shall have jurisdiction over all unincorporated areas outside any municipal jurisdiction located within the county, all areas in which a municipality has requested the county to enforce this code, and within the jurisdiction of another unit of government in which the county has contracted to perform code enforcement. A joint inspection department created by two or more units of government shall have the authority to enforce this code in all areas of legal jurisdiction of all units of government supporting the joint department. [G.S. 153A-352, 153A-353, 160A-411, 160A-413]

R-111.1.2 Duties: Inspection departments shall:

(1) receive applications and supporting data for permits;
(2) issue or deny permits;
(3) make all necessary inspections to insure code compliance;
(4) issue or deny certificates of compliance;
(5) issue or deny certificates of occupancy;
(6) issue stop work orders or orders to correct violations;
(7) maintain adequate records of permits issued or denied, inspections made, corrections ordered, and certificates issued;
(8) and take other actions that may be required to adequately enforce this code. [G.S. 153A-352 160A-412]

R-111.2 Inspections: CEOs are to provide inspection services based upon this code. Plans and specifications are to be used as a guide, but the written code text shall prevail.

R-111.2.1 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.

R-111.2.2 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.

R-111.2.3 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.

R-111.2.4 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.

R-111.2.5 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.

R-111.2.6 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.

R-111.2.7 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. [G.S. 153A-360, 160A-420]

R-111.2.8 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. [G.S. 153A-363, 160A-423]

R-111.2.9 Certificate of Compliance/Occuancy: 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. [G.S. 153A-363, 160A-423]

R-111.2.10 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 CEO 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. [G.S. 153A-359, 153A,360, 160A-419, 160A-420]

R-111.2.11 Stop Work Orders: Upon notice from the CEO, work on any building or service system that is being done contrary to the provisions of this code or in a dangerous or unsafe manner shall immediately cease. Such notice shall be in writing and given to the person doing the work. Such notice shall state the conditions under which work may be resumed. Where an emergency exists, the CEO shall give a verbal notice to be followed by written notice within eight (8) working hours to stop the work. Appeals to stop work orders are specified in R-107.2. [G.S. 153A-361, 160A-421]

R-111.3 Service Utilities:

R-111.3.1 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. [G.S. 143-143.2]

R-111.3.2 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. [G.S. 143-143.2, 153A-365, 153A-366, 160A-425, 160A-426]

R-111.3.3 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 IV–Electrical. [G.S. 153A-363, 160A-423]

SECTION R-112 — PREFABRICATED CONSTRUCTION

A certificate of approval by an approved inspection 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 CEO to determine compliance with this code, and a final inspection shall be provided in accordance with R-111.2.8.

SECTION R-113 — INSPECTION CARD

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

SECTION R-114 – 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 R-106 of this code. [G.S. 87-12, 87-21(e), 87-46]

SECTION R-115 — EFFECTIVE DATE OF AMENDMENTS

Amendments to this code adopted from July through June each year will become effective on the following January 1, 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 by the local CEO as an alternate method of construction or alternate materials prior to the effective date if requested by the owner or his agent.

Such amendments shall be published and available for distribution by December 1 each year. [G.S. 143-138(g)]

SECTION R-116 — 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 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 notified when new amendment packages to the codes become available. One copy of this information will be furnished free of charge to any trade or professional organization or State Licensing Board when requested on their letterhead.

SECTION R-117 — CEO NOT FULFILLING RESPONSIBILITY

When the local CEO 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. [G.S. 14-230, 14-231, 14-232, 153A-356, 160A-416]

SECTION R-118 — DEFINITIONS

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

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

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.

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 above or below the finished grade adjacent to the window.

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

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

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

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

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

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

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

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

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

Manufactured home: Manufactured home means a structure, transportable in one or more sections, which in the traveling mode is 8 body feet or more in width or 40 body feet or more in length, or, when erected on site, is 320 or more square feet, and which is built on a permanent chassis and designed to be used as a dwelling with or without a permanent foundation when connected to the required utilities, and includes the plumbing, heating, air-conditioning and electrical systems contained therein; except that such term shall include any structure which meets all the requirements of this paragraph except the size requirements and with respect to which the manufacturer voluntarily files a certification required by the secretary (HUD) and complies with the standards established under this title. For mobile homes built prior to June 15, 1976, a label certifying compliance to the Standard for Mobile Homes, NFiPA 501, ANSI 119.1, in effect at the time of manufacture is required. For the purpose of these provisions, a mobile home shall be considered a manufactured home.

Manufacturer's installation instructions: Printed instructions included with equipment as part of the conditions of listing or labeling.

Nails: Nails shall be defined as in ASTM F-547 as listed in Section S-26.118.

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.

Primary Level: The level which contains the primary living areas such as kitchen, den and living room. The primary level may also contain bedrooms.

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 the gross cross-sectional area measured in the same plane. 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 C55, C62, C73, C145, or C216 listed in Section S-26.115.

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

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

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

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

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

Chapter 2
BUILDING PLANNING

SECTION R-201—DESIGN CRITERIA

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

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

Table No. R-201.2[3]

CLIMATIC AND GEOGRAPHIC DESIGN CRITERIA

ROOF LIVE LOAD (Lbs. per Sq. Ft.)	WIND DESIGN[2] SPEED (mph)	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		N/A	Moderate	Local Conditions ____ in.	Yes	Yes	Local Conditions ____ °F

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 C34, C55, C62, C73, C90, C129, C145, C216, or C652 listed in Section S-26.201.

2 The jurisdiction shall fill in this portion of the table with wind design speeds determined from the Wind Probability Map in Appendix A. Wind pressures not specified shall be determined using procedures in North Carolina State Building Code, Volume I - General Construction or ASCE 7.

3 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 is acceptable.

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

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

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

Table No. R-201.4
MINIMUM UNIFORMLY DISTRIBUTED LIVE LOADS

USE	LIVE LOAD
Attics (accessible by fixed stairway)	30
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
Dwelling units: Primary Level	40
Other Levels	30
Stairs	40

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

Table No. R-201.6
ALLOWABLE DEFLECTION OF STRUCTURAL MEMBERS

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

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

SECTION R-202—LOCATION ON LOT

R-202.1 Exterior walls: Exterior walls located less than 5 feet from property lines or 10 feet between buildings shall have not less than a 1-hour fire-resistive rating. This fire-resistive rating shall be rated for exposure from both sides.

R-202.2 Openings: Openings shall not be permitted in exterior walls of dwellings located less than 5 feet from the property line, or less than 10 feet between buildings.

SECTION R-203—LIGHT, VENTILATION AND HEATING

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

Exceptions:

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

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

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

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

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

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

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

SECTION R-204—ROOM SIZES

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

not less than 50 square feet of floor area.

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

SECTION R-205—CEILING HEIGHT

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

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

Exceptions

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

SECTION R-206—SANITATION

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

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

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

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

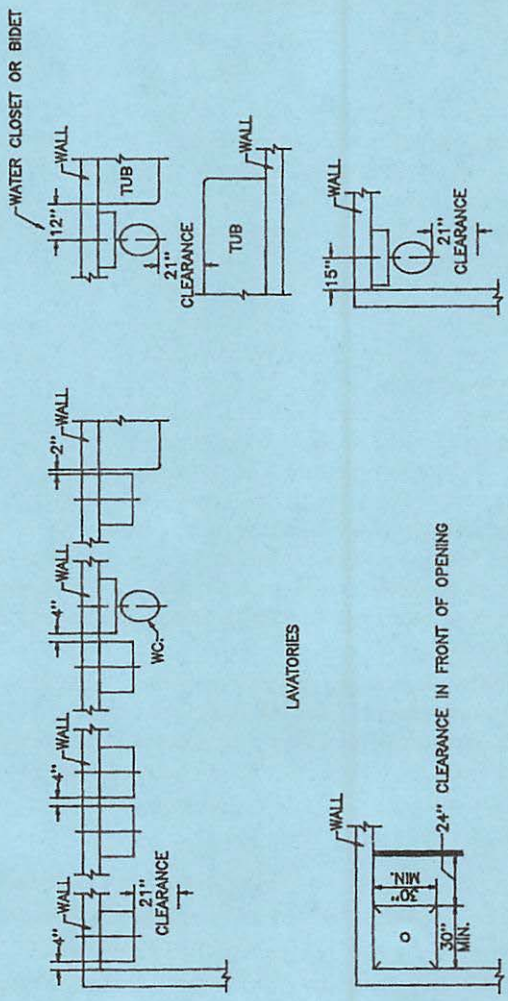
treated, tank-tight units. Portable toilets shall be enclosed, screened, and weatherproofed with internal latches. Temporary toilet facilities need not be provided on site for crews on a job site for no more than one working day and having transportation readily available to nearby toilet facilities.

SECTION R-207—TOILET, BATH AND SHOWER SPACES

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

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

Figure No. R-207.2
MINIMUM FIXTURE CLEARANCES



SECTION R-208—GLAZING

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

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

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

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

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

Exceptions

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

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

1. Glazing in ingress and means of egress doors except jalousies.
2. Glazing in fixed and sliding panels of sliding (patio) door assemblies and panels in swinging doors.
3. Glazing in storm doors.
4. Glazing in all unframed swinging doors.
5. Glazing in doors and enclosures for hot tubs, whirlpools, saunas, steam rooms, bathtubs and showers. Glazing in any part of a building wall enclosing these compartments where the bottom edge of the glazing is less than 60 inches above the drain inlet.

6. Glazing in an individual fixed or operable panel adjacent to and within the same plane as a door where the nearest vertical edge is within 24 inches of the door in a closed position and where the bottom edge is less than 60 inches above the floor or walking surface.
7. Glazing in an individual fixed or operable panel, other than those locations described in items 5 and 6 above, that meets all of the following conditions:
   1. Exposed area of an individual pane greater than 9 sq ft.
   2. Bottom edge less than 18 inches above the floor.
   3. Top edge greater than 36 inches above the floor.
   4. One or more walking surfaces within 36 inches horizontally of the glazing.
8. All glazing in railings regardless of an area or height above a walking surface. Included are structural baluster panels and nonstructural in-fill panels.

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

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

Table No. R-208.5a

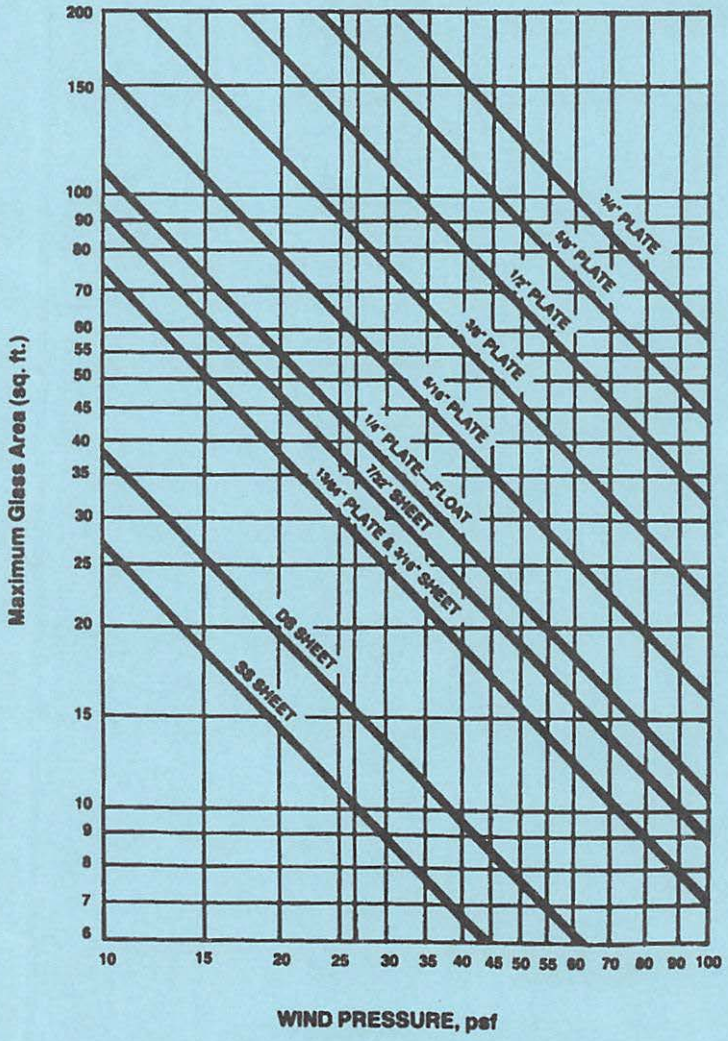
RELATIVE RESISTANCE TO WIND LOAD
(Assuming equal thickness)

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

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

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

Figure No. R-208.5—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)



Design wind load from Section R-201—Pounds-per-square-foot chart applies for ratios of width-to-length from 2:10 to 10:10.

R-208.5 Wind loads: Safety glass or glass areas in exterior walls in screens, in partitions and in other openings subject to wind loading shall be capable of safely withstanding the wind loads as shown in Section R-201 or Table R-208.5b acting either inward or outward. In the case of regular

plate, float or sheet glass supported on four sides, the design shall be not less than 2 1/2. Adjustment factors for other types of glass are given in Table No. R-208.5a.

Table R-208.5b
Pressure for which Glazing shall be sized [1, 2]

Positive and negative in psf

		One Story	Two Story	Three Story
Velocity (mph)	Height (ft.)	15	25	35
70		15	17	19
80		20	23	25
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, Volume I - General Construction or ASCE 7.

2. If glazing is more than 4 ft from a corner, the pressure from this table shall be permitted to be multiplied by 0.87.

R-208.6 Skylights and sloped glazing

R-208.6.1 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.

R-208.6.2 Permitted materials: The following types of glazing may be used:

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

R-208.6.3 Screens, general: For fully-tempered or heat-strengthened glass, a retaining screen meeting the requirements of Section R-208.6.6 shall be installed below the glass, except for fully-tempered glass that meets either condition listed in Section R-208.6.5.

R-208.6.4 Screens with multiple glazing: When the inboard pane is fully-tempered, heat-strengthened, or wired glass, a retaining screen meeting the requirements of Section R-208.6.6 shall be installed below the glass, except for either condition listed in Section R-208.6.5. All other panes in the multiple glazing may be of any type listed in Section R-208.6.2.

R-208.6.5 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 or less: Highest point of glass not more than 12 feet above a walking surface or other accessible area, nominal glass thickness not more than 3/16 inch (5 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: Glass sloped 30 degrees or less from vertical, and highest point of glass not more than 10 feet above a walking surface or other accessible area.

R-208.6.6 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 above grade.

R-208.6.7 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 by 1 inch.

R-208.6.8 Curbs for skylights: All unit skylights installed in a roof with a pitch flatter than 3:12 shall be mounted on a curb extending at least 4 inches above the plane of the roof.

SECTION R-209—ATTACHED GARAGES

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

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

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

SECTION R-210—EXITS

R-210.1 Exit required: Not less than one exit conforming to this chapter shall be provided from each dwelling unit provided that the travel distance does not exceed 75 feet.

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

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.

All egress or rescue windows from sleeping rooms must have a minimum net clear opening of 4.0 square feet. The minimum net clear opening height dimension shall be 22 inches. The minimum net clear opening width dimension 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 floor window and not less than 5.7 sq ft in the case of a second story window.

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

SECTION R-211—DOORS AND HALLWAYS

The required exit door shall be a side hinged door nominal 3 ft in width and 6 feet-8 inches in height. Other exterior hinged or sliding doors shall not be required to comply with these minimum dimensions. The minimum width of a hallway or exit access shall be not less than 3 feet. All required egress doors from habitable rooms shall be nominal 2 feet-6 inches in width and 6 feet-8 inches in height.

SECTION R-212—LANDINGS

A minimum 3-foot by 3-foot landing shall be required on each side of an egress door. The floor or landing shall not be more than 1-1/2 inches 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 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.

SECTION R-213—STAIRWAYS

R-213.1 General: When risers are closed, all treads may have a uniform projection not to exceed 1 inch. Nosing not required for masonry or concrete steps. Maximum riser height shall be 8 1/4 inches and minimum tread depth of 10 inches.

The greatest riser height within any flight of stairs shall not exceed the smallest by more than 3/8 inch. The greatest tread run within any flight of stairs shall not exceed the smallest by more than 3/8 inch. The top and bottom riser of interior stairs shall not exceed the smallest riser within that stair run by more than 3/4 inch. The height of the top and bottom riser of 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.

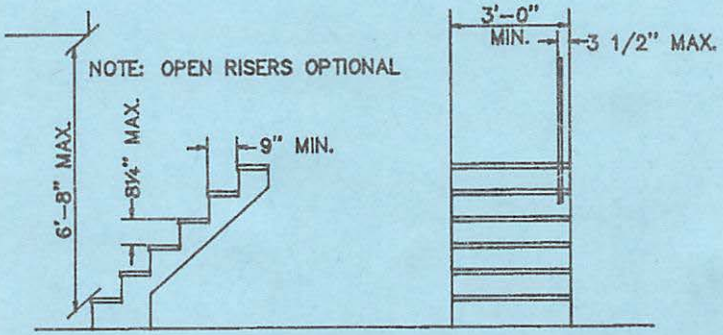
Stairways shall not be less than 3 feet in clear width, and the headroom rise and run shall conform to Figure No. R-213.1. Handrails may project from each side of a stairway a distance of 3 1/2 inches into the required width.

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

R-213.2 Winders: Winders are permitted, provided the width of the tread at a point not more than 12 inches from the side where the treads are narrower is not less than 9 inches, the minimum width of any tread is not less than 4 inches, and the average width of any tread is not less than 9 inches.

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

Figure No. R-213.1
STAIRWAYS



SECTION R-214—HANDRAILS AND GUARDRAILS

R-214.1 Handrails: Handrails having minimum and maximum heights of 30 inches and 34 inches, 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.

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.

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

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

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

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

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

SECTION R-215—SMOKE DETECTORS

R-215.1 Smoke detectors required: Smoke detectors shall be installed in accordance with North Carolina State Building Code, Volume IV–Electrical.

SECTION R-216—FOAM PLASTIC

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

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

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

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

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

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

R-216.2.2 Roofing: Foam plastic may be used in a roof-covering assembly without the thermal barrier when the foam is separated from the interior of the building by wood structural panel sheathing not less than

15/32 inch in thickness bonded with exterior glue, with edge supported by blocking, tongue-and-groove joints or other approved type of edge support, or an equivalent material. Foam plastic roof insulation which complies with FM 4450 or UL 1256, listed in Section S-26.216, need not meet the requirements of Section R-216.1 for all roof applications. The smoke-developed rating shall not be limited.

R-216.2.3 Attic spaces: Within attics which are accessible by fixed stairways, foam plastics shall be protected against ignition by 1 1/2-inch-thick mineral fiber insulation, 1/4-inch-thick wood structural panel, 3/8-inch particleboard, 1/4-inch hardboard, or 3/8-inch gypsum wallboard, corrosion-resistant steel having a base metal thickness of 0.016 inch, or other approved material installed in such a manner that the foam plastic is not exposed. The protective covering shall be consistent with the requirements for the type of construction.

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

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

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

1. The minimum density is 20 pounds per cubic foot,
2. The 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 E84 listed in Section S-26.216. The smoke-developed rating is not limited.

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

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

SECTION R-217—FLAME-SPREAD AND SMOKE DENSITY

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

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

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

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

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

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

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

SECTION R-218—DWELLING UNIT SEPARATION

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

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

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

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

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

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

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

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

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

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

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

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

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

Exceptions:

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

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

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

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

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

SECTION R-219—RAMPS

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

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

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

SECTION R-220 — MOISTURE VAPOR RETARDERS

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

Exceptions:

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

SECTION R-221 — EXTERIOR DECKS

Exterior wood decks shall be constructed in accordance with Appendix C of this code.

Chapter 3
FOUNDATIONS

SECTION R-301—GENERAL

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

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

R-301.3 Drainage: The surface area adjacent to the foundation shall be provided with adequate drainage and shall be graded so as to drain surface water away from foundation walls.

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

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

SECTION R-302–MATERIALS

R-302.1 Wood foundations: Wood foundation systems shall be designed and installed in accordance with NFoPA Technical Report No. 7 listed in Section S-26.302. All lumber and plywood shall be treated in accordance with AWPA C22 listed in Section S-26-302 and shall be identified as to conformance with such standard by an approved inspection agency.

R-302.2 Concrete: Concrete subject to weathering as indicated in Table No. R-201.2 shall have a minimum specified compressive strength and air content as shown in Table No. R-302.2. The minimum cement content of

concrete mixtures for exterior porches, carport slabs, and steps that will be exposed to freezing and thawing in the presence of deicing chemicals shall be 520 lbs of cement meeting ASTM C150 or C595, per cu yd of concrete.

Table No. R-302.2

MINIMUM SPECIFIED COMPRESSIVE STRENGTH OF CONCRETE

TYPE OR LOCATION OF CONCRETE CONSTRUCTION	MINIMUM SPECIFIED COMPRESSIVE STRENGTH[1] (f'c)		
	Weathering Potential[2]		
	Negligible	Moderate	Severe
Basement walls and foundations not exposed to the weather	2,500	2,500	2,500[3]
Basement slabs and interior slabs on grade, except garage floor slabs	2,500	2,500	2,500[3]
Basement walls, 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]	3,500[4, 5]

[1] At 28 days psi.
[2] See Table No. R-201.2 for weathering potential.
[3] Concrete in these locations which may be subject to freezing and thawing during construction shall be air-entrained concrete in accordance with Footnote 4.
[4] Concrete shall be air entrained. Total air content (percent by volume of concrete) shall be not less than 5 percent or more than 7 percent.
[5] See Section R-302.2 for minimum cement content.

SECTION R-303–FOOTINGS

R-303.1 General: All exterior walls, bearing walls, columns and piers shall be supported on continuous solid masonry or concrete footings, wood foundations, or other approved structural systems which shall be of sufficient design to support safely the loads imposed as determined from the character of the soil, and except when erected upon solid rock or otherwise protected from frost, shall extend below the frost line. Minimum sizes for concrete footings shall be as set forth in Figures R-303a and R-303b and Table Nos. R-303a and R-303b.

R-303.2 Concrete or masonry footings: The top surface shall be level (1/2 inch in 10 feet) or shall be brought to level with masonry units with full mortar joints. The bottom surface of footings may have a slope not exceeding 1 in 10. Footings shall be stepped where it is necessary to change the elevation of the top surface of the footings or where the slope of the bottom surface of the footing will exceed 1 in 10.

Effective March 1, 1995

R-303.3 Foundations in 70, 80 and 90 mph wind zones: Minimum sizes for concrete footings shall be as set forth in Figures No. R-303a and R-303b.

R-303.4 Foundations in 100 and 110 mph wind zones: In addition to the minimum requirements in Figure R-303a, foundation wall footings shall be at least 10 inches deep by 20 inches wide. Foundation wall and curtain wall footings shall have two # 5 bars at 3 inches above the bottom of the footing. The # 5 bars shall be continuous or lapped 25 inches at all reinforcing steel joints and footing corners. This foundation is valid for one, two and three story structures. For slab on grade, see Figure No. R-303b.

R-303.5 Wood foundations: Footings for wood foundations shall be in accordance with the details set forth in Figure Nos. R-304.5a and R-304.5b and NFoPA Technical Report No. 7 listed in Section S-26.303.

R-303.6 Slab-on-grade: Structural slabs-on-ground and mat-type footings for dwellings located on expansive soils shall be designed and installed in accordance with PTI "Post-Tensioned Slabs-on-Ground" or WRI "Design of Slabs-on-Ground Foundations" listed in Section S-26.303, or in accordance with other approved methods. See Section R-310.

SECTION R-304–FOUNDATION WALLS

R-304.1 Concrete and masonry: Foundation walls shall be constructed in accordance with the provisions of this section with footings as shown in Figure No. R-303 and in accordance with ACI 318, ACI 318.1, BIA "Building Code Requirements for Engineered Brick Masonry," NCMA TEK 15-1A, "Design of Concrete Masonry Walls", NCMA TR68-A, or ACI/ASCE 530 except Appendix A, listed in Section S-26.304 or other approved structural systems.

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

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

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

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

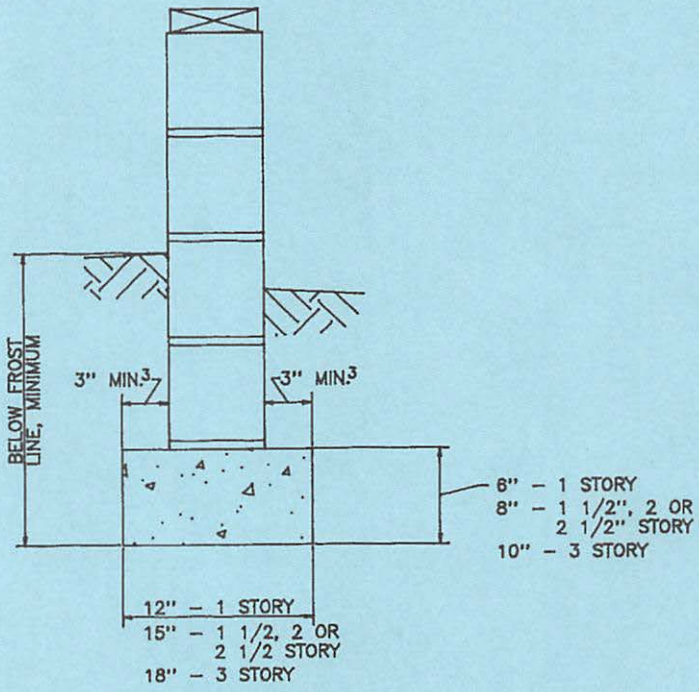
Foundation walls shall be drained and dampproofed in accordance with Section R-305 and Section R-306, respectively.

R-304.3 Masonry or concrete foundation: Masonry and concrete foundation walls shall be constructed using Table R-304.3.

Figure R-303a

MINIMUM FOUNDATION REQUIREMENTS[1, 2]

(For 70, 80 and 90 mph wind zones)



NOTES:

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

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

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

Figure R-303b CONCRETE SLAB FOOTING

For 70, 80 and 90 mph Wind Zones.
(See Section R-304.7 for 100 mph and above Wind Zones)

Table No. R-303a
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"x16"	1' -4"x2' -0"x8"	8"x16"	1' -4"x2'-6"x8"	8"x16"	1' -4"x2' -6"x8"
100	8"x16"	1' -4"x2' -0"x8"	8"x16"	2' -0"x2'-0"x10"	16"x16"	2' -6"x2' -6"x10"
150	8"x16"	2' -0"x2' -0"x8"	16"x16"	2' -8"x2'-8"x10"	16"x16"	3' -0"x3' -0"x10"
200	8"x16"	2' -4"x2' -4"x10"	16"x16"	3' -0"x3'-0"x10"	16"x16"	3' -8"x3' -8"x1'-0"
250	–	—	16"x16"	3' -4"x3'-4"x1'-0"	16"x24"	4' -0"x4' -0"x1'-0"
300	–	—	16"x16"	3' -8"x3'-8"x1'-0"	16"x24"	4' -6"x4' -6"x1'-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 R-404.4. In 100 mph and above wind zones, piers shall be sized to accommodate the anchor connections specified in R-304.7.3.
5. Area at first level supported by pier and footing (sq. ft.).

Table R-303b
Footings to Resist Uplift From Piers in 100 and 110mph Wind Zones Supporting Girders in Exterior Walls

Girder Span velocity (mph)	4'-0"	6'-0" Footing Size	8'-0"
100	2'-0"x2'-0"x10"	2'-4"x2'-4"x10"	2'-8"x2'-8"x10"
110	3'-0"x3'-0"x10"	3'-4"x3'-4"x12"	3'-8"x3'-8"x12"

Table No. R-304.3a
MINIMUM THICKNESS AND ALLOWABLE DEPTH OF UNBALANCED FILL FOR UNREINFORCED MASONRY AND CONCRETE FOUNDATION WALLS [1,4] WHERE UNSTABLE SOIL OR GROUND WATER CONDITIONS DO NOT EXIST IN SEISMIC ZONES NO. 0, 1 OR 2

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

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

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

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

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

Table No. R-304.3b
REQUIREMENTS FOR MASONRY OR CONCRETE FOUNDATIONS 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 NO. 3 OR 4 OR SUBJECTED TO UNSTABLE SOIL CONDITIONS

MATERIAL TYPE	HEIGHT OF UNBALANCED FILL IN FEET[3]	LENGTH OF WALL BETWEEN SUPPORTING MASONRY OR CONCRETE WALLS IN FEET	REQUIRED REINFORCING		
			MINIMUM[1] WALL THICKNESS IN INCHES[4]	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[2]	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

1 Thickness of concrete walls may be 6 inches, provided reinforcing is placed not less than 1 inch nor more than 2 inches from the face of the wall not against the earth.
2 Solid masonry shall include solid brick or concrete units and hollow masonry units with all cells grouted.
3 Backfilling shall not be commenced until after the wall is anchored to the floor.
4 The actual thickness shall not be more than 1/2 inch less than the required thickness specified in the table.

R-304.4 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 shall be designed in accordance with accepted engineering practices.

R-304.5 Wood foundation walls: Wood foundation walls shall be constructed in accordance with the provisoins of this section, with footings as shown in Figure Nos. R-304.5a and R-304.5b and NFoPA Technical Report No. 7 listed in Section S-26.304.

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 by an approved lumber or plywood grading or inspection bureau or agency.

All lumber and plywood used in a wood foundation shall be pressure preservatively treated in accordance with AWPA C22 listed in Section S-26.304 and shall be identified as to conformance with such standard by an approved agency.

When the height of fill is more than 12 inches above the interior grade or crawl space or floor of a basement, the plywood sheathing shall be designed to resist inward soil pressures occurring at the bottom of the wall in accordance with Table No. R-304.5.

Wood foundation walls, for most soils, shall be designed assuming a lateral soil pressure of 30 pounds per cubic foot equivalent fluid weight. For soils high in clay or fine silt and of low permeability, or for poorly drained soils, a higher pressure shall be assumed in accordance with NFoPA Technical Report No. 7 listed in Section S-26.304.

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

Wood foundation basements shall be drained and dampproofed in accordance with Section R-305 and Section R-306, respectively.

R-304.6 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 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 R-303a.

R-304.7 Anchorage

R-304.7.1 General: Exterior walls of structures in 100 mph and above wind zones shall be anchored to the foundation to resist the forces given in Table R-702.10. Acceptable methods of anchoring include the systems described in this Section and in Section R-304.7.2.

Sill plates shall be anchored with 1/2 inch standard anchor bolts of A307 or A36 steel with 2x2x1/8 inch washers or equivalent anchors. Bolts are to have 6 inch embedment in concrete or grout and be located at each door jamb, window jamb, corner and at the spacing in Table R-304.7. The spacing specified in Table No. R-304.7 may be varied up to a maximum of 3 inches to accommodate construction. If uplift connectors are continuous from the wall to the foundation wall or slab on grade and sized to resist the forces described in Table R-702.10, the spacing of the anchor bolts in Table No. R-304.7 may be increased to 6 ft on center and standard washers may be used instead of 2x2x1/8 inch washers.

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Table R-304.7
Structure Anchorage

Wind Speed (mph)	90	100	110
Maximum Spacing (inches)	24[1]	21	18

1. Required only for slab on grade (see Figure R- 303b).

R-304.7.2 Foundation Walls: 2x6 or larger sill plate shall be used at the top of foundation walls in 100 mph and above wind zones. Top course of foundation wall to have 8" x 8" concrete or masonry bond beam with one continuous horizontal # 5 bar in the foundation wall. Bar shall be considered continuous if laps are 25 inches long and if the bar is continuous around corners or properly lapped corner bars are used. The bond beam shall be anchored to the footing with vertical # 5 bars at corners and every 8 ft along the foundation wall. Vertical # 5 bars to have a standard hook with an 8 inch extension at each end. Where the # 5 bars are lapped, the minimum lap shall be 25 inches.

R-304.7.3 Exterior Wall Girders: Girders in exterior walls shall be anchored to the footing at the end of each span to resist the uplift forces shown in Table R-304.7.3. Anchors not embedded in mortar or concrete shall be hot dipped galvanized.

Table R-304.7.3
Girder Anchor Force At The End Of Each Span

Velocity (mph)	Required Anchor Capacity		
Girder Span	**4'-0"**	**6'-0"**	**8'-0"**
90	NOT REQUIRED		
100	950	1425	1900
110	1230	1845	2460

Connections specified in Appendix L Table L-1 and shown in Figure L-1 are one way of resisting the specified anchor forces at the ends of girders in exterior walls. Where there are bolts or reinforcing in masonry piers, the piers shall be fully grouted.

R-304.7.4 Footing Requirements: Footings for piers supporting girders in exterior walls shall be designed to resist the forces described in Chapter 2. As an alternate to an engineered design, the footings shall be permitted to be sized using Tables R-303a and R-303b.

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

HEIGHTOF FILL (Inches)	STUD SPACING (Inches)	FACE GRAIN ACROSS STUDS[2]			FACE GRAIN PARALLEL TO STUDS		
		Grade[3]	Minimum Thickness[1]	Identification Index	Grade[3]	Minimum Thickness[1, 4]	Identification Index
24	12	B	15/32	32/16	A	15/32	32/16
					B	15/32[5]	32/16
	16	B	15/32	32/16	A	15/32[5]	31/16
					B	19/32[5] (4, 5 ply)	40/20
36	12	B	15/32	32/16	A	15/32	32/16
					B	15/32[5] (4, 5 ply)	32/16
					B	19/32 (4, 5 ply)	40/20
	16	B	15/32[5]	32/16	A	19/32	40/20
					B	23/32	48/24
48	12	B	15/32	32/16	A	15/32[5]	32/16
					B	19/32[5] (4, 5 ply)	40/20
	16	B	19/32	40/20	A	19/32[5]	40/20
					A	23/32	48/24
60	12	B	15/32	32/16	A	19/32	40/20
					B	19/32[5] (5 ply)	40/20
					B	23/32	48/24
	16	B	19/32[5]	40/20	A	23/32[5]	48/24
72	12	B	15/32[5]	32/16	A	19/32	40/20
					B	23/32[5]	48/24
	16	B	23/32[5]	48/24	–	–	–
86	12	B	19/32	40/20	A	19/32[5]	40/20
					A	23/32	48/24
	16	B	23/32[5]	48/24	–	–	–

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

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

[3] Plywood shall be of the following minimum grades in accordance with DOC PS1 or DOC PS2 listed in Section S–26.304:

(i) DOC PS1 Plywood grades marked:

A. Structural I C-D (Exposure 1)

B. C-D (Exposure 1)

(ii) DOC PS2 plywood grades marked:

A. Structural 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 PS1).

B. A-C Group 1, B-C Group 1, C-C (Plugged) Group 1 or MDO Group 1 in accordance with DOC PS1.

C. Single Floor in accordance with DOC PS2.

[4] When face grain is parallel to studs, all veneer plywood panels of the required thickness, grade and identification index may be of any construction permitted under Article 3.2 of NFoPA Technical Report No. 7 listed in Section S-26.304 except as noted in the table for minimum number of piles required.

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

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

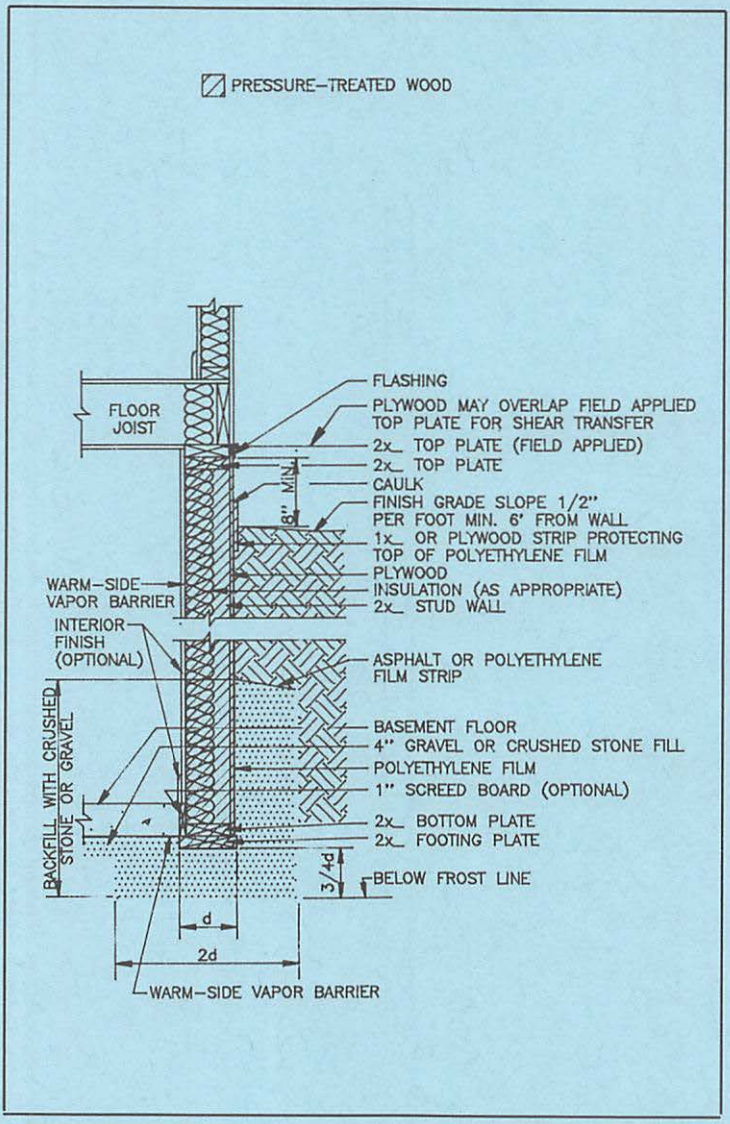
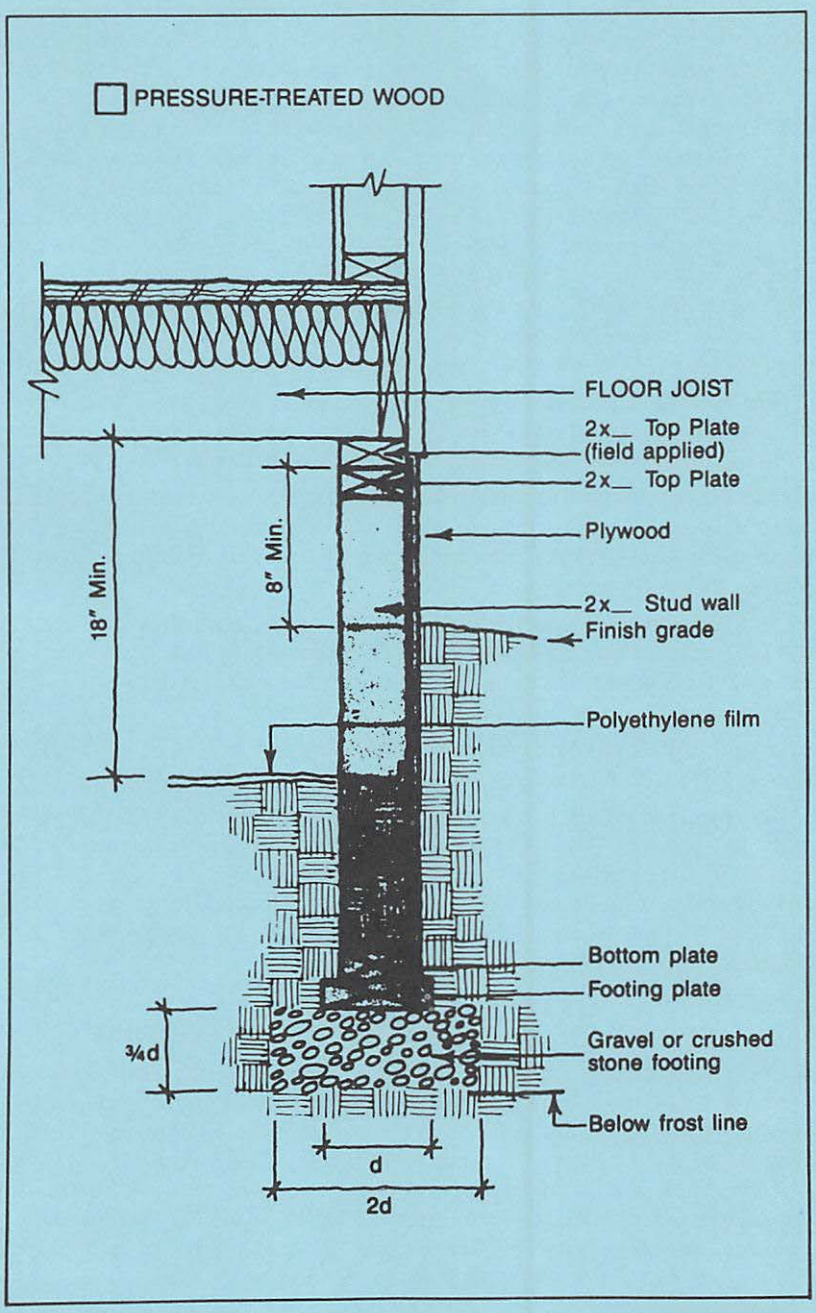


Figure No. R-304.5b
TYPICAL DETAILS FOR WOOD FOUNDATION CRAWL SPACE WALLS



SECTION R-305–FOUNDATION DRAINAGE

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

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

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

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

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

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

SECTION R-306–FOUNDATION DAMPPROOFING

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

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

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

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

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

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

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

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

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

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

SECTION R-307–FOUNDATION INSULATION

R-307.1 Protection of exposed foundation insulation: Foundation walls and the edges of slab-on-ground floors shall be insulated in accordance with Section R-310, Chapter 25, and Appendix N.

SECTION R-308–COLUMNS

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

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

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

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

SECTION R-309–PROTECTION AGAINST DECAY

R-309.1 Location required: In areas subject to termite or decay damage as established by Table No. R-201.2, the following locations shall require the use of an approved species and grade of lumber, pressure preservatively treated in accordance with AWPA C1, C2, C3, C4, C9, C15, C18, C20, C22, C23, C24, C27, C28, P1, P2, and P3 listed in Section S-26.309, or decay-resistant heartwood of redwood, black locust, or cedars.

1. Wood joists or the bottom of a wood structural floor when closer than 18 inches or wood girders when closer than 12 inches to exposed ground in crawl spaces or unexcavated areas located within the periphery of the building foundation.
2. All sills which rest on concrete or masonry walls.
3. Sills and sleepers on a concrete or masonry slab which is in direct contact with the ground.
4. The ends of wood girders entering exterior masonry or concrete walls having clearances of less than 1/2 inch on tops, sides and ends.
5. Wood siding, sheathing and wall framing on the exterior of a building having a clearance of less than 6 inches from the ground.
6. Wood structural members supporting moisture-permeable floors or roofs which are exposed to the weather, such as concrete or masonry slabs, wood decks, steps or stoops unless separated from such floors or roofs by an impervious moisture barrier.

7. Wood furring strips or other wood framing members attached directly to the interior of exterior masonry or concrete walls below grade except when an approved vapor retarder is applied to the interior of the exterior wall.

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

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, such as flashing, which would prevent moisture or water accumulation on the surface or at joints between members. Such members may include:

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

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

R-309.2 Quality of material: 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. R-309.3. 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, and treating company can be identified in service. Marking shall be as follows:

1. All rough lumber, 6 x 6 inch pilings and larger, 6 inch diameter and larger pilings shall be marked legibly with indelible ink, branding or non-corrosive metal tags.
2. All dressed dimensional lumber shall be legibly marked with indelible ink, branding or non-corrosive 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.

R-309.3 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. R-309.3

Table No. R-309.3
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[2]			
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/C2/C24
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.

R-309.4 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 Section S-26.309.

SECTION R-310–PROTECTION AGAINST TERMITES

R-310.1 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.

R-310.2 Chemical soil treatment: The concentration, rate of application and treatment method of the termiticide shall be consistent with and never less than the termiticide label and applied according to the standards of the North Carolina Structural Pest Control Committee of the North Carolina Department of Agriculture.

R-310.3 Foam plastic, General: This section shall apply to both treated and untreated foam plastic.

R-310.3.1 Foundation walls: All foam plastic shall be a minimum of 8" above grade. See Appendix N, Figure N-1.

EXCEPTION: Foam plastic less than 8" above or in contact with grade shall be installed in accordance with Section R-310.3.5 and Figure N-2.

R-310.3.2 Chemical treatment: When foam plastic is in contact with the ground, the soil area shall be chemically treated in accordance with R-310.2.

R-310.3.3 Slab-on-grade (non-structural): Foam plastic shall be installed along the vertical edge and underneath the slab as specified in Chapter 25.

R-310.3.4 Slab-on-grade (structural): All slabs which distribute the wall loads to the foundation shall be insulated as specified in Section R-310.3.5, Chapter 25, and Figures N-3 or N-4. Foam plastic shall not be positioned so as to receive vertical building loads.

R-310.3.5 Foam plastic in contact with ground:

R-310.3.5.1 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 N-2

R-310.3.5.2 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 N-2.

R-310.3.5.3 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.

R-310.3.5.4 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 R-306 and Figure N-2.

SECTION R-311–CRAWL SPACE

R-311.1 Ventilation: The space between the bottom of the floor joists and the earth under any building (except such space as is occupied by a basement or cellar) shall be provided with a sufficient number of ventilating openings through foundation walls or exterior walls to ensure ample ventilation. Ventilating openings shall be provided with corrosion-resistant wire mesh, not greater than 1/2 inch in any dimension. The minimum net area of ventilation openings shall be not less than 1 square foot for each 150 square feet of crawl space area. Vents shall be so placed as to provide ventilation at all points and prevent dead air pockets.

Exceptions:

1. Ventilation openings may be vented to the interior of buildings where warranted by climatic conditions.
2. When at least 75% of the crawl space ground surface is covered with 6 mil polyethylene vapor retarder or its equivalent, the net free area of the ventilation openings may be reduced 50%. To prevent excessive drying of the floor, not more than 80% of the crawl space should be covered.
3. Ventilation openings may be omitted on one side.
4. Under-floor spaces used as supply plenums for distribution of heated and cooled air shall comply with the requirements of Section M-1604.

R-311.2 Access: An access crawl hole 22 inches high by 36 inches wide shall be provided to the under-floor space. See M-1101.1.5 for equipment.

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

R-311.4 Finished grade: The finished grade of under-floor space shall provide a smooth surface free of pockets. Where there is evidence that the ground-water table can rise to within 6 inches of the finished grade at the building perimeter or where there is evidence that surface water does not not readily drain from the building site, the grade in the under-floor space shall be as high as the outside finished grade, unless an approved drainage system is provided.

Chapter 4
WALL CONSTRUCTION

SECTION R-401— GENERAL

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

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

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

SECTION R-402— DIMENSION LUMBER

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

R-402.2 Stud Sizing: Grade, size and spacing of studs shall be as specified in Tables R-402.2a and R-402.2b.

R-402.3 Construction: Exterior walls of wood-frame construction shall be in accordance with Figure Nos. R-402.3a and R-402.3b. Components of exterior walls shall be fastened in accordance with Table No. R-402.3a. In addition to the requirements of Table R-402.3a, exterior walls shall be connected from the roof to the foundation sill to resist the forces identified in R-702.10, no reduction will be taken for dead load. Walls of wood frame construction shall be designed and constructed in accordance with the NFoPA "National Design Specification for Wood Construction,"or "SSTD10, Standard for Hurricane Resistant Residential Construction" listed in Section S-26.402.

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

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

Table No. R-402.2a [1,2]
STUD SIZE, GRADE AND SPACING BEARING WALLS UP TO 10 FT. HIGH

STUD SIZE	SUPPORTING ROOF AND CEILING	SUPPORTING ONE FLOOR ROOF AND CEILING	SUPPORTING TWO FLOORS ROOF AND CEILING	SUPPORTING ONE FLOOR ONLY
70 AND 80 MPH ZONES Studs to be SP or SPF. Grade to be #3, STUD, STANDARD or better unless noted.				
2 X 4	24"	16"		24"
2 X 4	UTILITY @ 16"			UTILITY @ 16"
2 X 4 WITH STRUCTURAL SHEATHING			SP @12"	
2 X 4 WITH STRUCTURAL SHEATHING			SPF #2/STUD/STD @ 12"	
3 X 4	24"	24"	16"	24"
2 X 5	24"	24"		24"
2 X 6	24"	24"	16"	24"
90 AND 100 MPH ZONES Studs to be SP or SPF. Grade to be #2 or better unless noted.				
2 X 4	16"	16"		16"
2 X 4 WITH STRUCTURAL SHEATHING			12"	
2 X 6	SP #3/STUD @24"	SP #3/STUD @24"	SP #3/STUD @16"	SP #3/STUD @24"
2 X 6	SPF #3/STUD @16"	SPF #3/STUD @16"	SPF #3/STUD @16"	SPF #3/STUD @16"
110 MPH ZONES Studs to be SP or SPF. Grade to be #2 or better unless noted.				
2 X 4	12"	12"		12"
2 X 4 WITH STRUCTURAL SHEATHING			12"	
2 X 6	#3/STUD @16"	#3/STUD @16"	#3/STUD @16"	#3/STUD @16"

1. SP Stands for Southern Pine, SPF Stands for Spruce Pine Fir

2. For walls 8 ft. and less 2 X 4 SP or SPF Grade #2 studs at 16" may support up to one floor plus a roof and ceiling in wind zones of 110 mph or less.

Table No. R-402.2b [1]
STUD SIZE, GRADE AND SPACING NON BEARING WALLS

STUDS IN EXTERIOR WALLS	10' HEIGHT	12' HEIGHT	14' HEIGHT	16' HEIGHT
70 AND 80 MPH ZONES				
2 X 4	SP #3/STUD/STD @16"	SP #2 @ 16"		
2 X 4	SPF #2/STUD @16"	SPF #2 @ 12"		
2 X 6		SP #3/STUD @16"	SP #2 @ 24"	SP #2/SPF #2 @ 16"
2 X 6		SP #2/SPF #2 @ 24"	SPF #2 @ 16"	SP STUD @ 12"
2 X 6			SP #3/STUD @ 12"	
2 X 6			SPF #3/STUD @ 12"	
90 AND 100 MPH ZONES				
2 X 4	SP/SPF #2 @ 16"	SP #2 @ 12"		
2 X 6	SP #3/STUD/STD @ 24"	SP #3/STUD @ 16"	SP #2/SPF #2 @ 16"	SP #2/SPF #2 @ 12"
2 X 6	SPF #3 @ 24"	SP #2/SPF #2 @ 24"	SP #3/STUD @ 12"	
2 X 6	SPF STUD/STD @ 16"	SPF #3/STUD @ 12"		
110 MPH ZONES				
2 X 4	SP/SPF #2 @ 12"			
2 X 6	SP #3/STUD/STD @16"	SP #2 @ 16"	SP #2 @ 16"	SP #2 @ 12"
2 X 6	SPF #3/STUD @ 16"	SPF #2 @ 16"		

STUDS IN INTERIOR WALLS	
2 X 3	10 ft. high and less Utility grade @ 24"
2 X 4 flat	10 ft. high and less Utility grade @ 16"

Over 10' high use values for non bearing studs in exterior walls in 70 and 80 mph zones

1. SP Stands for Southern Pine, SPF Stands for Spruce Pine Fir.

R-402.4 Interior partitions: Interior load-bearing partitions shall be constructed, framed and firestopped as specified for exterior walls. Unless used to resist uplift, interior partitions do not have to be anchored to resist the uplift requirements of exterior walls. Stud size, grade and spacing shall be as described in Tables R-402.2a and R-402.2b.

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

Exception #1: 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.

Exception #2: Cutting and notching of studs may be increased to 65% of the width of the stud in exterior or interior walls and bearing partitions, provided that one of the following conditions are met:

1. The wall section is reinforced with 1/2 inch exterior grade plywood or equivalent reinforcement on the notched side of the wall. Plywood, if used, shall reach from the floor to ceiling and at least one stud further on each side of the section that has been notched or cut.
2. The exterior walls of a kitchen may be reinforced by placing 1/2 inch plywood or equivalent reinforcement on the notched side of the wall. Plywood, if used, shall reach from the floor to counter-top height and at least one stud further on each side of the section that has been notched or cut.

Table No. R-402.3a

FASTENER SCHEDULE FOR STRUCTURAL MEMBERS

DESCRIPTION OF BUILDING MATERIALS	NUMBER & TYPE OF FASTENER [1,2,3,6]	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"	– –
Wider than 1" x 6" subfloor to each joist, face nail	3-8d 4 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	16d	24" o.c.
Double top plates, face nail	16d	24" o.c.
Top plates, laps and intersections, face nail	2-16d	–
Continued header, two pieces	16d	16" o.c. along each edge
Ceiling joists to plate, toe nail	3-8d	–
Continuous header to stud, toe nail	4-8d	–
Ceiling joist, laps over partitions, face nail	3-16d	–
Ceiling joist to parallel rafters, face nail	3-16d	–
Rafter to plate, toe nail	2-16d	–
1" brace to each stud and plate, face nail	2-8d 2 staples, 1 3/4"	– –
1" x 6" sheathing to each bearing, face nail	2-8d 3 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	16d	24" o.c.
Built-up girder and beams	16d	32" o.c. at top and bottom and staggered two 20d or three 16d at ends and at each splice
Ledger strip	3 - 16d	Below each joist at 2" oc
2" planks	2-16d	At each bearing
Roof rafters to ridge, valley or hip rafters: toe nail face nail	4-16d 3-16d	– –
Rafter ties to rafters, face nail	3-8d	–

(Continued)

Table No. R-402.3a—(Continued)

DESCRIPTION OF BUILDING MATERIALS	DESCRIPTION OF FASTENERS [2, 3, 5]	SPACING OF FASTENERS	
		Edges	Intermediate Supports[4]
Wood Structural Panel and particleboard, roof and wall sheathing to frame			
5/16"-1/2"	6d Staple 16 ga.	6"	12"
19/32"-3/4"	8d smooth or 6d deformed	6"	12"
7/8"-1"	8d	6"	12"
1 1/8"-1 1/4"	10d smooth or 8d deformed	6"	12"
	Other wall sheathing[7]		
1/2" fiberboard sheathing[6]	1 1/2" galvanized roofing nail 6d common nail Staple 16 ga. 1 1/8" long	3"	6"
25/32" fiberboard sheathing[6]	1 3/4" galvanized roofing nail 8d common nail Staple 16 ga., 1 1/2" long	3"	6"
1/2" gypsum sheathing	1 1/2" galvanized roofing nail 6d common nail Staple 16 ga., 1 1/2" long	4"	8"
Particleboard roof and wall sheathing 5/16"-1/2"	6d common nail	6"	12"
5/8"-3/4"	8d common nail Staple 16 ga. 1 1/2" long	6"	12"
Wood Structural Panel and particleboard, combination subfloor-underlayment to framing			
3/4" and less	6d deformed	6"	12"
7/8"-1"	8d deformed	6"	12"
1 1/8"-1 1/4"	10d smooth or 8d deformed	6"	12"

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

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

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

[4] Nails shall be spaced at not more than 6 inches o.c. at all supports where spans are 48 inches or greater.

[5] The number of fasteners required for connections not included in this table shall be based on values set forth in Table No. R-402.3a(a).

[6] Four-foot by 8-foot or 4-foot by 9-foot panels shall be applied vertically.

[7] Gypsum sheathing shall conform to ASTM C79 listed in Section S-26.402. Fiberboard sheathing shall conform to AHA 194.1, ASTM D2277, and ASTM C208 listed in Section S-26.402. Other sheathing materials shall be approved by the building official.

Table No. R-402.3a (1)
ALTERNATE ATTACHMENTS

NOMINAL MATERIAL THICKNESS	DESCRIPTION [1, 2] OF FASTENERS [2, 3, 5]	SPACING OF FASTENERS	
		Edges	Intermediate Supports[4]
Wood Structural Panel or Particleboard Subfloor, Roof and Wall Sheathing to Framing			
5/16"	.097 - .099 Nail 1 1/2"	6"	12"
	Staple 15 ga. 1 3/8"		
3/8"	Staple 15 ga. 1 3/8"	6"	12"
	.097 - .099 Nail 1 1/2"	4"	10"
15/32" and 1/2"	Staple 15 ga. 1 1/2"	6"	12"
	.097 - .099 Nail 1 3/8"	3"	6"
19/32" and 5/8"	.113 Nail 1 7/8"		
	Staple 15 and 16 ga. 1 5/8"	6"	12"
	.097 - .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"
	.097 - .099 Nail 1 7/8"	3"	6"
1"	Staple 14 ga. 2"	5"	10"
	Staple 15 ga. 2"	4"	8"
	.097 - .099 Nail 2 1/8"	3"	6"
Floor Underlayment; Wood Structural Panel–Hardboard–Particleboard			
1/4" and 5/16"	.097 - .099 Nail 1 1/2"		
	Staple 15 and 16 ga. 1 1/4"	6"	12"
	.080 Nail 1 1/4"	5"	10"
	Staple 18 ga. 3/16 crown 7/8"	3"	6"
3/8"	.097 - .099 Nail 1 1/2"		
	Staple 15 and 16 ga. 1 3/8"	6"	12"
	.080 Nail 1 1/8"	5"	10"
1/2"	.113 Nail 1 7/8"		
	Staple 15 and 16 ga. 1 1/2"	6"	12"
	.097 - .099 Nail 1 1/3"	5"	10"

[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.

Table No. R-402.3b
WOOD STRUCTURAL PANEL WALL SHEATHING–
FACE GRAIN PARALLEL OR PERPENDICULAR TO STUDS[1]

Panel Span Rating	Panel Nominal Thickness (inch)	Maximum STUD SPACING (Inches) SIDING NAILED To[1]	
		Stud	Sheathing
12/0, 16/0, or wall @ 16 oc	5/16, 3/8	16	16[2]
24/0, 24/16, 32/16– or Wall @ 24 oc	3/8, 7/16, 15/32, 1/2	24	24[3]

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

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

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

[1]Wall sheathing. The allowable grade, panel thickness and stud spacing are shown in Table No. R-402.3c. The panels may be applied horizontally or vertically. If the panels are applied horizontally, the end joints of the panels shall be offset so that four panels 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.

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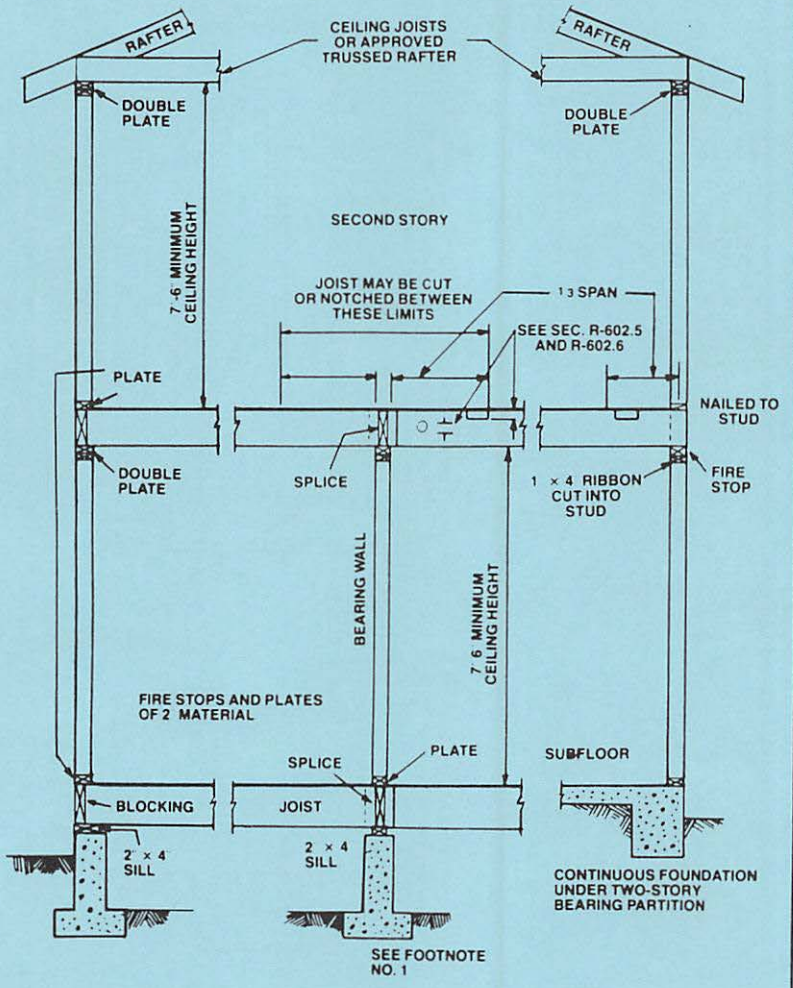
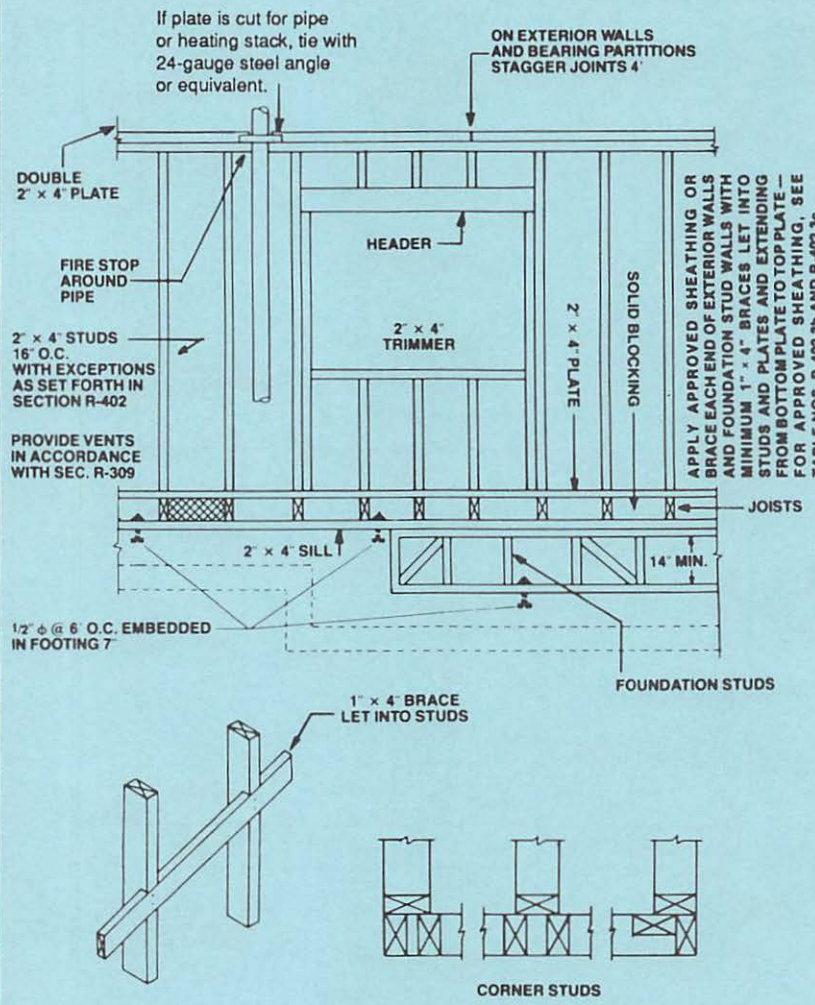
Figure No. R-402.3a
TYPICAL WALL, FLOOR AND ROOF FRAMING



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

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

Figure No. R-402.3b
FRAMING DETAILS



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

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

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

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

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

Nailed-only plywood-box headers shall be designed in accordance with the NAHB "Construction Guide, Design Tables and Technical Report for Plywood Headers for Residential Construction, Table F," listed in Section S-26.402, or by approved engineering practice. Plywood used for beam webs shall be in accordance with DOC PS1 or DOC PS2 listed in Section S-26.402.

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

R-402.6.1 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 of the header shall rest on a single header (jack) stud.
3. For openings more than 6 feet wide, each end of the header shall rest on two header (jack) studs.

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

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

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

The integrity of all firestops shall be maintained.

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

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

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

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

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

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

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

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

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

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

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

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

*See notes to Table No. R-402.6a

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

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

*See notes to Table No. R-402.6a

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

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

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

*See notes to Table No. R-402.6a

Table No. R-402.6f
HEADER DESIGN CHART
(Spruce-Pine-Fir No. 2, Roof Load = 30 LL + 10 DL; Floor Load = 40 LL + 10 DL)
F_b = 875 E = 1,300,000 F_v = 70

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

*See notes to Table No. R-402.6a

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

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

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

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

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

The integrity of all draftstops shall be maintained.

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

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

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

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

Table No. R-402.10
WALL BRACING

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

Table No. R-402.10(Continued)
WALL BRACING

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

[1]Foundations wall panels braced same as story above.
[2]Where structural sheathing is used, each braced panel must be at least 48 inches in width.
[3]Structural sheathing and let-in bracing shall be located at each end or as near thereto as possible.

R-402.10.1 Structural bracing in 100 mph zone:

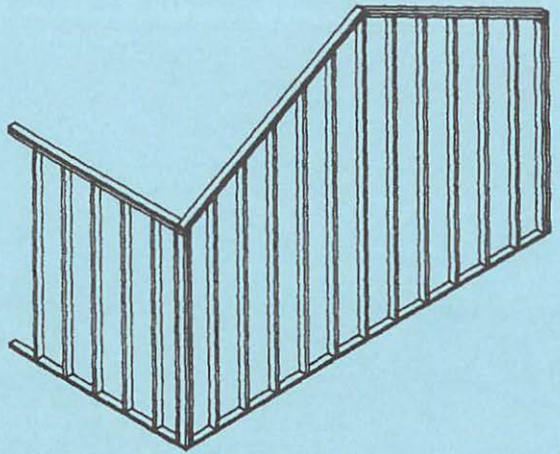
1. One story or top story: brace each corner and at 25 foot intervals with 1 X 4 let-in bracing of 4 X 8 wood structural sheathing panel.
2. All other stories: solid wood structural sheathing panels with blocking at all panel edges.

R-402.10.2 Structural bracing in 110 mph zone: All stories: solid wood structural sheathing panels with blocking at all edges.

R-402.11 Gable endwalls: Gable endwalls in wind zones of 90 mph and above shall be built using full-height studs continuous from the uppermost floor to the roof, or a floor or ceiling diaphragm shall be provided to resist the lateral loads at the horizontal joint between the top plate of a platform-framed end wall and the gable construction above.

R-402.11.1 Full-height studs: Where full-height studs are used for gable construction, the wall shall be built in accordance with Figure R-402.11a.

R-402.11.2 Ceiling diaphragm: Where a gypsum board ceiling is used to create the required diaphragm, the diaphragm length shall be a minimum of two times the width of the building. The gypsum board shall be a minimum of 1/2 inch thick, be attached with the long direction perpendicular to the ceiling framing members, and be fastened directly to the ceiling joist or bottom chords of trusses (no furring) with 5d cooler nails or GWB-54 1-1/2 inch nails, installed ten inches on center in the board field and 7 inches on center at the board ends and the ceiling edges. The ceiling diaphragm shall be fastened to 2x perimeter blocking members which are fastened to the top plates with 10d common or hot-dipped box nails at 6 inches on center. (See Figure R-402.11b). Lateral bracing shall be installed on the tops of ceiling joists or truss bottom chords at a spacing of not greater than six feet. The lateral bracing shall be a minimum of 2x4 lumber extending inward from the gable end a minimum of eight feet and fastened to each truss or ceiling joist and the gable end with a minimum of two 10d common or hot-dipped galvanized box nails. A minimum of 2x4 lumber blocking shall be installed in the first truss or joist space directly below, and attached to, the lateral brace with a minimum of four 10d common or hot-dipped galvanized box nails. A minimum of a one inch wide 16 gauge steel strap shall be fastened lengthwise over the top of each lateral brace, and to the endwall studs, with a minimum of ten 8d common or hot-dipped galvanized box nails (see Figure 402.11c).



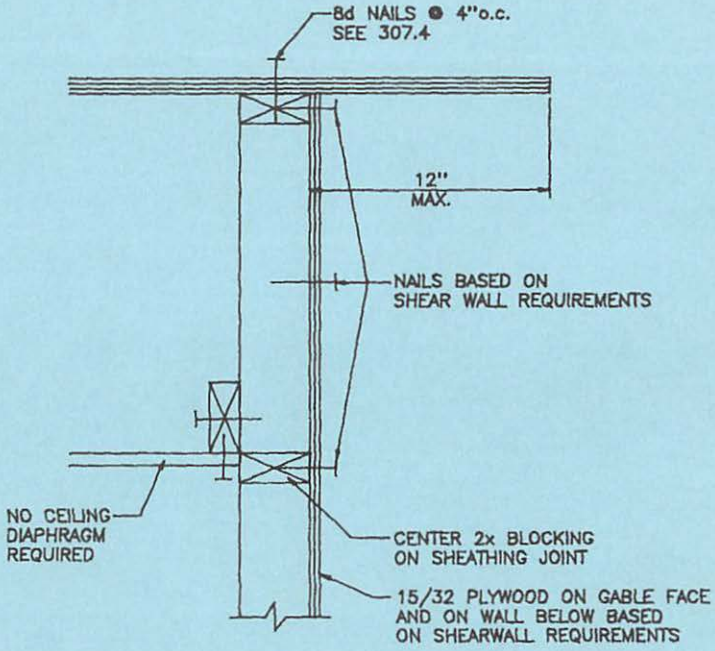


Figure R-402.11a
Gable Endwall Balloon Framing
Preferred Method

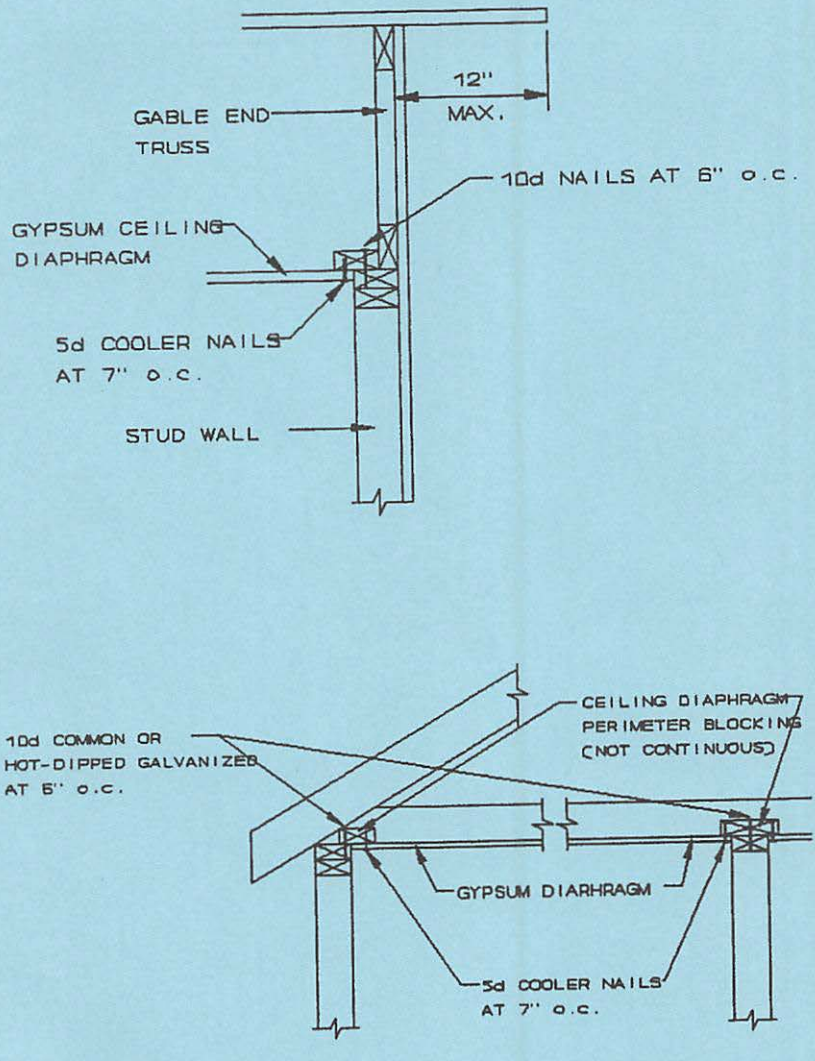
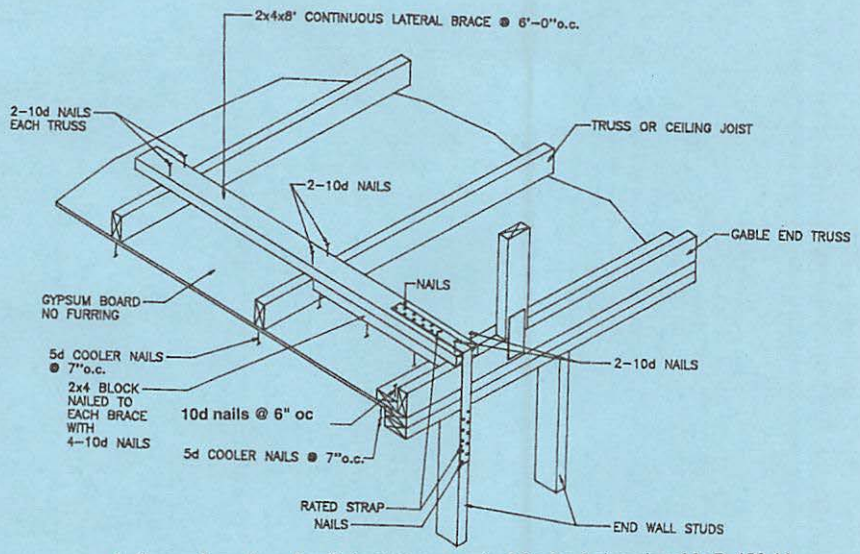


Figure R-402.11b
Gable Endwall Balloon Framing
Alternate Method



1. Size and number of nails in strap as required for load given in table R-402.11.

Figure R-402.11c
Ceiling Connection to Gable Endwall
For Gypsum Board Diaphragms

Table R-402.11
Required Endwall Connection Capacities

Wind Speed (mph)	Building Width (feet)	Required Capacity of Rated Straps in Gable Endwall Construction (lbs)
90	24	540
	36	660
	44	720
	52	780
	60	840
100	24	690
	36	810
	44	888
	52	972
	60	1050
110	24	840
	36	990
	44	1092
	52	1182
	60	1260

SECTION R-403— METAL

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

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

SECTION R-404— GENERAL MASONRY CONSTRUCTION

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

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

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

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

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

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

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

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

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

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

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

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

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

R-404.3.3 Combined units: In walls or other structural members composed of different kinds or grades of units, materials or mortars, the combination of units, materials and mortars of which the member is composed. The net thickness of any facing unit which is used to resist stress shall not be less than 1 1/2 inches.

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

Hollow piers shall be capped with 4 inches of solid masonry or concrete for 1 story and 8 inches of solid masonry or concrete for 2 or 2-1/2 story buildings or shall have cavities of the top course filled with concrete or grout or other methods approved by the building official.

Table No. R-404.3.1
ALLOWABLE COMPRESSIVE STRESSES FOR EMPIRICAL DESIGN OF MASONRY

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

[1] See Section R-408.

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

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

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

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

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

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

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

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

Table No. R-404.7
WALL LATERAL SUPPORT REQUIREMENTS

CONSTRUCTION	Maximum Wall Length to Thickness,[1, 2] or Wall Height to Thickness
Bearings walls	
Solid or solid grouted	20
All other[3]	18
Nonbearing walls	
Exterior[3]	18
Interior	36

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

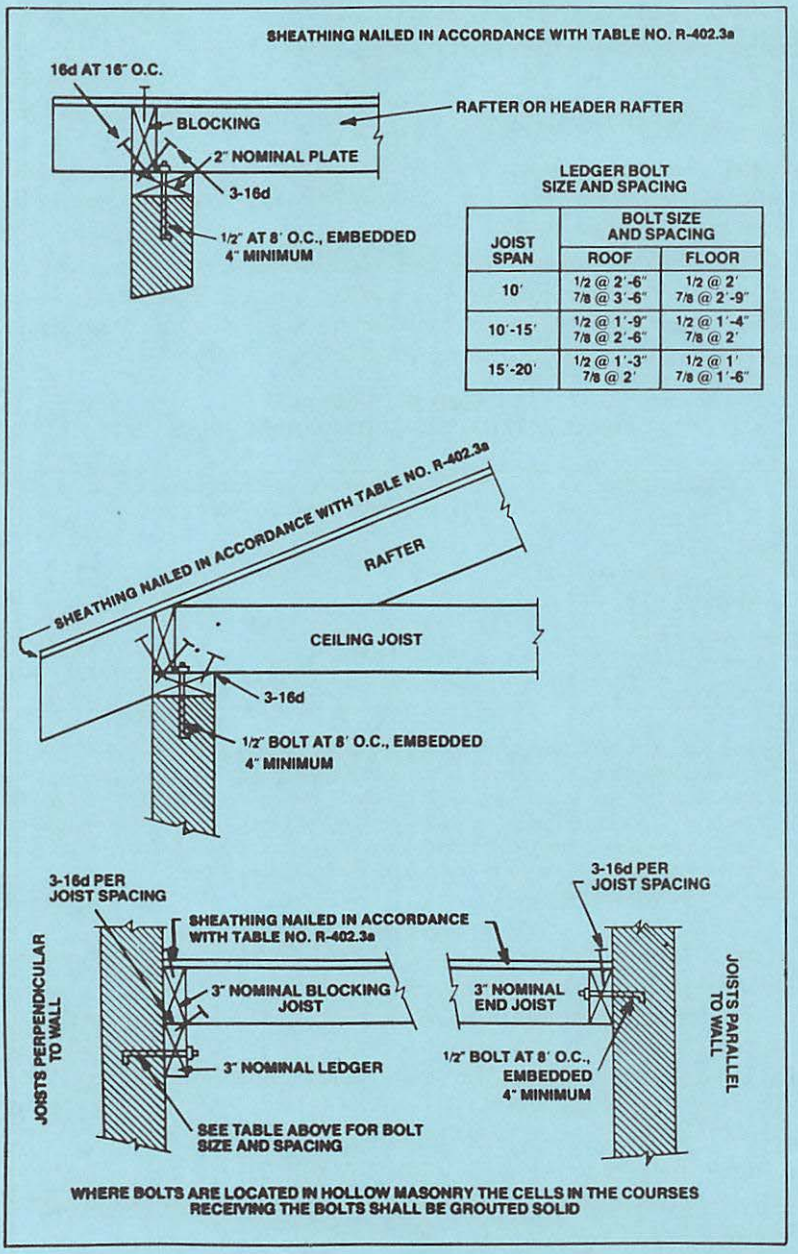
[2] An additional unsupported height of 6 feet is permitted for gable end walls.

[3] Cavity walls maximum ratio 15.

R-404.8 Lintels: Masonry over openings shall be supported by steel lintels, reinforced concrete or masonry lintels or masonry arches, designed to support load imposed. Lintels and arches shall be constructed of materials and designed in accordance with the AISC "Specification for the Design, Fabrication and Erection of Structural Steel Buildings," BIA Technical Notes 17H, 31A, or 31B, NCMA TR 91, NCMA TEK 25A or NCMA TEK 81, listed in Section S-26.404. See Table R-503.4.1.

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

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



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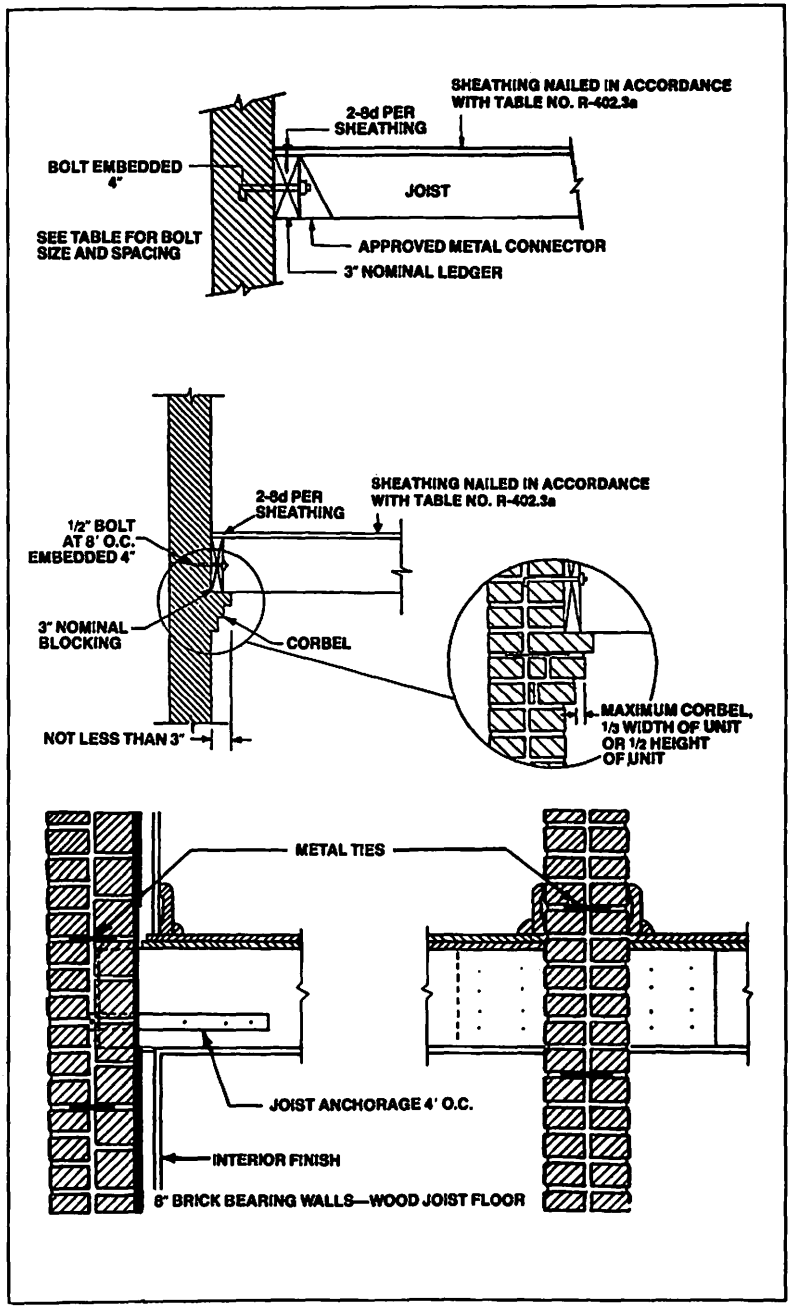

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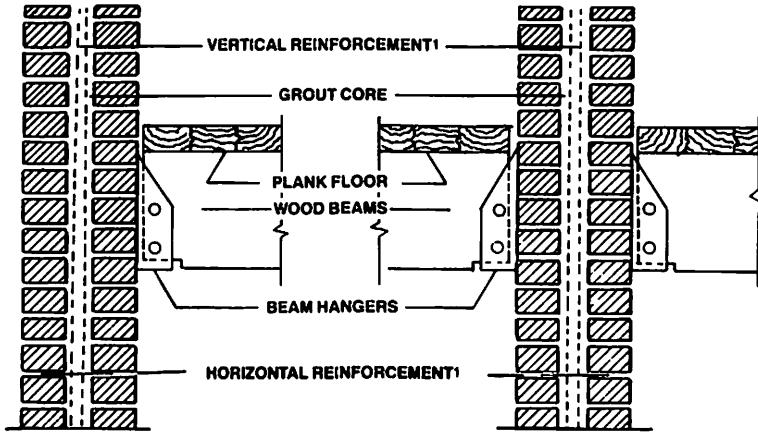
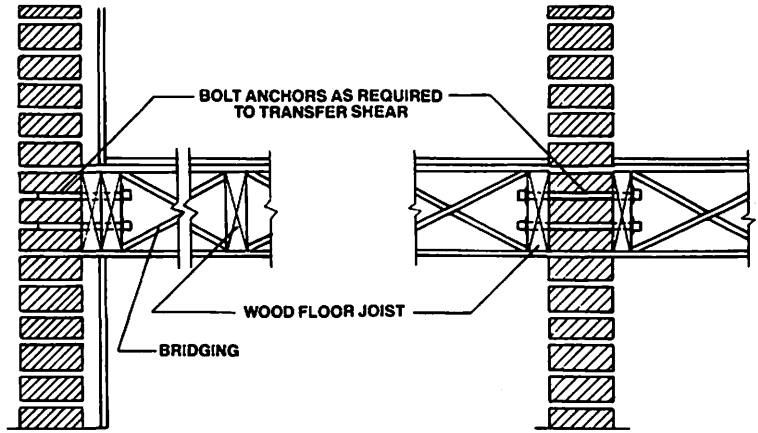


1. Horizontal and vertical reinforcement will vary with design requirements.

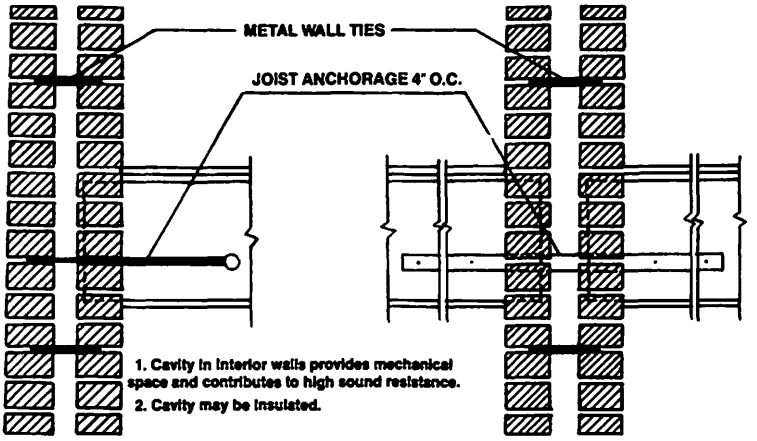
10" RBM BEARING WALLS—PLANK AND BEAM TIMBER FLOOR



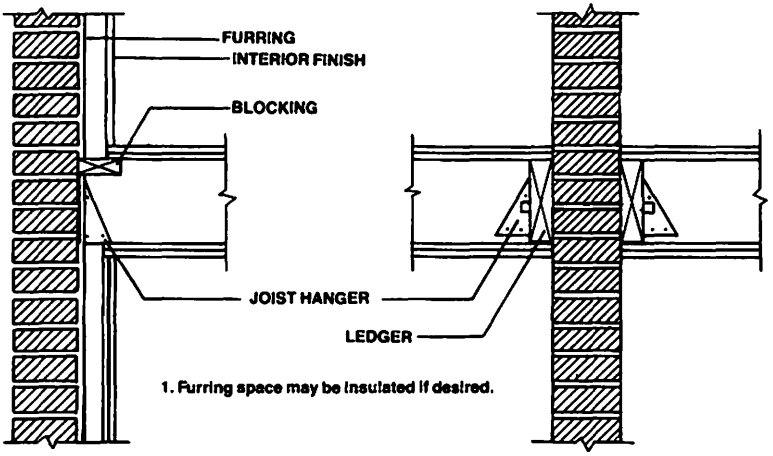
6" BRICK SHEAR WALLS—WOOD JOIST FLOOR

(Continued)

Figure No. R-404.9 (Continued)



10" BRICK CAVITY BEARING WALLS—
WOOD JOIST FLOOR



6" BRICK BEARING WALLS—WOOD JOIST FLOOR

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

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

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

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

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

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

(Remove pages 69-70)

Table No. R-404.13.1
MINIMUM CORROSION PROTECTION

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

R-404.14 Used Brick or Materials: Used materials shall not be used, unless such materials conform to these requirements and have been thoroughly cleaned.

SECTION R-405–UNIT MASONRY

R-405.1 Placing mortar and masonry units

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

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

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

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

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

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

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

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

SECTION R-406—ANCHORAGE

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

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

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

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

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

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

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

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

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

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

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

SECTION R-407— MULTIPLE WYTHE MASONRY

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

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

R-407.1.1 Bonding with masonry headers:

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

R-407.1.2 Bonding with wall ties or joint reinforcement:

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

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

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

R-407.1.3 Bonding with natural or cast stone:

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

R-407.2 Masonry bonding pattern

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

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

SECTION R-408— GROUTED MASONRY

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

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

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

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

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

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

[1]For grouting between masonry wythes.

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

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

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

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

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

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

Grout shall not be pumped through aluminum pipes.

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

SECTION R-409— REINFORCED GROUTED MASONRY

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

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

SECTION R-410— REINFORCED HOLLOW-UNIT MASONRY

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

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

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

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

SECTION R-411— WINDOWS

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

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

1. Regardless of the type or requirements of the windows set forth in the aforementioned specifications, no window may be selected whose air infiltration exceeds 0.50 cfm per linear foot of crack when tested in accordance with ASTM E283 listed in Section S-26.411 at a pressure differential of 1.56 psf.

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

SECTION R-412— SLIDING GLASS DOORS

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

Aluminum: AAMA (ANSI) 101

Wood: ANSI/NWWDA I.S.3

Exceptions

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

SECTION R-413— WOOD STRUCTURAL PANELS

R-413.1 Identification and grade: Wood structural panels shall conform to DOC PS1, DOC PS2, APA PRP-108, HPMA (ANSI) HP, APA E30, APA Y510 or HPMA HP-SG, listed in Section S-26.413 and shall be so identified by a grade mark or certificate of inspection issued by an approved agency. Wood structural panels shall comply with the grades specified in Table No. R-402.3b.

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

R-413.3 Installation: Wood structural panel wall sheathing shall be attached to framing in accordance with Table No. R-402.3a. Wood structural panels rated for Exposure 1 or Exterior are considered water-repellent sheathing under this code.

SECTION R-414— PARTICLEBOARD

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

Chapter 5
WALL COVERING

SECTION R-501 — GENERAL

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

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

SECTION R-502 — INTERIOR COVERING

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

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

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

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

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

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

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

TYPE OF LATH		MINIMUM WEIGHT (Per Square Yard) GAUGE AND MESH SIZE	VERTICAL (In Inches)			HORIZONTAL (In Inches)	
				Metal			
			Wood	Solid Plaster Partitions	Other	Wood or Concrete	Metal
Expanded metal lath (diamond mesh)		2.5 3.4	16 16	16 16	12 16	— 16	— 13½
Flat rib expanded metal lath		2.75 3.4	16 19	16 24	16 19	16 19	12 19
Stucco mesh expanded metal lath		1.8 and 3.6	16[2]	—	—	—	—
⅜" rib expanded metal lath		3.4 4.0	24 24	24 24	24 24	24 24	24 24
Sheet lath		4.5	24	—	24	24	24
¾" rib expanded metal lath		5.4	—	—	—	36[3]	36[3]
Wire lath	Welded	1.95 pounds, No. 11 gauge, 2" × 2"	24	24	24	24	24
		1.4 pounds, No. 16 gauge, 2" × 2"	16	16	16	16	16
		1.4 pounds, No. 18 gauge, 1" × 1"[4]	16	—	—	—	—
	Woven	1.4 pounds, No. 17 gauge, 1½" hexagonal[4]	16	—	—	—	—
		1.4 pounds, No. 18 gauge, 1" hexagonal[4]	16	—	—	—	—
⅜" Gypsum lath (perforated)			16	—	16	16	16
⅜" Gypsum lath (plain)			16	—	16	16	16
½" Gypsum lath (perforated)			16	—	16	16	16
½" Gypsum lath (plain)			24	—	24	24	24

[1]Metal lath and wire lath as reinforcement for portland cement plaster shall be furred out away from vertical supports at least ¼ inch. Self-furring lath meets furring requirements.

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

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

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

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

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

[1]With divergent points and semiflattered round wire for gypsum lath.
[2]When lath and stripping are stapled simultaneously, increase leg length of staple 1/8 inch.
[3]For interior only.
[4]Attach self-furring wire fabric lath to supports at furring device.
[5]Perforated lath.
[6]Plain lath.

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

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

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

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

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

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

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

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

SECTION R-503 — EXTERIOR COVERING

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Table No. R-503.3a
THICKNESS OF PLASTER

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

[1]When measured from back plane of expanded metal lath, exclusive of ribs, or self-furring lath, plaster thickness shall be 3/4 inch minimum.
[2]When measured from face of support or backing.
[3]Because masonry and concrete surfaces may vary in plane, thickness of plaster need not be uniform.
[4]When applied over a liquid bonding agent, finish coat may be applied directly to concrete surface.
[5]Approved acoustical plaster may be applied directly to concrete or over base coat plaster, beyond the maximum plaster thickness shown.
[6]Attachment shall be in accordance with Table No. R-502.5.

3. Minimum of 4 inches x 3-1/2 inches x 1/4 inches steel angle shall be attached to the roof surface. Attachment shall be made 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 rafters. When the roof slope exceeds 4:12, minimum of 3 inches x 3 inches x 1/4 inch plates shall be welded at 24 inch o.c. along the steel angle as stops to prevent the veneer from sliding down the roof slope.
4. Minimum of 1 inch air space shall be maintained between the wall and veneer.
5. Flashing shall be installed over steel angle and a minimum of 6 inch under the wall sheathing.

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

Figure No. R-503.4

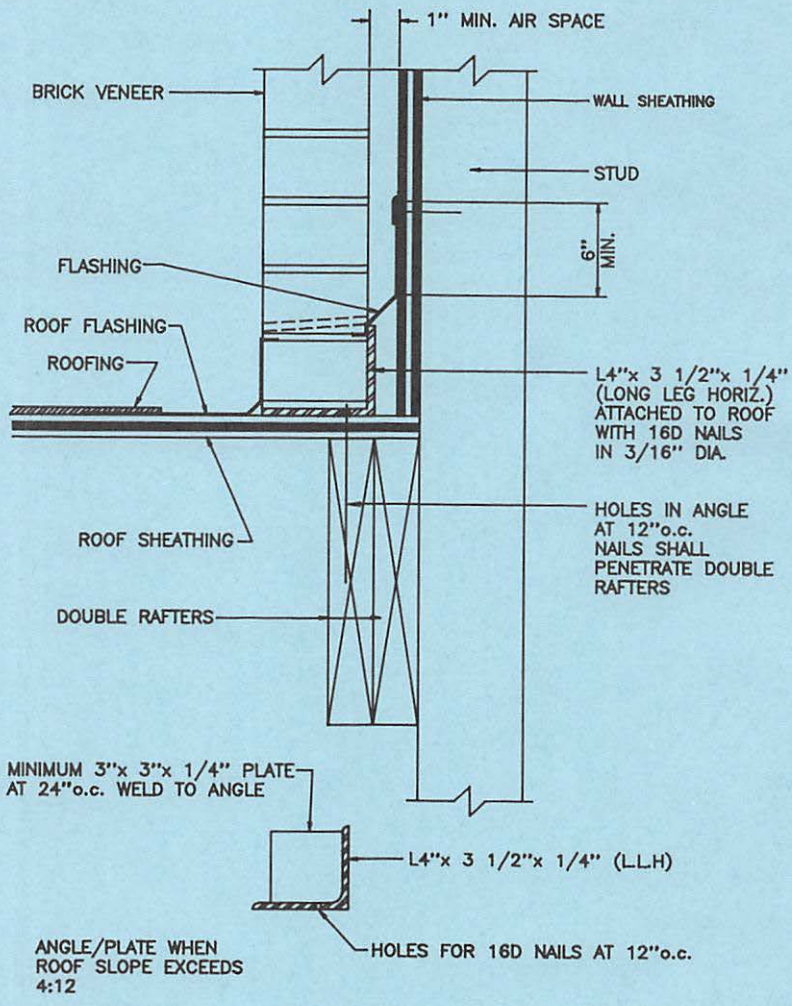


Table No. R-503.3b
GYPSUM PLASTER PROPORTIONS[1]

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

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

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

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

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

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

Table No. R-503.3c
PORTLAND CEMENT PLASTER

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

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

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

3 No additions of plasticizing agents shall be made.

4 See Table No. R-503.3a.

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

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

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

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

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

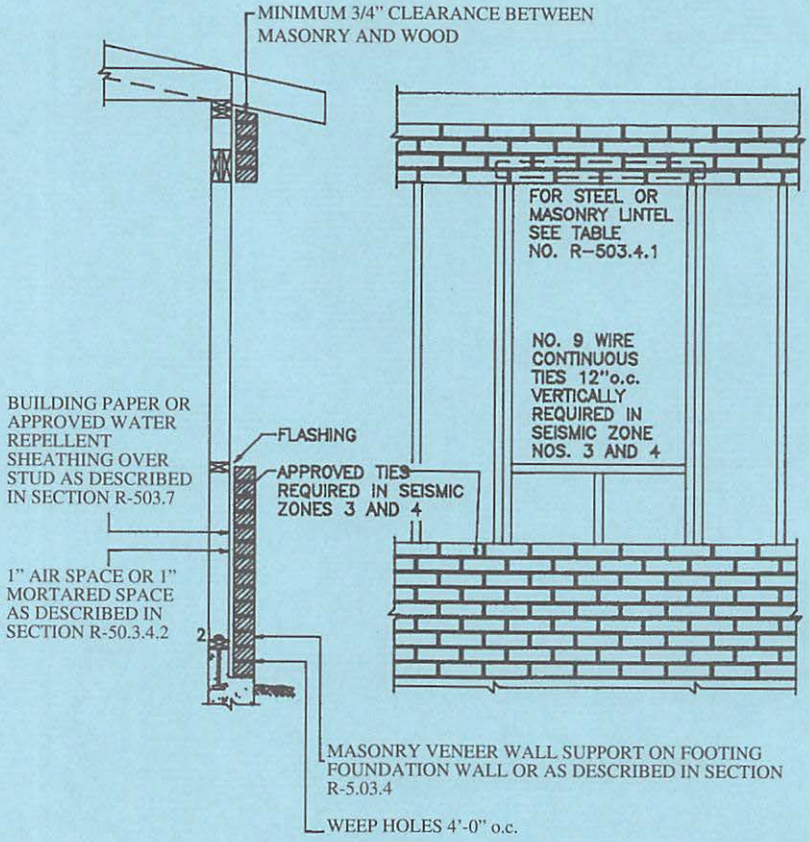


Figure No. R-503.4a
MASONRY VENEERED
WALL DETAIL

R-503.4 Masonry veneer, general: All masonry veneer shall be installed in accordance with this chapter, Figure Nos. R-503.4a and R-503.4b and Table No. R-503.6.

R-503.4.1 Vertical support: Veneers used as interior wall finishes may be supported on wood floors which are designed to support the loads imposed.

1. Exterior masonry veneers having an installed weight of 40 psf or less may be vertically 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 veneer supported by the foundation. The wood construction supporting the masonry veneer shall be designed to limit deflections to L/600 of the span for the supporting members, or

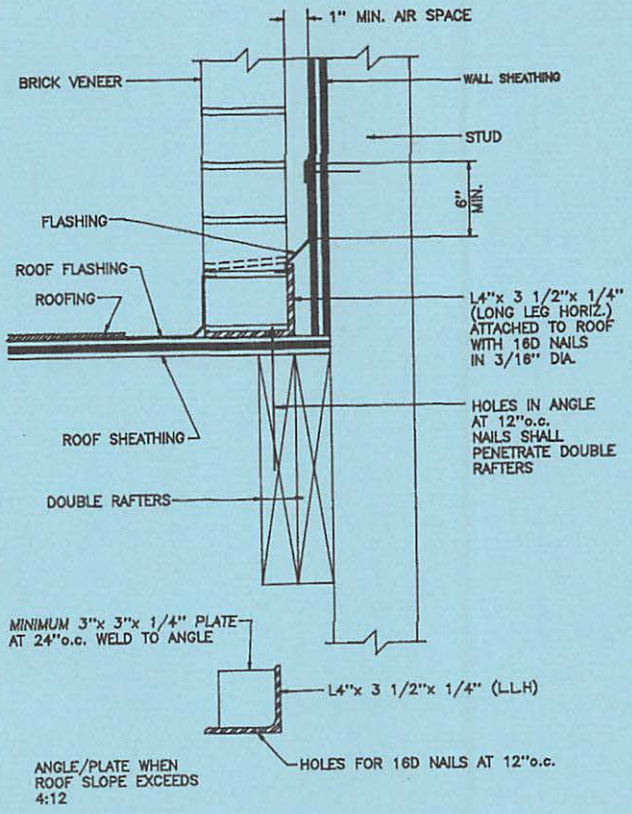


Figure No. R-503.4b
MASONRY VENEERED
SUPPORTED ON WOOD DETAIL

2. Veneer may be vertically supported on sloping surfaces as shown in Figure No. R-503.4b and described in the following provisions:
   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 made 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.

R-503.4.1.1 Wood foundations: Masonry veneers and veneers of concrete or stone may be vertically supported by wood foundations in accordance with NFoPA Technical report No. 7 listed in Section S-26.503.

R-503.4.1.2 Lintels: Masonry veneer shall not support any vertical load other than the dead load of the veneer above. Veneer above openings shall be supported upon lintels of noncombustible materials and the allowable span shall not exceed the values set forth in Table No. R-503.4.1. The lintels shall have a length of bearing of not less than 4 inches.

Table No. R-503.4.1
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 placed 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 standards.

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

Veneer ties, if strand wire, shall not be less in thickness than No. 9 U.S. gauge wire and shall have a hook embedded in the mortar joint, or if sheet metal, not less than No. 22 U.S. gauge by 7/8-inch corrugated. Each tie shall be spaced not more than 24 inches on center horizontally and 16 inches vertically.

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

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

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

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

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

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

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

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

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

Such felt or membrane may be omitted:

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

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

Approved corrosion-resistive flashing (30# felt or 6 mil polyethylene) to prevent moisture from penetration behind the veneer shall be provided at wall bases. The flashing shall extend on the top of the foundation wall to not less than 6 inches under sheathing paper or waterproof sheathing. Provide weep holes at 4-feet on centers.

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

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

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

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

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

					TYPE OF SUPPORTS FOR THE SIDING MATERIAL AND FASTENERS [2,3,4]				
	SIDING MATERIAL	NOMINAL THICKNESS[1] (inches)	JOINT TREATMENT	WEATHER-RESISTANT MEMBRANE REQUIRED	Wood, Wood Structural panel or Particle-board Sheathing	Fiberboard Sheathing into Stud	Gypsum Sheathing into Stud	Direct to Studs	Number or Spacing of Fasteners
Horizontal aluminum [3,6,15]	Without insulation	.019[7]	Lap	No	.120 nail-1 1/2"	.120 nail-2"	.120 nail-2"	Not allowed	Same as stud spacing
		024	Lap	No	.120 nail 1 1/2" long	.120 nail 2" long	.120 nail 2" long	Not allowed	
	With insulation	.019	Lap	No	.120 nail-1 1/2"	.120 nail-2 1/2"	.120 nail-2 1/2"	.120 nail-1 1/2"	
Brick veneer[16] Clay tile veneer Concrete veneer		2 1/4 to 1 2	Sec. 503	Yes	See Sec. R-503 and Figure No. R-503.4[10]				
Horizontal fiberboard[11]		1/2	Sec. 503	No	.099 nail-2" Staple-1 3/4"	.113 nail-2 3/4" Staple-2 1/2"	.113 nail-2 1/2" Staple 2 1/4"	.099-nail 2" Staple-1 3/4"	Same as stud spacing
Hardboard[14] Board and batten-vertical		1/4	(9)	(9)	.099 nail 2"	.099 nail 2 1/2"	.099 nail-2"	.099 nail-1 3/4"	6" panel edges 8" inter.sup.
Hardboard[14] Lap-siding-horizontal		7/16	(9)	(9)	.099 nail-2"	.099 nail-2 1/2"	.099 nail-2 1/4"	.099 nail-2"	Same as stud spacing 2 per bearing
Vertical panel siding		7/16	(9)	(9)	.099 nail-2"	.099 nail-2 1/4"	.099 nail-2"	.080 nail-1 3/4"	6" panel edges 12" inter. sup.
Steel[11]		29 ga.	Lap	No	.113 nail-1 3/4" Staple-1 3/4"	.113 nail-2 3/4" Staple-2 1/2"	.113 nail-2 1/2" Staple-2 1/4"	Not allowed	Same as stud spacing

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

Stone veneer	2	Sec. 503	Yes	See Sec. R-503 and Figure No. R-503.4				
Particleboard panels	3/8	(9)	(9)	.113 nail-2" Staple-1 3/8"	.113 nail-2" Staple-2 1/4"	.113 nail-2" Staple 2	Not allowed	6" on edges 8" inter. sup.
	5/8	(9)	(9)	.113 nail-2" Staple-1 7/8"	.113 nail-2 1/2" Staple-2 1/2"	.113 nail-2 1/2" Staple-2 1/4"	.113 nail-2" Staple-1 3/8"	6" on edges 8" inter. sup.
Wood structural panels[12] (Exterior grade)	3/8	(9)	(9)	.099 nail 2" Staple-1 3/8"	.113 nail-2 1/2" Staple-2 1/4"	.099 nail-2" Staple-2"	.099 nail-2" Staple-1 3/8"	6" on edges 12" inter. sup.
Wood[13] Rustic, drop Shiplap	3/8 Minimum 19/32 Average	Lap	No	Fastener penetration into stud–1"			113 nail-2 1/2" Staple-2"	Face nailing up to 6" widths, 1 nail per bearing, 8" widths and over, 2 nails per bearing
Bevel	7/16	Lap	No					
Butt tipp	3/16	Lap	No					
Shakes[8]	3/8	Lap	Yes	.0915 nail-2"		Staple 2"		
Shingles[8]	3/8	Lap	Yes		16" and 18" shingles 24" shingles	.076 nail-1 1/4" Staple-1 1/4" .080 nail-1 1/2" Staple-1 1/2"		2-fasteners per shingle or shake

1 Based on stud spacing of 16 inches o.c. Where studs are spaced 24 inches, siding may be applied to sheathing approved for that spacing.
2 Nail is a general description and may be T-head, modified round head, or round head with smooth or deformed shanks.
3 Staples shall have a minimum crown width of 7/16-inch O.D. and be manufactured of minimum No. 16 gauge wire.
4 Nails or staples must be aluminum, galvanized, or rust-preventive coated and shall be driven into the studs for fiberboard or gypsum backing.
5 Aluminum nails or other nails complying with AAMA 1402 listed in Section S-26.503 shall be used to attach aluminum siding.
6 As an alternate to the values of Table R-503.6, aluminum siding complying with AAMA 1402 listed in Section S-26.503 may be used.
7 Aluminum (.019 inch) may be unbacked only when the maximum panel width is 10 inches and the maximum flat area is 8 inches. The tolerance for aluminum siding shall be ±0.002 inch of the nominal dimension.
8 Shingles and shakes applied over regular density fiberboard or gypsum sheathing shall be fastened to horizontal wood nailers or fiberboard shingle backer.
9 If boards are applied over sheathing or weather-resistant membrane, joints need not be treated. Otherwise vertical joints must occur at studs and be covered with battens or be lapped.
10 All attachments shall be coated with a corrosion-resistive coating.
11 Shall be of approved type.
12 Three-eighths-inch Wood Structural Panel may be applied directly to studs spaced 16 inches on center. One-half-inch plywood may be applied directly to studs spaced 24 inches on center.
13 Wood board sidings applied vertically shall be nailed to horizontal nailing strips or blocking set 24 inches o.c. Nails shall penetrate 1 1/2 inches into studs, studs and wood sheathing combined, or blocking. A weather-resistant membrane shall be installed weatherboard fashion under the vertical siding unless the siding boards are lapped or battens are used.
14 Hardboard siding shall comply with AHA A135.6 listed in Section S-26.503.
15 Rigid vinyl siding shall be installed in accordance with the vinyl siding institute application instructions.
16. As an alternate to weather resistance membrane, water repellant sheathing may be used if a 1 inch air space is maintained between brick-veneer facing and the sheathing.

Chapter 6
FLOORS

SECTION R-601—GENERAL

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

R-601.2 Requirements: Floors of wood construction shall be designed and constructed in accordance with the NFoPA "National Design Specification for Wood Construction," HPMA (ANSI) LHF, the "Canadian Dimension Lumber Data Book" and the "Southern Pine Maximum Spans for Joists and Rafters," listed in Section S-26.601 and be capable of accommodating all loads imposed according to Section R-201 and transmitting the resulting loads to its supporting structural elements.

SECTION R-602—DIMENSION LUMBER

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

Preservatively treated dimensional lumber shall be identified by the quality mark of an approved agency. See R-308.3.

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

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

R-602.2 Allowable spans

R-602.2.1 Joists, beams and girders: The clear span of floor joists shall not exceed the values set forth in Table Nos. 6-A and 6-B in Appendix B. The modulus of elasticity, E, and the actual stress in bending, F_b, shown in the tables shall not exceed the values specified in Table Nos. 6/7A and 6/7B in Appendix B. The values for F_b, specified as "repetitive member use" may be used when floor joists are spaced not more than 24 inches on center. When floor spans exceed 20 feet, floor joists, built-up beams and trusses shall not be spaced greater than 24 inches o.c. and the total live load deflection shall not exceed the span divided by 480.

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

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

GIRDER LOADING TABLE NOS. R-602.1A-R-602.1D

NOTE: For Loading conditions and Lumber species other than those in the tables, girders shall be designed by a professional engineer with experience in structural design of buildings.

Table No. R-602.2.1a

ALLOWABLE SPAN FOR GIRDERS SUPPORTING ONE FLOOR ONLY

INTERIOR GIRDER CLEAR SPANS [1,2] (FEET)										
Nominal Lumber	HOUSE WIDTH (FEET) [4]									
	20		24		28		32		36	
Size	#2SPF	#2SP	#2SPF	#2SP	#2SPF	#2SP	#2SPF	#2SP	#2SPF	#2SP
2-2x8	5'-3"	6'-5"	4'-7"	5'-7"	4'-1"	4'-11"	3'-9"	4'-6"	3'-6"	4'-1"
3-2x8	7'-4"	7'-11"	6'-3"	7'-3"	5'-7"	6'-8"	5'-0"	6'-1"	4'-7"	5'-7"
2-2x10	6'-9"	7'-9"	5'-10"	7'-1"	5'-3"	6'-4"	4'-9"	5'-8"	4'-5"	5'-3"
3-2x10	9'-1"	9'-6"	8'-0"	8'-8"	7'-1"	8'-0"	6'-5"	7'-6"	5'-10"	7'-1"
2-2x12	8'-2"	9'-1"	7'-1"	8'-3"	6'-4"	7'-8"	5'-10"	6'-11"	5'-4"	6'-4"
3-2x12	10'-6"	11'-1"	9'-7"	10'-2"	8'-8"	9'-5"	7'-9"	8'-9"	7'-2"	8'-3"

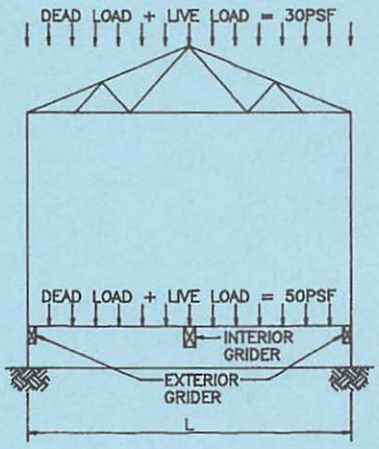
EXTERIOR GIRDER CLEAR SPANS [1,2,3] (FEET)										
Nominal Lumber	HOUSE WIDTH (FEET)									
	20		24		28		32		36	
Size	#2SPF	#2SP	#2SPF	#2SP	#2SPF	#2SP	#2SPF	#2SP	#2SPF	#2SP
2-2x8	5'-9"	6'-10"	5'-0"	6'-2"	4'-6"	5'-6"	4'-2"	5'-0"	3'-10"	4'-7"
2-2x10	7'-4"	8'-2"	6'-5"	7'-6"	5'-9"	7'-0"	5'-4"	6'-4"	4'-11"	5'-10"
2-2x12	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.

(TYPICAL ALL DIAGRAMS)

PSF = POUNDS PER SQUARE FOOT

PLF = POUNDS PER LINEAR FOOT



ONE STORY

Table No. R-602.2.1b

ALLOWABLE SPAN FOR GIRDERS SUPPORTING 2-STORY ONLY

INTERIOR GIRDER CLEAR SPANS [1,2,4] (FEET)

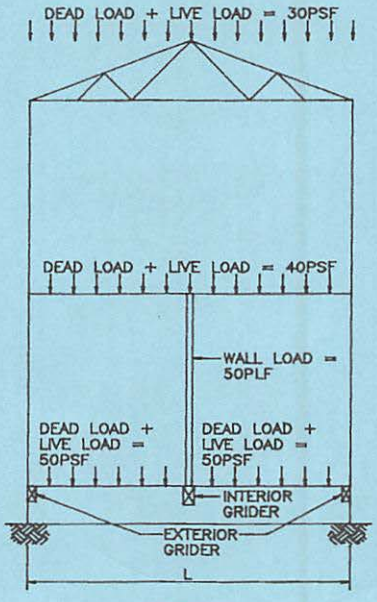
Nominal Lumber Size	HOUSE WIDTH (FEET) [5]									
	20		24		28		32		36	
	#2SPF	#2SP	#2SPF	#2SP	#2SPF	#2SP	#2SPF	#2SP	#2SPF	#2SP
3-2x10	5'-8"	6'-10"	5'-0"	6'-0"	4'-6"	5'-4"	4'-2"	4'-11"	3'-10"	4'-6"
4-2x10	7'-0"	7'-11"	6'-2"	7'-3"	5'-6"	6'-8"	5'-0"	6'-0"	4'-8"	5'-6"
3-2x12	6'-10"	8'-1"	6'-1"	7'-3"	5'-6"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

EXTERIOR GIRDER CLEAR SPANS [1,2,3,4] (FEET)

Nominal Lumber Size	HOUSE WIDTH (FEET)									
	20		24		28		32		36	
	#2SPF	#2SP	#2SPF	#2SP	#2SPF	#2SP	#2SPF	#2SP	#2SPF	#2SP
2-2x10	5'-3"	6'-4"	4'-8"	5'-7"	4'-4"	5'-1"	4'-0"	4'-8"	3'-9"	4'-4"
3-2x10	7'-1"	8'-0"	6'-3"	7'-5"	5'-8"	6'-10"	5'-2"	6'-3"	4'-10"	5'-9"
2-2x12	6'-4"	7'-8"	5'-9"	6'-10"	5'-3"	6'-2"	4'-10"	5'-8"	4'-7"	5'-4"
3-2x12	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.



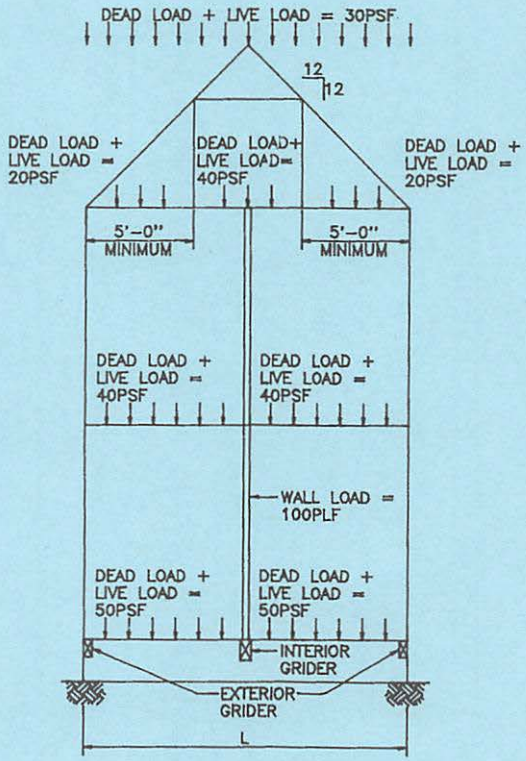
TWO STORY

Table No. R-602.2.1c
ALLOWABLE SPAN FOR GIRDERS SUPPORTING 2 1/2 STORY ONLY

INTERIOR GIRDER CLEAR SPANS [1,2,3] (FEET)										
Nominal Lumber	HOUSE WIDTH (FEET) [4]									
	20		24		28		32		36	
Size	#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 12, for 2 1/2 story construction.
4. House width is equal to 2 x girder spacing.



TWO AND ONE-HALF STORIES

Table No. R-602.1d has been moved to Table No R-303a.

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

Table No. R-602.2.2
MINIMUM THICKNESS OF FLOOR SHEATHING

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

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

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

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

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

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

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

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

R-602.7 Floor framing: Floor framing shall be nailed in accordance with Table No. R-402.3a. Floor systems shall be anchored to foundations in accordance with R-304.7.2. Where posts and beam or girder construction is used to support floor framing, positive connections shall be provided to ensure against uplift and lateral displacement.

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

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

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

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

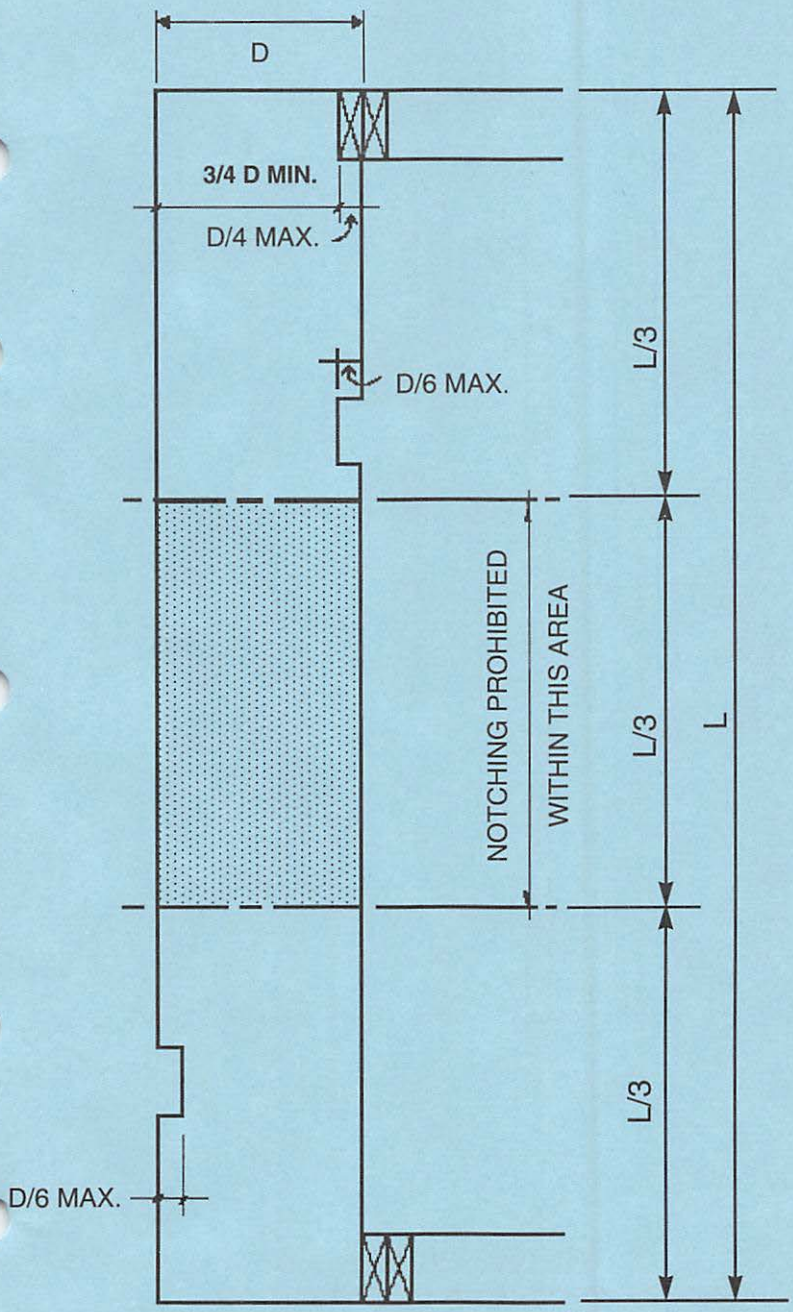


FIGURE 602.5
CUTTING AND NOTCHING LIMITATIONS

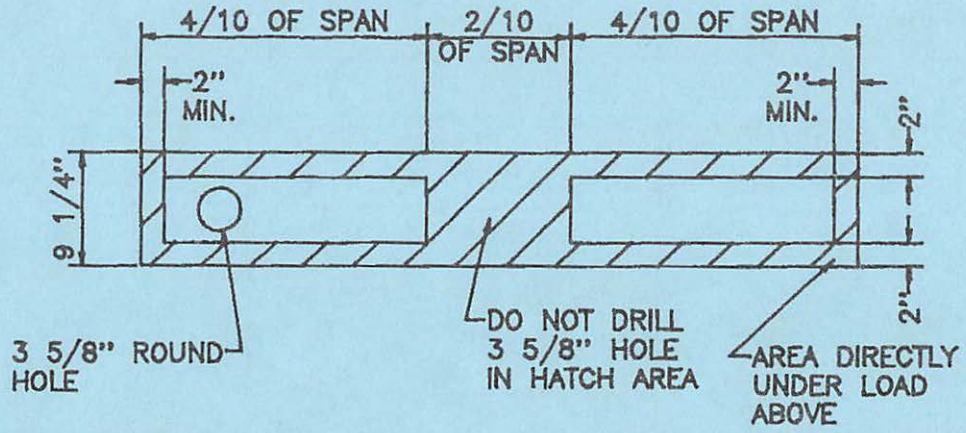


FIGURE No. R–602.6
ACCEPTABLE LOCATION OF 3 5/8' DIAMETER HOLE IN 2X10 JOIST

(1) Do not drill in center 2/10's of joint span.
(2) Do not drill directly under load bearing walls at ends.
(3) Do not drill closer than 2" to top or bottom edge.
(4) Apply 4'–0" joist width x 1/2" CDX plywood with face grain running with joist to both sides using 6d nails or 1 1/2" screws 1" from top and bottom 4" o. c.
(5) Holes shall not be closer than 2'–0" o.c. within unhatched area only.
(6) Plywood shall be attached such that 2' minimum of plywood is on each side of the hole location, except when the hole is located within 2' of end of joist.

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

SECTION R-603—CONCRETE FLOORS (ON GROUND)

R-603.1 General: Concrete slab-on-ground floors shall be constructed in accordance with Figure No. R-303. The specified compressive strength of concrete at 28 days shall be not less than 2,500 pounds per square inch, except where weather exposure requires greater strength and air-entrained concrete, as set forth in Table No. R-302.2. Slab shall be a minimum of 3 1/2 inches thick.

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

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

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

Exception: The vapor retarder and base may be omitted:

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

SECTION R-604–DELETED

SECTION R-605—METAL

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

SECTION R-606—WOOD STRUCTURAL PANELS

R-606.1 Identification and grade: Wood structural panels used for structural purposes shall conform to APA E30, APA Y510, DOC PS1,DOC PS2, APA PRP-108, HPMA (ANSI) HP, and HPMA HP-SG listed in Section S-26.606 and shall be so identified by a grade mark or certificate of inspection issued by an approved agency.

Where used as structural subflooring, wood structural panels shall be of one of the grades specified in Table No. R-606.1a. When used as combination subflooring-underlayment (single floor), the grade shall be as specified in Table No. R-606.1b.

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

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

SECTION R-607—PARTICLEBOARD

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

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

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

Table No. R-606.1a

ALLOWABLE SPANS FOR WOOD STRUCTURAL PANELS FLOOR AND ROOF SHEATHING CONTINUOUS OVER TWO OR MORE SPANS AND FACE GRAIN PERPENDICULAR TO SUPPORTS[1]

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

[1]The allowable loads were determined using a dead load of 10 lbs. per square foot. If the dead load exceeds 10 lbs. per square foot, 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]Includes Structural 1 panels in these grades.

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

[6]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 lbs. per square foot.

[7]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.

[8]Unsupported edges shall have tongue-and-groove joints or shall be supported by blocking unless nominal 1/4-inch-thick underlayment 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 lbs. per square foot, except panels with a Span Rating of 48 oc are limited to 65 lbs. per square foot total uniform load at maximum span.

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

[10]Maximum span 24 inches where 1 1/2 inches of lightweight concrete or approved cellular concrete is placed over the subfloor.

[11]Maximum span 24 inches for 1/2-inch panels.

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

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

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

[2]Applicable to all grades of sanded Exterior-type wood structural panel.

Table R-607.1.2
ALLOWABLE SPANS FOR PARTICLEBOARD SUBFLOOR AND COMBINED SUBFLOOR-UNDERLAYMENT[1,4]

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

1 All panels are continuous over two or more spans and the tongue-and-groove panels are installed with the long dimension perpendicular to supports.

2 Uniform deflection limitation: 1/360 of the span under 100 psf minimum load.

3 Edges shall have tongue-and-groove joints or shall be supported with blocking unless 1/4-inch minimum thickness underlayment is installed or finish floor is 25/32-inch wood strip.

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

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

Chapter 7
ROOF-CEILING CONSTRUCTION

SECTION R-701—GENERAL

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

R-701.2 Requirements: Roof-ceilings of wood construction shall be designed and constructed in accordance with the NFoPA *National Design Specification for Wood Construction,* the *Canadian Dimension Lumber Data Book,* or the *Southern Pine Maximum Spans for Joists and Rafters,* listed in Section S-26.701 and shall be capable of accommodating all loads imposed according to Section R-201 and shall transmit the resulting loads to its supporting structural elements. Roofs shall be designed to resist both the positive and negative wind forces. Roof rafters with slopes 7:12 and greater in 110 mph wind zones sized to resist a live load of 25 psf are adequate to resist the positive wind forces. Roof rafters in lower wind zones or with lower slopes designed to resist a live load of 20 psf or more are adequate to resist the positive wind forces. Interpolation may be done between 20 psf and 30 psf span tables in Appendix B.

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

SECTION R-702—DIMENSION LUMBER

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

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

R-702.2 Framing details: Rafters shall be nailed to ceiling joists to form a continuous tie between exterior walls where joists are parallel to the rafters. Where not parallel, rafters shall be tied with a rafter tie, located as near the plate as practical. Rafter ties shall be spaced not more than 4 feet on center. Rafters shall be framed to ridge board or to each other with gusset plate as a tie. Ridge board shall be at least 1-inch nominal thickness and not less in depth than the cut end of the rafter and opposing rafter shall not be offset more than the thickness of the ridge board. At all valleys and hips there shall be a valley or hip rafter not less than 2-inch nominal thickness and not less in depth than the cut end of the rafter. Hip and valley rafters shall be supported at the ridge by a brace to a bearing partition or be designed to carry and distribute the specific load at that point.

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

A 1x6 or 2x4 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 No. R-402.3a for rafter ties.

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

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

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

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

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

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

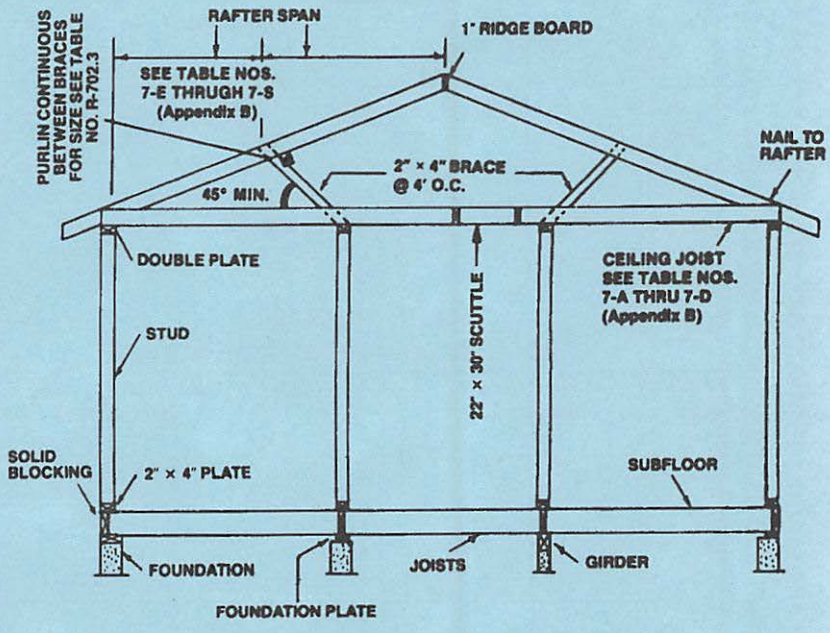
SIZE OF ROOF PURLIN BRACED AT 4'O.C.	MAXIMUM ALLOWABLE RAFTER SPAN [1]	
	30 Lbs. Per Sq. Ft. L.L. & D.L.	40 Lbs. Per Sq. Ft. L.L. & D.L.
2"x 4"	5' - 0"	3' - 6"
2" x 6"	11' - 6"	8' - 6"

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

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

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

Figure No. R-702.3
FRAMING DETAILS



Notes:

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

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

[3]Braces over 5 feet in length shall be laterally supported.

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

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

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

R-702.10 Roof Tie-Down: Roof rafters and trusses shall be attached to the wall in accordance with the requirements of Table No. R-702.10 in addition to the nailing requirements in Table No. R-402.3a. For trusses, the nailing requirements from Table No. R-402.3a shall include the nailing requirements for both rafters and ceiling joist. As an alternate to the anchorage requirements of Tables R-402.3a and R-702.10, 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 conection 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 No. R-702.10. 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 No. R-702.10 [1, 2]

ROOF TIE DOWN REQUIREMENTS

Basic Wind Velocity (MPH)	Maximum Structure	Roof Slopes	Anchorage along Exterior Wall
70	All Widths	All Slopes	Table No. R-402.3a
80	All Widths	All Slopes	Table No. R-402.3a
90	36 feet	2:12 to 12:12	345 lb/ft
100	36 feet	2:12 to 12:12	475 lb/ft
110	36 feet	2:12 to 12:12	615b/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 C-2705.5 for material requirements in Coastal High Hazard Areas and Ocean Hazard Areas.

SECTION R-703—WOOD STRUCTURAL PANELS

R-703.1 Identification and grade: Wood structural panels shall conform to DOC PS1, DOC PS2or APA PRP-108 listed in Section S-26.703, and be identified by grade mark or certificate of inspection issued by an approved agency. Wood structural panels shall comply with the grades specified in Table No. R-606.1a.

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

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

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

R-703.3 Installation: Wood structural panels roof sheathing shall be installed with joints staggered or nonstaggered, in accordance with APA E30 listed in Section S-26.703 and Table No. R-606.1a..

SECTION R-704—PARTICLEBOARD

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

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

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

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

[1]Panels are continuous over two or more spans.
[2]Uniform load deflection limitations: 1/180 of the span under live load plus dead load and 1/240 of the span under live load only.
[3]Edges shall be tongue and groove or supported with blocking or edge clips.
[4]The panels may be applied parallel or perpendicular to the span of the rafters or joists and shall be continuous over two or more spans. If the panels are applied perpendicular to roof supports, the end joints of the panels shall be offset so that four panel corners will not meet. Cutouts for items such as plumbing and electrical shall be oversized to avoid a forced fit. A 1/2-inch gap must be provided between the panel and concrete and masonry walls. Leave a 1/16-inch gap between panels and nail no closer than 3/8 inch from panel edge.

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

SECTION R-705 — METAL

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

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

SECTION R-706 — CEILING FINISHES

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

SECTION R-707 — ATTIC VENTILATION

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

Exception: turbine ventilators

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

Cathedral ceilings shall have a 1 inch minimum clearance between the bottom of the roof deck and the insulation.

SECTION R-708 — ATTIC ACCESS

An accessible attic access framed opening not less than 21 inches by 30 inches shall be provided to any attic area having a clear height of over 30 inches. See M-1101.1.4 for equipment access.

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.

Chapter 8
ROOF COVERINGS

SECTION R-801—GENERAL

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

R-801.2 Requirements: The roof covering shall be capable of accommodating the loads indicated in Section R-201 and provide a barrier against the weather to protect its supporting elements and the structure beneath. Fasteners shall be in accordance with Table Nos. R-803.4 and R-808.2a. Not more than one extra roof covering may be installed over the original roof.

R-801.3 Roofing covering materials: Roofs shall be covered with materials as set forth in Sections R-803 through R-809. Roof covering materials shall conform to ASTM A239, A361, B134, B209, B211, B250, C406, and D312; the CSSB "Grading Rules for Wood Shakes and Singles" listed in Section S-26.801. Classified roofing shall conform to UL 790 listed in Section S-26.801 and shall be installed in areas designated by law as requiring their use or when the edge of the roof is less than 6 feet from a property line or less than 12 feet between buildings. The roofing materials set forth in Sections R-804 through R-807 and concrete slabs may be accepted as Class A roofing.

SECTION R-802—DECK PREPARATION

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

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

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

SECTION R-803 — ASPHALT SHINGLES

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

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

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

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

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

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

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

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

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

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

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

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

Table No. R-803.4
ASPHALT SHINGLE APPLICATION

ROOF SLOPE	NOT PERMITTED BELOW 2:12	
	2:12 to less than 4:12	4:12 and over
DECK REQUIREMENT	Asphalt shingles shall be fastened to solidly sheathed roofs. Sheathing shall conform to Table Nos. R-606.1a & R-704.2.	
UNDERLAYMENT Temperate climate	Asphalt strip shingles may be installed on slopes as low as 2 inches in 12 inches, provided the shingles are approved self-sealing or are hand-sealed and are installed with an underlayment consisting of two layers of nonperforated Type 15 felt applied shingle fashion. Starting with an 18-inch-wide sheet and a 36-inch-wide sheet over it at the eaves, each subsequent sheet shall be lapped 19 inches horizontally.	One layer nonperforated Type 15 felt lapped 2 inches horizontally and 4 inches vertically to shed water.
Severe climate: In areas subject to wind-driven snow or roof ice buildup.	Same as for temperate climate, and additionally the two layers shall be solid cemented together with approved cementing material between the plies extending from the eave up the roof to a line 24 inches inside the exterior wall line of the building.	Same as for temperate climate, except that one layer No. 40 coated roofing or coated glass base sheet shall be applied from the eaves to a line 12 inches inside the exterior wall line with all laps cemented together.
ATTACHMENT Type of fasteners	Corrosion-resistant nails, minimum 12-gauge ⅜-inch head, or approved corrosion-resistant staples, minimum 16-gauge $^{15}/_{16}$-inch crown width. Fasteners shall be long enough to penetrate into the sheathing ¾ inch or through the thickness of the sheathing, whichever is less.	
No. of fasteners[1]	4 per 36-40-inch strip 2 per 9-18-inch shingle	
Exposure Field of roof Hips and ridges	Per manufacturer's instructions included with packages of shingles. Hip and ridge weather exposures shall not exceed those permitted for the field of the roof.	
Method	Per manufacturer's instructions included with packages of shingles.	
FLASHINGS Valleys Other flashings	Per Section R-803.5 Per Sections R-803.6 and R-803.7	

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

SECTION R-804 — SLATE SHINGLES

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

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

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

SECTION R-805 — METAL

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

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

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

SECTION R-806 — TILE, CLAY OR CONCRETE SHINGLES

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

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

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

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

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

SECTION R-807 — BUILT-UP ROOFING

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

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

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

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

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

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

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

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

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

SECTION R-808 — WOOD SHINGLES

R-808.1 Sheathing requirements: Wood shingles may be applied to roofs with solid or spaced sheathing. Spaced sheathing shall be not less than 1" x 4" nominal dimensions and shall be spaced on center a distance equal to the weather exposure set forth in Table R-808.2b.

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

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

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

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

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

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

ROOF SLOPE DECK REQUIREMENT	WOOD SHINGLES Not Permitted below 3:12 See Table No. R-808.2b Wood shingles shall be applied to roof having solid or spaced sheathing in accordance with Section R-808.1	WOOD SHAKES Not Permitted below 4:12[1] See Table No. R-808.2b Wood shakes shall be applied to roof having solid or spaced sheathing in accordance with Section R-808.1
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 wind-driven snow or 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 Type of Fasteners	Corrosion-resistant nails, minimum No. 14 1/2-gauge, 7/32-inch head, or corrosion resistant staples when approved by the building officials.	Corrosion-resistant nails, minimum No. 13-gauge 7/32 inch head, or corrosion-resistant staples, when approved by the building official.
	Fasteners shall be long enough to penetrate into the sheathing 3/4 inch or through the thickness of the sheathing, whichever is less.	
No. of fasteners	2 per shingle	2 per shake
Exposure Field of roof Hips and ridges	Weather exposures shall not exceed those set forth in Table No. R-808.2b. Hip and ridge weather exposures shall not exceed those permitted for the field of the roof.	

(continued)

Table No. R-808.2a (Continued)

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

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

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

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

[1]To be used only when specifically permitted by the building official.
[2]Exposure of 24-inch by 3/8-inch resawn handsplit shakes shall not exceed 7 1/2 inches regardless of the roof slope.
[3]No. 2 grade wood shakes pertain to Taper-Sawn shakes only.

SECTION R-809 — WOOD SHAKES

R-809.1 Sheathing requirements: Wood shakes and preservatively treated wood shakes shall be applied to roofs with solid or spaced sheathing. Spaced sheathing boards shall be not less than 1-inch by 4-inch nominal size for shakes installed at 7 1/2-inch exposures and shall be spaced on centers a distance equal to the weather exposure set forth in Table R-808.2b. For 24 inch shakes used at 10 inch exposure, the spaced sheathing shall be either 1 inch x 4 inch nominal dimension boards spaced on centers a distance equal to the weather exposure with an additional 1-inch X 4-inch nominal dimension boards spaced on centers a distance equal to the weather exposure with an additional 1-inch X 4-inch board placed between these boards, or 1-inch X 6-inch nominal dimension boards spaced on centers a distance equal to the weather exposure. In snow areas, sheathing shall be solid and the shakes shall be applied over an underlayment of not less than No. 15 felt, applied as required in Section R-802.

R-809.2 Installation: Wood shakes and preservatively treated wood shakes shall be applied in accordance with CSSB "Grading Rules for Wood Shakes and Shingles" listed in Section S-26.810. Preservatively treated wood shakes shall conform to CSSB "Wood Shakes (Preservative Treated) based on Grading and Packing Rules for treated Southern Pine Taper-Sawn Shakes of the Cedar Shake and Shingle Bureau" listed in Section S-26.810.

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

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

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

Shakes shall not be installed on a roof having a slope less than 4 inches in 12 inches unless they are installed over an underlayment of not less than No. 30 felt, applied as required in Section R-802.

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

Weather exposures shall not exceed those set forth in Table No. R-808.2b. Hip and ridge weather exposures shall not exceed those permitted for the field of the roof. Wood shake hip and ridge units shall conform to CSSB "Grading Rules for Shake Hip and Ridge based on the Standards of the Cedar Shake and Shingle Bureau" listed in Section S-26.810. Nails used to fasten hip and ridge units shall be longer than those used in the field of the roof in order to penetrate the sheathing 3/4 inch minimum.

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

Chapter 9
CHIMNEYS AND FIREPLACES

SECTION R-901—MASONRY CHIMNEYS

R-901.1 Support: Masonry chimneys shall be designed, anchored, supported and reinforced as required in this chapter and the applicable provisions of Chapters 2, 3 and 4. Chimneys shall be structurally sound, durable, smoke-tight and capable of conveying flue gases to the exterior safely.

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

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

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

R-901.4 Additional load: Chimneys shall not support loads other than their own weight unless they are designed and constructed to support the additional load. Ends of wood girders may be supported on a corbeled shelf of a chimney.

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

Cap chimneys with brick, concrete, stone, terra cotta, or other non-combustible 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.

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

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

R-901.8 Flue Linings

R-901.8.1 Flue lining (installation): Flue liners shall extend from a point not less than 8 inches below the lowest inlet or, in the case of fireplaces, from the top of the smoke chamber, the entire height of the chimney. Fireclay flue liners shall be laid with tight mortar joints left smooth on the inside. When soot pocket extends more than 12 inches below the thimble, ash dumps shall be provided. If a change in direction is necessary, lining joints shall be made tight not only by mortaring but also by mitering or cutting equally the end of each adjoining section. The chimney shall be as vertical as possible with a maximum slope no greater then 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.

R-901.8.2 Flue Sizing: The net free area of square or rectangle flues as listed in Table No. R-901.8a shall not be less than 1/10 the face area of the fireplace opening. The net free area of round flues as listed in Table No. R-901.8b shall not be less than 1/12 the face area of the fireplace opening. For fireplaces with more than one opening, the combined areas of all faces or damper manufacturer's recommendations shall be used.

Table No. R-901.8a
RECTANGULAR AND SQUARE CLAY FLUE LINING

Nominal Outside Dimensions (In.)[1]	Net Free Area (In.)
8 1/2 x 8 1/2	49
8 1/2 x 13	76
8 1/2 x 17 3/4	102
13 x 13	127
13 x 17 3/4	173
17 3/4 x 17 3/4	233
20 x 20	298
20 x 24	357
24 x 24	431

1 Variations of 1/2" in outside dimensions and 1/8" in wall thickness permitted.

Table No. R-901.8b
ROUND CLAY FLUE LINING

Nominal Inside Dimensions (In.)[1]	Net Free Area (In.)
8 ± 1/4	50
10 ± 5/16	78
12 ± 3/8	113
15 ± 3/8	177
18 ± 7/16	254
21 ± 7/16	346
24 ± 1/2	452

1 Variations of 1/2" in outside dimensions and 1/8" in wall thickness permitted.

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

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

R-901.10 Flue area (appliance): Chimney flues shall not be smaller in area than that of the area of the connector from the appliance. The sizing and installation of a chimney flue to which multiple-appliance venting systems are connected shall be in accordance with Section M-1603.

Flues for equipment burning solid or liquid fuels shall have a minimum outside dimension of 5 1/2 inch x 8 1/2 inch in size or equivalent area and comply with ASTM-C315.

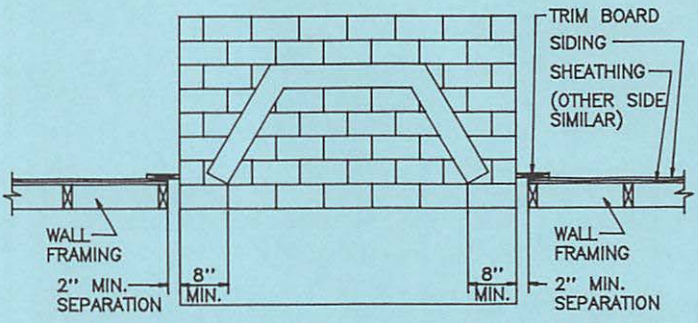
R-901.11 Inlet: Inlets to masonry chimneys shall enter from the side. A thimble shall be required for connecting fuel burning equipment to flues. Where thimbles are required, a flue liner manufactured with an integral thimble opening shall be used.

R-901.12 Cleanout opening: Cleanout openings, when provided, shall be equipped with ferrous metal doors and frames constructed to remain tightly closed, except when in use.

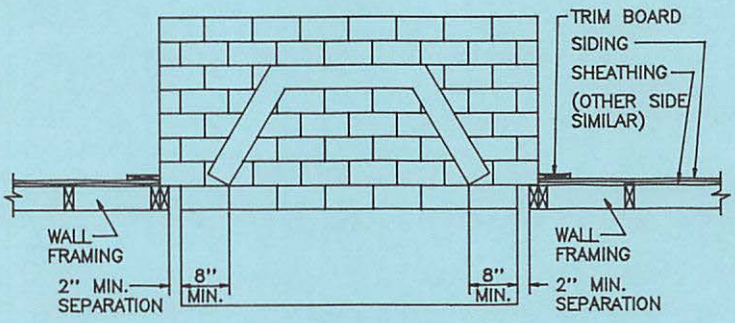
Cleanouts shall be accessible and so located that ash removal will not create a hazard to combustible materials. Except for chimneys serving fireplaces, cleanouts shall be not less than 2 feet below the lowest flue inlet.

R-901.13 Chimney clearance: 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. R-901.13). Woodwork, such as studs and paneling, shall not be placed within four (4) inches of the back masonry fireplaces.

Figure No. R-901.13



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)

R-901.14 Chimney firestopping: See Section R-402.7.

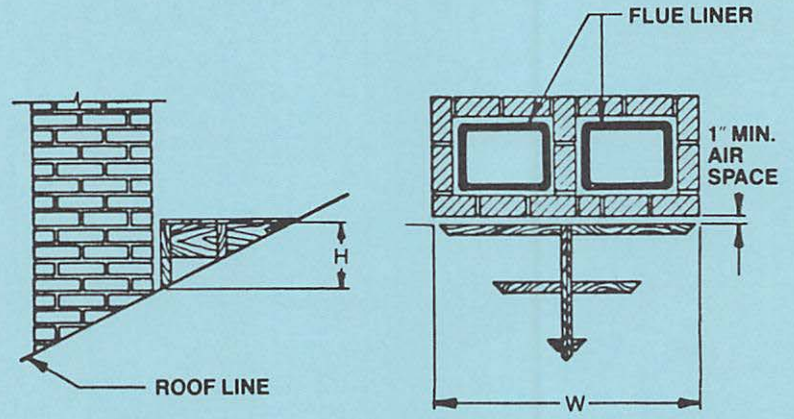
R-901.15 Chimney crickets: Chimney shall be provided with crickets or chimney saddles when the dimension parallel to the ridgeline is greater than 30 inches and does not intersect the ridgeline. The intersection of the cricket or chimney saddles and the chimney shall be covered and flashed so as not to leak. Crickets shall be constructed in conformity with Figure No. R-901.15 and Table No. R-901.15.

R-901.16 Flashing: All chimneys shall be flashed in accordance with R-503.8 and shall have corrosion-resisting counterflashing built in. All metals other than copper, lead, zinc, stainless steel, galvanized, and aluminum shall be painted both sides before installation.

Table No. R-901.15
CRICKET DIMENSIONS

ROOF SLOPE	H
12 - 12	1/2 of W
8 - 12	1/3 of W
6 - 12	1/4 of W
4 - 12	1/6 of W
3 - 12	1/8 of W

Figure No. R-901.15
CHIMNEY CRICKET



SECTION R-902—FACTORY-BUILT CHIMNEYS

Factory-built chimneys shall conform to the conditions of their listing and the manufacturer's instructions.

Factory-built fireplaces shall conform to Section R-904.

Prefabricated metal chimneys shall not be enclosed until the installation is inspected and approved by the building official.

SECTION R-903—MASONRY FIREPLACES

R-903.1 Fireplace support: Fireplace foundations and supporting walls shall be designed, supported and reinforced as required in this chapter and the applicable provisions of Chapters 2 and 3. When a design is not provided, foundations for masonry fireplaces and their chimneys shall be constructed of concrete or solid masonry at least 12 inches thick and extend at least 12 inches beyond the fireplace supporting wall on all sides.

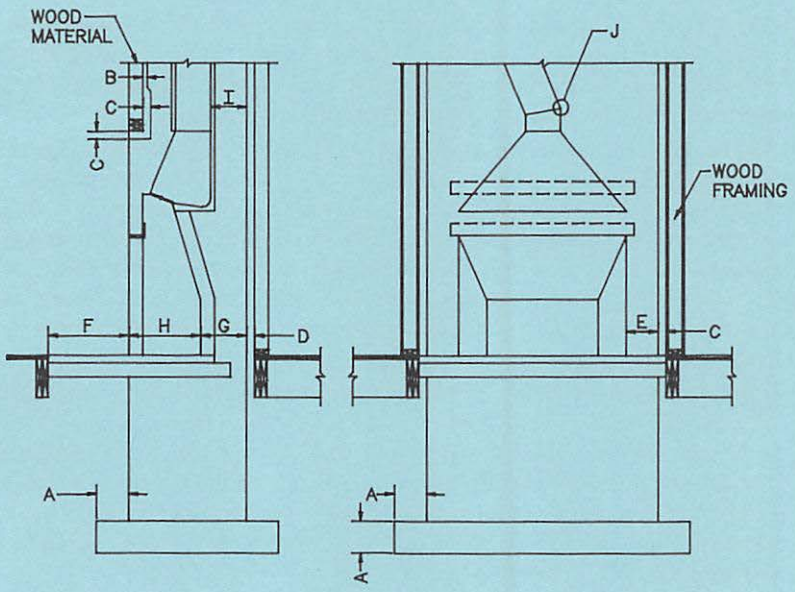
Bottom of footings shall be founded on natural, undisturbed earth below frost depth. In areas not subjected to freezing, bottom of footings shall be at least 12 inches below finished grade. Masonry fireplaces and chimneys constructed in conformity with Figure No. R-903.1 and Table No. R-903.1 shall be deemed to meet the requirements of this section.

Table No. R-903.1
REQUIREMENTS FOR MASONRY FIREPLACES AND CHIMNEYS

ITEM	LETTER[1]	REQUIREMENT
Footings:		
thickness	A	12" minimum, See R-901.1
projection	A	12" minimum all sides, See R-901.1
Mortar:		
firebrick		type M, S, or N with fire clay additive and tight fitting joints
flue lining		type M,S,N or refractory
masonry other than above		type M,S or N
Masonry Support (Lintels):		masonry, concrete or steel, See R-903.4
Ash Dump:		not required, however, when used must be fireproof, See R-901.12
Clearances:		
wood framing	B	1 inch chimney masonry, See R-901.13
	C	2 inches fireplace masonry excluding facing material, See R-901.13
	D	4 inches at back of fireplace masonry, See R-901.13
combustible material	E	6 inches from edges of fireplace opening except material above fireplace opening, See R-903.7 & R-901.9
above roof		2 feet above highest point or 2 feet higher than any portion of building within 10 feet, See R-901.5
Hearth Extension:		
fireplace opening < 6 sq. ft	F	8 inch each side of opening, 16 inches in front of facing material, See R-903.6
fireplace opening 6 sq ft. or >	F	12 inches each side of opening, 20 inches in front of facing material, See R-903.6
Thickness of Firebox Walls:	G	See R-903.2
Firebox Depth:	H	See R-903.6
Flue Requirements:		
walls around flue	I	flue shall be encased in not less than 4 inches of solid masonry, See R-901.6
distances between adjacent flues		two flues adjoining each other shall have joints staggered 7 inches, See R-901.9, 3 inches
thickness		See R-901.7 & R-901.8
effective flue area (see tables Nos R-901.8a and R-901.8b)		rectangular 1/10 of fireplace opening, round 1/12 of fireplace opening, See R-901.8.2
slope	J	maximum 30 degrees from vertical with mitered joints, See R-901.8.1

[1]The letters refer to FIgure No. R-903.1.

Figure No. R-903.1
FIREPLACE AND CHIMNEY DETAILS



R-903.2 Fireplace walls: Masonry fireplaces shall be constructed of solid masonry units, stone, or reinforced concrete in accordance with Figure No. R-903.1. Where a lining of firebrick at least 2 inches in thickness or other approved lining is provided, the total thickness of back and sides, including the lining, shall be not less than 8 inches. Where no lining is provided, the thickness of back and sides shall be not less than 12 inches.

R-903.3 Steel fireplace units: Steel fireplace units incorporating a firebox liner of not less than 1/4 inch 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, of which not less than 4 inches 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.

R-903.4 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. Use structural steel angles only. Corrugated or light gauge angles are prohibited.

R-903.5 Hearth extension material: Masonry fireplaces at or near the floor level shall have hearth extensions of not less than 3/8-inch-thick millboard, brick, concrete, stone, tile or other approved noncombustible material properly supported or 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 hearth and hearth extensions shall be removed after the construction is completed.

R-903.6 Hearth extension: The hearth and the hearth extension shall extend a minimum of 36 inches from the back of the firebox to the end of the hearth extension. Hearth extensions shall extend at least 16 inches in front of, and at least 8 inches beyond, each side of the fireplace opening. Where the fireplace opening is 6 square feet or larger, the hearth extension shall extend at least 20 inches in front of, and at least 12 inches beyond, each side of the fireplace opening.

R-903.7 Fireplace clearance: Wood or combustible framing shall not be placed within 2 inches of outside face of masonry fireplace and not less than 6 inches from inside surface of nearest flue lining. Wood framing and other combustible material shall not be placed within 4 inches of the back surface of a masonry fireplace.

R-903.8 Fireplace firestopping: See Section R-402.7.

R-903.9 Combustible materials: Woodwork or other combustible materials shall not be placed within 6 inches of a fireplace opening. Combustible material within 12 inches above the fireplace opening shall not project more than 1/8 inch for each 1-inch distance from such opening.

R-903.10 Smoke Chamber Walls: The inner surfaces of the smoke chamber shall not be inclined more than 45° from vertical. Joints shall be struck smooth to clear mortar.

SECTION R-904–FACTORY-BUILT FIREPLACES

Factory-built fireplaces, that have been tested and are listed by a nationally recognized 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 unless otherwise authorized by the listing.

SECTION R-905—FACTORY-BUILT FIREPLACE STOVES

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 unless otherwise authorized by the listing.

SECTION R-906–DELETED

Chapter 10
GENERAL MECHANICAL REQUIREMENTS AND DEFINITIONS

SECTION M 1001—GENERAL

M-1001.1 Application: The provisions of this part shall establish the general scope of the mechanical system and equipment requirements of this code and the definitions of terms related thereto. The use of materials or methods accomplishing the purposes intended by this code and approved by the building official in accordance with Section R-108 shall be accepted as complying with this code.

M-1001.2 Approval: Heating and cooling appliances shall bear the label of an approved agency or shall be approved by the building officials for safe use.

M-1001.3 Conformity: Conformity with the applicable provisions and standards specified in each section of Part IV shall indicate that the equipment is safe for installation under this code. Where differences occur between the provisions of this code and referenced standards, the provisions of this code shall apply.

M-1001.4 Authority to disconnect: The building official shall have the authority to order disconnected any fuel supply or appliance that does not conform to this code. A notice shall be attached to the piping or appliances stating the reasons for disconnection. Such notice shall not be removed nor shall the system or appliance be reconnected until authorized by the building official.

SECTION M-1002—APPLIANCE LABELING

M-1002.1 General: All appliances shall bear a permanent and legible factory-applied label which shall include the following information:

1. Name or trademark of the manufacturer.
2. The model and serial number.
3. Identity of the agency certifying compliance of equipment with recognized standards.
4. Clearances from combustible construction for heat producing appliances.

M-1002.2 Fuel-burning appliances: The label for fuel burning appliances, except wood stoves and fireplaces, shall also indicate:

1. The type of fuel approved for use with the appliance.
2. The input or output ratings.

M-1002.3 Other than fuel-burning appliances: The label for other than fuel-burning appliances shall also indicate, where applicable:

1. The output or capacity rating.
2. The electrical rating in volts, amperes (or Watts) and phase.
3. Type of refrigerant and test pressures for heat pumps and refrigeration cooling equipment.

SECTION M-1003—TYPE OF FUEL

Each appliance shall be designed for use with the type of fuel to which it is connected. Appliances converted from the fuel specified on the rating plate for use with a different fuel shall be reapproved by the building official. Gas conversion burners shall conform to ANSI Z21.17 and shall be installed in accordance with ANSI Z21.8.

SECTION M-1004—APPLIANCE ACCESS

Appliances shall be accessible for inspection, service, repair and replacement without removing permanent construction. Unless otherwise specified, at least 30-inches of working space and platform shall be provided in front of the control side to service an appliance. Room heaters shall be installed with at least an 18-inch working space. A platform shall not be required for room heaters.

SECTION M-1005—APPLIANCE CLEARANCES

Appliances shall have clearances from combustible materials in accordance with Figure No. M-1005 and Table No. M-1005a, unless otherwise provided in the manufacturer's installation instructions and approved by the building official. Reduced clearances are allowed where protection is provided in accordance with Table No. M-1005b, or labeled systems in accordance with the manufacturer's installation instructions. Forms of protection with ventilated air space shall conform to the following requirements:

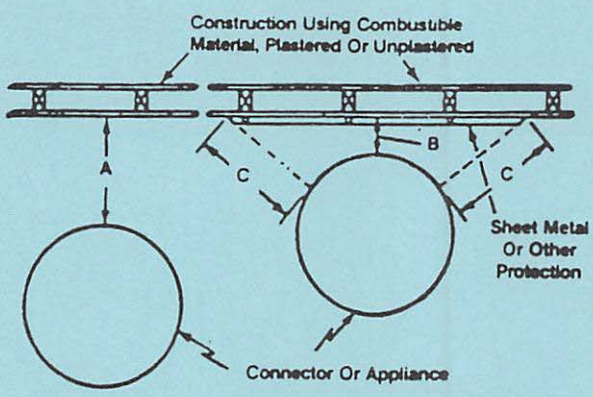
1. Not less than 1-inch air space shall be provided between the protector and combustible wall surface.

2. Adequate air circulation shall be provided by having edges of the wall protector open at least 1 inch.

3. If the wall protector is mounted on a single flat wall away from corners, adequate air circulation shall be provided by having the bottom and top edges, or the side and top edges open at least 1-inch.

4. Wall protectors covering two walls in a corner shall be open at the bottom and top edges at least 1-inch.

Figure No. M-1005
REDUCED CLEARANCE DIAGRAM



Notes:
"A" equals the required clearance with no protection, specified in Table No. M-1005a. "B" equals the reduced clearance permitted in accordance with Table No. M-1005b. The protection applied to the construction using combustible material shall extend far enough in each direction to make "C" equal to "A".

Table No. M-1005a
STANDARD INSTALLATION CLEARANCES FOR 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

[1]Reductions in the required clearance shall be permitted in accordance with Table No. M-1005b.
[2]Same clearances required from top and sides of warm air bonnet or plenum of central furnaces.
[3]Room heaters shall be installed on noncombustible floors.

Table No. M-1005b
REDUCED CLEARANCES FOR UNLISTED HEAT PRODUCING 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-gauge sheet metal with ventilated air space	12	18	6	9	4	6	2	3
3 1/2-inch thick masonry wall with air space	12	—	6	—	4	—	2	—

NOTES:
[1]Required clearances shall be measured as shown in Figure No. M-1005.
[2]The clearance between the appliance and the face of the protection shall not be reduced below that shown in the table. Required clearances between those shown in the table may be interpolated.
[3]With all clearance reduction systems using ventilated air space, adequate air circulation shall be provided as described in Section M-1005.
[4]Spacers and ties shall be noncombustible, and shall not be used directly behind an appliance or a connector.
[5]Mineral wool batts shall have a minimum density of 8 lb per cubic foot and a minimum melting point of 1500°F.
[6]Insulation material shall have a thermal conductivity of 1.0 (Btu-in)/(sq ft-hr F) or less.
[7]A single wall connector passing through the masonry wall shall have at least 1/2-inch of open ventilated air space between the connector and the masonry.

SECTION M-1006—APPLIANCE INSTALLATION

M-1006.1 General: Except as otherwise provided in this code, the installation of appliances shall conform to the conditions of their label and the manufacturer's installation instructions. The manufacturer's operating instructions shall remain attached to the appliance.

M-1006.2 Anchorage of appliances: Appliances designed to be fixed in position shall be securely fastened in place. In Seismic Zones Nos. 3 and 4 (see Seismic Risk Map in Appendix A) water heaters having nonrigid water connections and over 4-feet in height from the base to the top of the tank case shall be anchored or strapped to the building to resist horizontal displacement due to earthquake motion.

M-1006.3 Appliances located in garage: Heating and cooling appliances located in a garage shall be protected from impact by automobiles. Appliances that generate a glow, spark, or flame capable of igniting flammable vapors and located in a garage shall be installed with the burners, burner ignition devices or heating elements and switches at least 18-inches above the floor level. Sealed combustion system heaters

may be installed on the floor. Appliances enclosed in a separate compartment having access only from outside of the garage, and installed at floor level, shall have combustion air taken from and the products of combustion discharged to, the exterior of the garage.

M-1006.4 Electrical appliances: Electrical appliances shall be installed in accordance with Chapter 12 and Part VI of this code.

SECTION M-1007—CONTROL DEVICES

M-1007.1 Gas Appliances: Automatic gas-burning appliances shall be equipped with a labeled device or devices that will shut off the fuel supply to the main burner or burners in the event of pilot or ignition failure. In addition, liquefied petroleum gas heating appliances shall be equipped with a labeled automatic device or devices that will shut off the flow of gas to the pilot in the event of ignition failure. The labeled shutoff devices shall not be required on range or cooking tops, log lighters, lights or other open-burner manually operated appliances, or labeled appliances not requiring such devices as approved by the building official.

M-1007.2 Oil-burning appliances: Oil burning appliances shall be provided with automatic limit devices to sense and control overheating, and primary safety controls that will shut off flow of fuel to the burners in the event of ignition failure or failure of the main burner flame. Oil-fired water boilers shall be provided with labeled relief valves and temperature-limiting devices whose combined Btu/h rating shall be equal to or greater than the boiler rating.

M-1007.3 Forced-air furnaces: Forced-air furnaces shall be equipped with a labeled limit control that will prevent outlet air temperature from exceeding 250°F. Such controls shall be located in the bonnet or plenum, or in accordance with the terms of the label.

M-1007.4 Electric duct heaters: Electric duct heaters shall be equipped with an approved automatic reset air outlet temperature-limit control that will limit the outlet air temperature to not more than 200°F. The electric elements of the heater shall be equipped with fusible links or a manual reset temperature-limit control that will prevent air temperature in the immediate vicinity of the heating elements from exceeding 250°F.

SECTION M-1008—EXISTING MECHANICAL SYSTEMS

Any addition, alteration, repair or replacement made to an existing mechanical system shall be made in conformity with applicable regulations of this code. Where additions or alterations subject parts of existing systems to loads exceeding those permitted herein, such parts shall be made to comply with this code. When fuel fired appliances located under stairways are replaced, the space under the stairway shall be protected in accordance with Section R-210.3.

SECTION M-1009—INSPECTIONS

All fuel supply piping and equipment installations shall be subject to rough and final inspections. Portions of fuel supply piping or equipment intended to be concealed shall be inspected before concealment. When installation of equipment is complete, a final inspection shall be made. Equipment regulated by this code shall comply with all applicable requirements of this code and shall be approved by final inspection before being placed in service. See Section R-111. *

SECTION M-1010—DEFINITIONS

Unless otherwise expressly stated, the following terms shall, for the purpose of this code, have the meanings indicated in this section. Words used in the present tense include the future; the singular number includes the plural and the plural the singular. Where terms are not defined in this section and are defined in Section R-118 or Section P-2016 of this code, they shall have the meanings ascribed to them as those sections. Where terms are not defined in these sections, they shall have their ordinarily accepted meanings or such as the context implies.

Accessible and readily accessible: See Section R-118.

Air circulation, forced: A means of providing space conditioning utilizing movement of air through ducts or plenums by mechanical means.

Air-conditioning system: An air-conditioning system consists of heat exchangers, blowers, filters, supply exhaust and return-air systems and shall include any apparatus installed in connection therewith.

Alteration: A change in an air-conditioning, heating, ventilating or refrigeration system that involves an extension, addition or change to the arrangement, type or purpose of the original installation.

Appliance: A device which utilizes fuel or other forms of energy to produce light, heat, power, refrigeration or air-conditioning. This definition shall also include a vented decorative appliance.

Boiler, hot water heating: A self-contained appliance from which hot water is circulated for heating purposes and then returned to the boiler, and which operates at water pressures not exceeding 160-psig and at water temperatures not exceeding 250°F at or near the boiler outlet.

Brazed joints: A joint obtained by the joining of metal parts with metals or alloys that melt at a temperature above 1000°F. but lower than the melting temperature of the parts to be joined.

Chimney: (See also "Vent" and "Venting System") One or more passageways, vertical or nearly so, for conveying flue or vent gases to the outside atmosphere.

Factory-built chimney: A chimney composed of labeled factory-built components assembled in accordance with the label to form the completed chimney.

Masonry chimney: A field-constructed chimney of masonry units, bricks, stones, labeled masonry chimney units, or reinforced portland cement concrete, lined with suitable chimney flue liners.

H.T. chimney: A high temperature chimney complying with the requirements of Section 21 in UL 103, as listed in Section S-26.1010. A Type H.T. chimney is identifiable by markings stating "Type H.T." on each chimney pipe section.

Chimney connector: A pipe that connects a fuel appliance to a chimney.

Closet: A small room or chamber used for storage.

Combustible material: Any material not defined as noncombustible.

Combustion air: The air that must be provided to fuel-burning equipment including air for fuel combustion, draft hood dilution, and ventilation of the equipment enclosure.

Concealed gas piping: Piping that is enclosed in the building construction with no means of access.

Condensate: The liquid which separates from a gas due to a reduction in temperature, e.g. water that condenses from flue gases and water that condenses from air circulating through the cooling in air conditioning equipment.

Condensing appliance: An appliance that condenses water generated by the burning of fuels.

Conditioned air: Air treated to control its temperature, relative humidity or quality.

Conditioned space: The space contained within an insulated building enclosure which is conditioned directly or indirectly by heating the operation of an appliance.

Confined space: A space whose volume is less than 50 cubic feet per 1,000 Btu/h of the aggregate input rating of all 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 safety shutdown of mechanical equipment.

Convector: A system incorporating heating element in an enclosure in which air enters an opening below the heating element, is heated, and leaves the enclosure through an opening located above the heating element.

Convenience outlet, gas: A permanently mounted hand operated device for connecting and disconnecting an appliance to the gas supply piping conforming to AGA Requirement 7-90, as listed in Sections S-26.1010. The device includes an integral, manually operated gas valve so that the appliances can be disconnected only when the valve is in the closed position.

Damper, volume: Any device that will restrict, retard or direct the flow of air in any duct, or the products of combustion in any heat-producing equipment, vent connector, vent or chimney.

Decorative appliance: An appliance whose function lies primarily in the aesthetic effect rather than heating.

Dilution air: Air that enters a draft hood or draft regulator and mixes with flue gases.

Direct-vent appliance: A fuel-burning appliance that draws all air for combustion from the outside atmosphere and discharges all flue gases to the outside atmosphere.

Draft: The flow of gases or air through chimney, flue or equipment caused by pressure differences.

Mechanical or induced: The draft developed by fan or air or steam jet or other mechanical means.

Natural: The draft developed by the difference in temperature of hot gases and outside atmosphere.

Draft hood: A device built into an appliance, or a part of the vent connector from an appliance, which is designed to (1) provide for the ready escape of the flue gases from the appliance in the event of no draft, backdraft, or stoppage beyond the draft hood, (2) prevent a back draft from entering the appliance, and (3) neutralize the effect of stack action of the chimney or gas vent upon the operation of the appliance.

Draft regulator: A device which functions to maintain a desired draft in the appliance by automatically reducing the draft to the desired value.

Duct system: A duct system is a continuous passageway for the transmission of air which, in addition to ducts, may include duct fittings, dampers, plenums, fans and accessory air-handling equipment.

Equipment: A general term including materials, fittings, devices, appliances and apparatus used as part of or in connection with installations regulated by this code.

Evaporative cooler: A device used for reducing air temperature by the process of evaporating water into an air stream.

Excess air: Air which passes through the combustion chamber and the appliance flue in excess of that which is theoretically required for complete combustion.

Exhaust hood, full opening: An exhaust hood with an opening at least equal to the diameter of the connecting vent.

Fireplace stove: A freestanding, chimney-connected solid-fuel-burning heater with or without doors connected to the chimney.

Flame-spread rating: A numerical index indicating the relative surface burning behavior of a material tested in accordance with ASTM E84 listed in Section S-26.1010.

Floor furnace: A self-contained furnace suspended from the floor of the space being heated, taking air for combustion from outside such space, and with means for lighting the appliance from such space.

Flue: See "Vent."

Flue collar: The portion of a fuel-burning appliance designed for the attachment of a draft hood, vent connector, or venting system.

Flue gases: Products of combustion plus excess air in appliance flues or heat exchangers.

Fuel piping system: All piping, tubing, valves, and fittings used to connect fuel utilization equipment to the point of fuel delivery.

Furnace, warm-air: A vented comfort-heating appliance designed or arranged to discharge heated air into a conditioned space.

* **Gas:** Fuel gas, such as natural gas, manufactured gas, undiluted liquefied petroleum gas (vapor phase only), liquefied petroleum gas-air mixture, or mixtures of these gases.

Labeled: The word "labeled" refers to equipment or materials bearing the inspection label of an approved inspection agency.

Listed: Equipment or materials included in a list published by an approved testing laboratory, inspection agency or other organization concerned with product evaluation that maintains periodic inspection of production of listed equipment or materials, and whose listing states whether that the equipment or material meets applicable standards or has been tested and found suitable for use in a specified manner. The means for identifying listed equipment may vary for each testing laboratory, inspection agency, or other organization concerned with product evaluation, some of which do not recognize equipment as listed unless it is also labeled.

LP-gas: Liquefied petroleum gas composed predominately of propane, propylene, butanes or butylenes, or mixtures thereof which are gaseous under normal atmospheric conditions, but can be liquefied under moderate pressure at normal temperatures.

Manufacturer's installation instructions: Printed instructions included with equipment as part of the conditions of listing or labeling.

Mechanical exhaust system: Equipment installed in a venting system to provide an induced draft.

Noncombustible material: Materials that pass the test procedure for defining noncombustibility of elementary materials set forth in ASTM E136 listed in Section S-26.1010.

Nonconditioned space: A space that is isolated from any conditioned space by insulated walls, floors or ceilings.

Plenum: A chamber which forms part of an air-circulation system other than the occupied space being conditioned

Purge: To clear of air, gas, or other foreign substances.

Quick disconnect device: A hand-operated device that provides a means for connecting and disconnecting an appliance to a gas supply and that is equipped with an automatic means to shut off the gas supply when the device is disconnected.

Refrigerant: A substance used to produce refrigeration by its expansion or evaporation.

Refrigerating System: A combination of interconnected refrigerant-containing parts constituting one closed refrigerant circuit in which a refrigerant is circulated for the purpose of extracting heat. In a direct cooling system, the refrigeration is circulated through a heat exchanger located in the circulating air passage. In an indirect cooling system, a secondary working fluid is cooled by the refrigerating system and circulated through a heat exchanger located in the circulating air passage.

Regulator: A device for reducing, controlling, and maintaining the pressure in a portion of a piping system downstream of the device.

Return air: Air removed from a conditioned space through openings, ducts, plenums or concealed spaces to the heat exchanger of a heating, cooling or ventilating system.

Room heater: A freestanding, comfort-heating appliance installed in the space being heated and not connected to ducts.

Smoke-developed rating: A numerical index indicating the relative density of smoke produced by burning assigned to a material tested in accordance with ASTM E84 listed in Section S-26.1010.

Supply air: Air delivered to a conditioned space through ducts or plenums from the heat exchanger of a heating, cooling or ventilating system.

Type B vent: A labeled vent conforming to UL 441, as listed in Section S-26.1010, for venting gas appliances with draft hoods and other gas appliances listed for use with Type B vents.

Type BW vent: A labeled vent conforming to UL 441, as listed in Section-26.1010, for venting gas-fired vented wall furnaces listed for use with Type BW vents.

Type L vent: A labeled vent conforming to UL 641, as listed in Section S-26.1010, for venting oil-burning appliances listed for use with Type L vents or with listed gas appliances.

Unconfined space: A space whose volume is not less than 50 cubic feet per 1,000 Btu/h of the aggregate input rating of all appliances installed in that space. Rooms communicating directly with the space in which the appliances are installed, through openings not furnished with doors, are considered a part of the unconfined space.

Vent: A passageway for conveying flue gases from fuel-fired appliances, or their vent connectors, to the outside atmosphere.

Vent collar: See "Flue collar.".

Vent connector: That portion of a venting system which connects the flue collar or draft hood of an appliance to a vent. This term is interchangeable with the term flue connector.

Vent damper device, automatic: A device intended for installation in the venting system, in the outlet of or downstream of the appliance draft hood, of an individual, automatically operated fuel-burning appliance and which is designed to automatically open the venting system when the appliance is in operation and to automatically close off the venting system when the appliance is in a standby or shutdown condition.

Vent gases: Products of combustion from fuel-burning appliances, plus excess air and dilution air, in the venting system above the draft hood or draft regulator.

Vented gas appliance categories: The following categories are used to differentiate gas utilization equipment according to vent pressure and flue gas temperature:

Category I: An appliance that operates with a non-positive vent pressure and with a flue gas temperature at least 140°F above its dewpoint.

Category II: An appliance that operates with a non-positive vent pressure and with a flue gas temperature less than 140°F above its dewpoint.

Category III: An appliance that operates with a positive vent pressure and with a flue gas temperature at least 140°F above its dewpoint.

Category IV: An appliance that operates with a positive vent pressure and with a flue gas temperature less than 140°F degrees above its dewpoint.

Ventilation: The process of supplying or removing conditioned or unconditioned air by natural or mechanical means to or from any space.

Venting: Removal of combustion products to the outdoors.

Chapter 11
CENTRALLY DUCTED HEATING AND COOLING SYSTEMS

SECTION M-1101—HEATING AND COOLING EQUIPMENT

M-1101.1 General: Heating and cooling equipment shall be installed in accordance with the manufacturers installation instructions and the requirements of this code.

M-1101.1.1 Access: Heating and cooling equipment shall be located with respect to building construction and other equipment to permit maintenance, servicing, and replacement. Sufficient clearances shall be maintained to permit cleaning of heating and cooling surfaces, replacement of filters, blowers, motors, controls, vent connections, lubrication of moving parts, and adjustments.

M-1101.1.2 Sizing: Heating and cooling equipment shall be sized according to ACCA Manual J, as listed in Section S-26.1101, or other approved methods.

M-1101.1.3 Furnace room installations: When equipment is located in an equipment room, the room shall have an opening or door that is large enough to permit removal of the largest piece of equipment, but not less than 20-inches wide. An unobstructed working space not less than 30-inches wide and not less than 30 inches high shall be provided along the control side of the equipment when the door of the equipment room is open.

M-1101.1.4 Attic installations: When equipment is located in an attic, a minimum 22-inch wide by 30-inch high passageway shall be provided from the attic opening to the equipment and its controls. The access opening shall be not smaller than 20-inches wide by 30-inches long, and may be located in any room, hall or closet. The opening and passageway shall be large enough to allow replacement of any part. The passageway shall have a minimum 22-inch wide floor. Flooring shall extend a minimum of 30-inches in width along the control side of the equipment with a 30-inch high clear working space on all sides where access is necessary for servicing.

M-1101.1.5 Crawl space installations: When equipment is installed in a crawl space, an access opening and passageway of a height and width sufficient to permit replacement of the mechanical equipment, but not less than 36-inches wide by 22-inches high, shall be provided to the working space in front of the equipment.

Equipment supported from the ground shall be level and firmly supported on a concrete slab or 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.

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.

M-1101.1.6 Exterior installations: Equipment installed outdoors shall be labeled for outdoor installation. Supports and foundations shall be adequate to prevent excessive vibration, settlement, or movement of the equipment. Supports and foundations shall be level and conform to the manufacturer's recommendations. 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.

M-1101.2 Warm Air Furnaces

M-1101.2.1 General: Warm air furnaces shall conform to the applicable ANSI standard Z21.47 or Z21.64, as listed in Section S-26.1101. Fuel-burning warm-air furnaces shall not be installed in a storage closet or under a stairway. Furnaces located in a bedroom or bathroom shall be installed in a sealed enclosure such that combustion air will not be taken from the living space. Direct vent furnaces are not required to be installed within an enclosure.

M-1101.2.2 Clearance: Clearances shall be provided for warm-air furnaces in accordance with Table No. M-1005a or in accordance with the manufacturer's installation instructions, as approved.

M-1101.2.3 Combustion air: Fuel-burning warm-air furnaces shall be supplied with adequate combustion air in accordance with Chapter 15 of this code. Combustion air openings shall have clearance not less than 6-inches in front of the openings.

M-1101.2.4 Electric furnaces: Electric furnaces shall be installed in accordance with Part VI of this code.

M-1101.3 Heat Pump Equipment

M-1101.3.1 Heating elements: Heat pump equipment utilizing supplement electric heating elements shall have such elements installed in accordance with Part VI of this code.

M-1101.3.2 Foundations and supports: Supports and foundations for the outdoor unit of heat pumps shall be raised at least 3-inches above the ground to permit free drainage of defrost water, and shall conform to the manufacturer's recommendations.

M-1101.4 Refrigeration Cooling Equipment

M-1101.4.1 Approved refrigerants: Only Group I refrigerants, as specified in ANSI/ASHRAE 15, as listed in Section S-26.1101, shall be used in direct refrigeration equipment.

M-1101.4.2 Refrigeration coils in warm air furnaces: Where a cooling coil is located in the supply plenum of a warm air furnace, the furnace blower shall be rated at not less than 0.5-inch water column static pressure unless the furnace is labeled for use with a cooling coil. Cooling coils shall

not be located upstream from heat exchangers unless labeled for such use. Conversion of existing furnaces for use with cooling coils shall be permitted provided the furnace will operate within the temperature rise specified for the furnace.

M-1101.4.3 Condensate disposal: A 3/4 inch minimum condensate drain shall be provided to dispose of condensate from the cooling coil. Condensate drains shall terminate to daylight outside of the building, or to a floor drain, plumbing fixture, sump, french drain or other approved location.

Where the cooling coil or air conditioning unit is located indoors above a living space, a water-tight pan of corrosion-resistant 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.

M-1101.4.4 Insulation of refrigerant piping: Refrigerant piping and fittings within a building that return refrigerant to the outdoor unit shall be insulated to prevent condensation from forming on the piping.

M-1101.5 Absorption Cooling Equipment

M-1101.5.1 Approval of equipment: Absorption systems shall be labeled and installed in accordance with the manufacturer's installation instructions.

M-1101.5.2 Condensate disposal: Condensate from the cooling coil shall be disposed of as provided in Section M-1101.4.3.

M-1101.5.3 Insulation of piping: Refrigerant piping, brine piping, and fittings within a building shall be insulated to prevent condensation from forming on piping.

M-1101.5.4 Pressure-relief protection: Absorption systems shall be protected by a pressure-relief device. Discharge from the pressure relief device shall be located so as not to create a hazard to persons or property.

M-1101.6 Evaporative Cooling Equipment: Cooling equipment that utilizes evaporation of water for cooling shall be installed in accordance with manufacturer's recommendations. Evaporative coolers shall be installed on a level platform or base not less than 3-inches above the adjoining ground and secured to prevent displacement. Openings in exterior walls shall be flashed in an approved manner in accordance with the building requirements of this code.

SECTION M-1102—DUCT SYSTEMS

M-1102.1 Materials: Ducts and duct materials used for a duct serving heating and cooling equipment shall be fabricated in accordance with the

following requirements:

1. Above ground duct systems shall conform to the following:
   a. Equipments connected to duct systems shall have a maximum 250°F temperature limit control.
   b. Supply ducts shall be constructed of Class O, Class 1 or Class 2 materials as designated in Table No. M-1102.1a. Class 2 materials shall not be used for ducts located within the first 3-feet of the bonnet, plenum or casing of the heating unit.
   c. Minimum thicknesses of metal duct material shall be listed in Table No. M-1102.1b. Galvanized steel shall conform to ASTM A525, as listed in Section S-26.1102.
   d. Gypsum products may be used as ducts or plenums, provided that the air temperature does not exceed 125°F and exposed surfaces are not subject to condensation.
   e. Return ducts, except those portions directly above the heating surface or closer than 2-feet to the heating unit casing, shall be constructed of materials having a flame spread rating not greater than 200.
   f. Structural areas between studs or partitions to be used as return ducts shall be isolated from unused spaces with tight-fitting stops of sheet metal, or with wood not less than 2-inch nominal thickness.
2. Underground duct systems shall be constructed of approved concrete, clay, metal, plastic or other approved materials. The maximum duct temperatures for plastic ducts shall be not greater than 150°F. Plastic pipe and fittings shall conform to cell classification 12454-B of ASTM D1784, as listed in Section S-26.1102, and external loading properties of ASTM D2412, as listed in Section S-26.1102.

M-1102.1.1 Factory-made ducts: Factory made air ducts or duct material shall be approved for the use intended, and shall be installed in accordance with the manufacturer's installation instructions. Each portion of a factory-made air duct system shall bear a label or mark indicating compliance with UL 181, as listed in Section S-26.1102.

M-1102.1.2 Duct insulation materials: Duct insulation materials shall conform to the following requirements:

1. Duct coverings and linings shall have a flame-spread rating not greater than 25, and a smoke-developed rating not greater than 50.
2. Duct coverings and duct linings shall withstand a test temperature of 250°F minimum in accordance with the Test for Hot-Surface Performance of High-Temperature Thermal Insulation, ASTM C411, as listed in Section S-26.1102.
3. Fiberglass or mineral wool insulation shall be a minimum 2-inch thick, 3/4-pound density wrap or 1-inch thick, 1 1/2-pound liner.
4. When nonmetallic ducts or other approved insulating or lining materials are used, the minimum thermal resistance value of the material shall be R-4.2.
5. Blanket insulation and factory-insulated flexible duct shall be labeled with the R-value, flame-spread rating, and smoke-developed rating.

Table No. M-1102.1a
CLASSIFICATION OF DUCTS

Duct Class	Maximum Flame Spread Rating
0	0
1	25
2	50

Table No. M-1102.1b
GAUGES OF METAL DUCTS AND PLENUMS USED FOR COMFORT HEATING OR COOLING

TYPE OF DUCT	SIZE (INCHES)	NOMINAL THICKNESS (INCHES)	EQUIVALENT GALVANIZED SHEET GAUGE	APPROXIMATE ALUMINUM B. & S. GAUGE
Round ducts and enclosed rectangular ducts	14 or less	0.016	30	26
	Over 14	0.019	28	24
Exposed rectangular ducts	14 or less	0.019	28	24
	Over 14	0.022	26	22

M-1102.1.3 Vibration isolators: Vibration isolators installed between mechanical equipment and metal ducts shall be fabricated from approved materials and shall not exceed 10-inches in length.

M-1102.2 Installation

M-1102.2.1 Duct Sizing: Supply and return ducts shall be sized according to ACCA Manual D or SMACNA Installation Standards for Residential Heating and Air Conditioning Systems, as listed in Section S-26.1102, or other approved methods.

M-1102.2.2 Joints and seams: Joints of duct systems shall be made substantially air-tight by means of tapes, mastics, gasketing, or other means. Crimp joints for round ducts shall have a contact lap of at least 1-1/2-inches and shall be mechanically fastened by means of at least three sheet metal screws equally spaced around the joint, or an equivalent fastening method.

M-1102.2.3 Support: Metal ducts shall be securely supported. 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 except 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.

M-1102.2.4 Firestopping: Duct installations shall be firestopped in accordance with Section R-402.7.

M-1102.2.5 Duct insulation: Duct insulation shall be installed in accordance with the following requirements:

1. All ductwork installed in non-conditioned areas shall be insulated.
2. Vapor retarders with a maximum permeance of 0.05 perm, or aluminum foil with a minimum thickness of 2 mils, shall be installed on cooling supply ducts that pass through non-conditioned spaces conducive to condensation.
3. Exterior ducts shall be protected with an approved weatherproofing covering.
4. Duct coverings shall not penetrate a fire-stopped 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.

M-1102.2.6 Ducts in slabs: Ducts shall be labeled for underground installation. Metallic ducts not having an approved protective coating shall be completely encased in a minimum of 2-inches of concrete. Metallic ducts having an approved protective coating and nonmetallic ducts shall be installed in accordance with the manufacturer's installation instructions.

M-1102.2.7 Factory-made air ducts: All air ducts, unless labeled for such use, shall not be installed in or within 4 inches of the ground, in tile or metal pipe, or within masonry or concrete.

M-1102.3 Under-floor plenums: An under-floor space used as a supply plenum shall conform to the requirements of this section.

M-1102.3.1 General: The space shall be cleaned of all loose combustible materials and scrap, and shall be tightly enclosed. The ground surface of the space shall be covered with a moisture barrier having a permeability not greater than 1 perm.

M-1102.3.2 Materials: The under-floor space, including the sidewall insulation, shall be formed by materials having flame spread ratings not greater than 200.

M-1102.3.3 Furnace connections: A duct shall extend from the furnace supply outlet to not less than 6-inches below the combustible framing. This duct shall comply with the provisions of Section M-1102.1. A noncombustible receptacle shall be installed below the floor opening into the plenum in accordance with the following requirements:

1. The receptacle shall be securely suspended from the floor members and shall be not more than 18-inches below the floor opening.
2. The area of the receptacle shall extend 3-inches beyond the opening on all sides.
3. The perimeter of the receptacle shall have a vertical lip at least 1-inch high at the open sides.

M-1102.3.4 Access: Access to an under-floor plenum shall be provided through an opening in the floor with minimum dimensions of 18-inches by 24-inches.

M-1102.3.5 Furnace controls: The furnace shall be equipped with an automatic control that will start the air-circulating fan when the air in the furnace bonnet reaches a temperature not greater than 150°F. The furnace shall additionally be equipped with an approved automatic control that limits the outlet air temperature to 200°F.

SECTION M-1103—CIRCULATING AIR

M-1103.1 Return air

M-1103.1.1 Required area: The total unobstructed area of return ducts or openings to a warm air furnace shall be inaccordance with the manufacturer's recommendations, but not less than 2-square inches for each 1,000 Btu/hr rating of the furnace. The minimum unobstructed total area of the return air ducts or openings to a heat pump shall be in accordance with the manufacturer's recommendations, but shall be not less than 6-square inches for each 1,000 Btu/h nominal output rating.

M-1103.1.2 Prohibited sources: Return air for a warm-air furnace shall not be taken from bathrooms, garages, or other dwelling units. Outdoor air shall not be taken from within 10-feet of an appliance or plumbing vent outlet that is located less than 3-feet above the air inlet.

M-1103.1.3 Inlet opening protection: Outdoor air inlets shall be covered with screen or equivalent protection having no less than 1/4-inch openings and no greater than 1/2-inch openings.

M-1103.2 Supply air: The minimum unobstructed total area of supply ducts from a warm-air furnace shall be in accordance with the manufacturer's recommendations, but shall be not less than 2-square inches for each 1,000 Btu/h rating of the furnace. The minimum unobstructed total area of the supply air ducts from a heat pump shall be in accordance with the manufacturer's recommendations, but shall be not less than 6-square inches per 1,000 Btu/h nominal output rating. Dampers, grilles, or registers installed for the purpose of controlling the supply airflow shall not be considered as obstructions.

M-1104—RETURN AIR INTAKE (Non-Engineered Systems)

M-1104.1 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.

M-1104.2 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 inches joists and 525 CFM for 10 inches joists. Wiring located in spaces used for return air ducts shall comply with North Carolina State Building Code, Volume IV - Electrical.

Chapter 12
ELECTRIC RESISTANCE HEATERS

SECTION M-1201—BASEBOARD CONVECTORS

Electric baseboard convectors shall be labeled and shall be installed in accordance with the manufacturer's installation instructions and Part VI of this code.

SECTION M-1202—RADIANT HEATING SYSTEMS

M-1202.1 General: Radiant heating systems shall be labeled and shall be installed in accordance with the manufacturer's installation instructions and Part VI of this code.

M-1202.2 Clearances: Clearances for radiant heating panels or elements to any wiring, outlet boxes, and junction boxes used for installing electrical devices or mounting lightening fixtures shall comply with Part VI of this code.

M-1202.3 Installation of radiant panels: Radiant panels installed to wood framing shall conform to the following requirements:

1. Heating panels shall be installed parallel to framing members, and secured to the surface of framing members or mounted between framing members.
2. Panels shall be nailed or stapled only though the unheated portions provided for this purpose and shall not be fastened at any point closer than 1/4-inch from an element.
3. Unless labeled for field cutting, heating panels shall be installed as complete units.

M-1202.4 Installation in concrete or masonry: Radiant heating systems installed in concrete or masonry shall conform to the following requirements:

1. Radiant heating systems shall be identified as being suitable for the installation and shall be secured in place as specified in the manufacturer's installation instructions.
2. Radiant heating panels or radiant heating panel sets shall not be installed where they bridge expansion joints unless protected from expansion and contraction.

M-1202.5 Gypsum panels: Where radiant heating systems are used in gypsum assemblies, operating temperatures shall not exceed 125°F.

M-1202.6 Finish Surfaces: Finish materials installed over radiant heating panels or systems shall be installed in accordance with the manufacturer's installation instructions. Surfaces shall be secured such that nails or other fastenings do not pierce the radiant heating elements.

SECTION M-1203—DUCT HEATERS

M-1203.1 General: Electric duct heaters shall be labeled and shall be installed in accordance with the manufacturer's installation in accordance with the manufacturer's installation instructions and Part VI of this code.

M-1203.2 Installation: Electric duct heaters shall be installed such that they will not create a fire hazard. Class 1 ducts, duct coverings and linings shall be interrupted at each heater to provide the clearances specified in the manufacturer's installation instructions. Such interruptions are not required for duct heaters labeled for zero clearance from combustible materials. Insulation installed in the immediate area of each heater shall be classified for the maximum temperature produced on the duct surface.

M-1203.3 Installation with heat pumps and air conditioners: Duct heaters located within 4-feet of a heat pump or air conditioner shall be labeled for such installations. The heat pump or air conditioner shall additionally be labeled for such duct heater installations.

M-1203.4 Access: Duct heaters shall be accessible for servicing, and sufficient clearances shall be maintained to permit adjustment, servicing, and replacement of controls and heating elements.

Chapter 13
HYDRONIC HEATING SYSTEMS

SECTION M-1301—BOILERS

M-1301.1 Installation: The installation of boilers shall conform to the manufacturer's installation instructions and the requirements of this code. Operating instructions shall be attached to the boiler. Boilers shall have all controls set, adjusted, and tested by the installer. Fuel-burning boilers shall be provided with combustion air as required by Chapter 15.

M-1301.2 Clearance: Boiler clearances shall be in accordance with their label or Section M-1005.

SECTION M-1302— OPERATING AND SAFETY CONTROLS

M-1302.1 Safety controls: Electrical and mechanical operating and safety controls for boilers shall be labeled.

M-1302.2 Boiler gauges: Boilers shall be equipped with pressure and temperature gauges that indicate pressure and temperature within the normal range of operation.

M-1302.3 Pressure relief valve: Boilers shall be equipped with pressure-relief valves with minimum rated capacities for the equipment served. Pressure-relief valves shall be set at the maximum rating of the boiler. Discharge shall be piped to drain by gravity to within 18-inches of the floor or to an open receptor.

SECTION M-1303—EXPANSION TANKS

M-1303.1 General: Boilers shall be provided with expansion tanks. Nonpressurized expansion tanks shall be securely fastened to the structure or boiler and supported adequately to carry twice the weight of the tank filled with water without placing any strain on connecting piping. Provisions shall be made for draining nonpressurized tanks without emptying the system.

Pressurized expansion tanks shall be consistent with the volume and capacity of the system. Tanks shall be capable of withstanding a hydrostatic test pressure of two and one half times the allowable working pressure of the system.

M-1303.2 Minimum capacity: The minimum capacity of expansion tanks shall be determined from Table No. M-1303.2.

Table No. M-1303.2
EXPANSION TANK MINIMUM CAPACITY[1]
FOR FORCED HOT-WATER SYSTEMS (GALLONS)

SYSTEM VOLUME[2] (GALLONS)	PRESSURIZED DIAPHRAGM TYPE	NONPRESSURIZED TYPE
10	1.0	1.5
20	1.5	3.0
30	2.5	4.5
40	3.0	6.0
50	4.0	7.5
60	5.0	9.0
70	6.0	10.5
80	6.5	12.0
90	7.5	13.5
100	8.0	15.0

[1]Based on average water temperature of 195°F, fill pressure of 12-psig, and a maximum operating pressure of 30-psig.
[2]System volume includes volume of water in boiler, convectors, and piping, not including the expansion tank.

SECTION M-1304—HYDRONIC PIPING SYSTEMS INSTALLATION

M-1304.1 General: Hydronic piping shall conform to Table No. M-1304.1 or other approved materials. Approved piping, valves, fittings, and connections shall be installed in accordance with the installation instructions of the manufacturers of system equipment and components. Pipe and fittings shall be rated for use at the operating temperature and pressure of the hydronic system. Used pipe, fittings, valves, or other materials shall be free of foreign materials and adequate for the service intended.

M-1304.2 Prohibited tees: Circulating hot water in a system shall not enter a tee fitting through the side opening.

M-1304.3 System drain down: Hydronic piping systems shall be designed and installed to permit the system to be drained. When the system drains to the plumbing drainage system, the installation shall conform to the requirements of Part V of this code.

M-1304.4 Protection of potable water: The potable water system shall be protected from backflow in accordance with the provisions listed in Section P-2402.

M-1304.5 Pipe penetrations: Openings through concrete or masonry building elements shall be sleeved.

M-1304.6 Contact with building material: A hydronic piping system shall not be in direct contact with any building material which causes the piping material to degrade or corrode.

M-1304.7 Drilling and notching: Wood-framed structural members shall be drilled, notched or altered in accordance with the provisions of Sections R-402.5, R-602.5, R-602.6, R-702.5 and R-702.6.

M-1304.8 Expansion, contraction and settlement: Piping shall be installed so that piping, connections and equipment shall not be subjected to excessive strains or stresses. Provisions shall be made to compensate for expansion, contraction, shrinkage, and structural settlement.

M-1304.9 Piping support: Hangers and supports shall be of material of sufficient strength to support the piping, and shall be fabricated from materials compatible with the piping material. Piping shall be supported at intervals not exceeding the spacing specified in Table No. M-1304.9.

TABLE NO. M-1304.1
HYDRONIC PIPING MATERIALS

MATERIAL	USE CODE[1]	STANDARD[2]	JOINTS	NOTES
Copper Pipe	1	ASTM B42, B302	Brazed, soldered mechanical fittings, threaded, welded, flanged	
Copper Tubing (Type K, L, or M)	1,2	ASTM B75, B88 B251	Brazed, soldered, flared mechanical fittings	Joints embedded in concrete
Steel Pipe	1,2	ASTM A53, A106	Brazed, welded, threaded, flanged mechanical fittings	Joints in concrete shall be welded. Galvanized shall not be welded or brazed.
Steel Tubing	1	ASTM A254	Mechanical fittings welded	
Brass Pipe	1	ASTM B43	Brazed, welded threaded mechanical flanged fittings	
Brass Tubing	1	ASTM B135	Brazed, soldered, mechanical fittings	
Polybutylene (PB) pipe and tubing	1,2,3	Heat-fusion, crimp/insert, compression	Joints in concrete shall be heat-fused.	
Crosslinked Polyethylene (PEX) tubing	2,3	ASTM F876, F877	Mechanical compression	Install in accordance with manufacturer's instructions.

[1]Use Code:
1. Above ground.
2. Embedded in radiant system.
3. Temperatures below 180°F only.

[2]Standards as listed in Section S-26.1304.

SECTION M-1305—BASEBOARD CONVECTORS

Baseboard convectors shall be installed in accordance with the manufacturer's installation instructions. Convectors shall be supported independent of hydronic piping.

Table No. M-1304.9
HANGER SPACING INTERVALS

PIPING MATERIAL	MAXIMUM HORIZONTAL SPACING (FEET)	MAXIMUM VERTICAL SPACING (FEET)
Copper or copper alloy pipe	12	10
Copper or copper alloy tubing	6	10
PB pipe or tubing	3	4
Steel pipe	12	15
Steel tubing	8	10

SECTION M-1306—FLOOR HEATING SYSTEMS

M-1306.1 Piping materials: Piping for embedment in concrete or gypsum materials shall be standard-weight steel pipe, copper tubing, polybutylene, other approved plastic pipe or tubing with a minimum rating of 100-psi at 180°F, or other approved materials.

M-1306.2 Piping joints: Piping joints that are embedded shall be installed in accordance with the following requirements:

1. Steel pipe joints shall be welded.
2. Copper tubing shall be joined with brazing material having a melting point exceeding 1000°F.
3. Polybutylene pipe and tubing joints shall be installed with socket type heat fused polybutylene fittings.

M-1306.3 Testing: Piping or tubing to be embedded shall be tested by applying a hydrostatic pressure of not less than 100-psi. The pressure shall be maintained for 30 minutes, during which all joints shall be visually inspected for leaks.

SECTION M-1307—WATER HEATERS USED FOR SPACE HEATING

M-1307.1 Piping: Piping and components connected to a water heater for space heating application shall be suitable for use with potable water. Water heaters that will be used to supply potable water shall not be connected to a heating system or components previously used with a non-potable water heating appliance.

M-1307.2 Labeling: Water heaters shall bear the label or marking of an approved labeling agency.

M-1307.3 Installation: Where a combination water heating-space heating system requires water for space heating at temperatures higher than 140°F, a means such as a mixing valve shall be installed to temper the water for domestic uses. The input capacity of the water heater shall be 30% greater than the capacity of the heating coil.

M-1307.4 Protection of potable water: Toxic chemicals used for boiler treatment shall not be introduced into a water heater for potable water heating.

SECTION M-1308—STEAMBOILERS

See North Carolina State Building Code, Volume III - Mechanical.

Chapter 14
VENTED FLOOR, WALL AND ROOM HEATERS

SECTION M-1401—VENTED FLOOR FURNACES

M-1401.1 General: Vented floor furnaces shall conform to ANSI Z21.48, as listed in Section S-26.1401, and shall be installed in accordance with the manufacturer's installation instructions and the requirements of the code.

M-1401.2 Clearances: Vented floor furnaces shall be installed in accordance with Table No. M-1005a unless otherwise approved.

M-1401.3 Location: Unless otherwise approved, location of floor furnaces shall conform to the following requirements:

1. Floor registers of floor furnaces shall be installed not less than 6-inches from a wall.
2. Wall registers of floor furnaces shall be installed not less than 6-inches from the adjoining wall at inside corners.
3. The furnace register shall be located not less than 12-inches from doors, draperies, or similar combustible objects.
4. The furnace register shall be located at least 5-feet below any projecting combustible materials.
5. The floor furnace burner assembly shall not project into an occupied under-floor area.

M-1401.4 Access: An opening in the foundation not less than 18-inches by 24-inches, or a trap door not less than 20-inches by 30-inches shall be provided for access to a floor furnace. The opening and passageway shall be large enough to allow replacement of any part of the equipment.

M1401.5 Installation: Unless otherwise approved, floor furnace installations shall conform to the following requirements:

1. Thermostats controlling floor furnaces shall not be located in a room that can be separated from the room in which the register of the floor furnace is located.
2. Floor furnaces shall be supported independently of the furnace floor register.
3. Floor furnaces shall be installed not closer than 6-inches to the ground. Clearance may be reduced to 2-inches, provided that the lower 6-inches of the furnace is sealed to prevent water entry.
4. When excavation is required for a floor furnace installation, the excavation shall extend 18-inches beyond the control side of the floor furnace and 12-inches beyond the remaining sides. Excavations shall slope outward from the perimeter of the base of the excavation to the surrounding grade at an angle not exceeding 45 degrees from horizontal.
5. Floor furnaces shall not be supported from the ground.

SECTION M-1402—VENTED WALL FURNACES

M-1402.1 General: Vented wall furnaces shall conform to ANSI Z21.44 or Z21.49, as listed in Section S-26.1402 and shall be installed in accordance with the manufacturer's installation instructions and the requirements of this code.

M-1402.2 Locations: Unless other

sealed so tightly that infiltration air is not adequate for combustion, combustion air shall be obtained from outdoors or from spaces freely communicating with the outdoors in accordance with Section M-1503 or M-1504.

SECTION M-1503—OUTDOOR AIR

M-1503.1 Connections to outdoors: When the space in which fuel-burning appliances are located does not meet the criterion for indoor air specified in Section M-1502, outside combustion air shall be supplied through openings or ducts extending from the appliance room to the outdoors. One opening shall be within 12-inches of the top, and one within 12-inches of the bottom of the space, as illustrated in Figure No. M-1503.1. Openings are permitted to connect to spaces directly communicating with the outdoors, such as ventilated crawl spaces or ventilated attic spaces. The same duct shall not serve both combustion air openings. The duct serving the upper air opening shall be level or extend upward from the appliance space.

M-1503.2 Size of opening: When communicating with the outdoors by means of vertical ducts, each opening shall have free area of at least 1-square inch per 4,000 Btu/h of total input rating of all appliances in the space. If horizontal ducts are used, each opening shall have free area of at least 1-square inch per 2,000 Btu/h of total input of all appliances in the space. Ducts shall be of the same minimum cross-sectional area as the required free area of the openings to which they connect. The minimum cross-sectional dimension of rectangular air ducts shall be 3-inches.

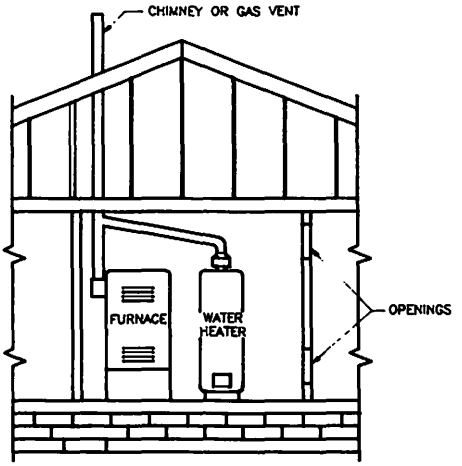
M-1503.3 Attic combustion air: Combustion air obtained from an attic area, as illustrated in Figure No. M-1503.3, shall be in accordance with the following:

1. The attic ventilation shall be sufficient to provide the required volume of combustion air.
2. The combustion air opening shall be provided with a metal sleeve or other approved material extending from the appliance enclosure to at least 6-inches above the top of the ceiling joists and ceiling insulation.
3. The end of ducts that terminate in an attic shall not be screened unless required by the building official.

M-1503.4 Under-floor combustion air: Combustion air obtained from under-floor areas, as illustrated in Figure No. M-1503.4, shall have free openings area to the outside equivalent to not less than twice the required combustion air opening.

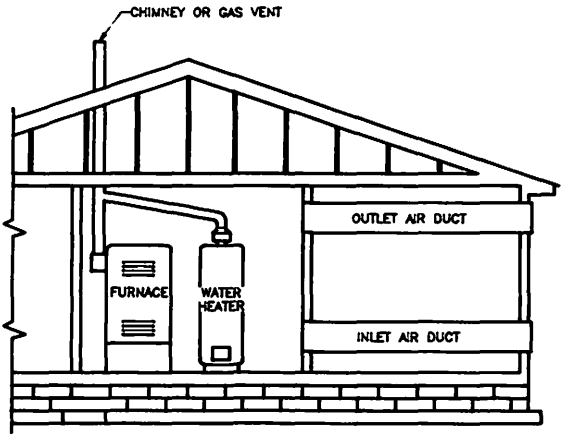
M-1503.5 Opening requirements: Outside combustion air openings shall be covered with corrosion-resistant screen or equivalent protection having no less than 1/4-inch openings, and not greater than 1/2-inch openings.

Figure No. M-1502.2
EQUIPMENT LOCATED IN CONFINED SPACES
ALL AIR FROM ADJACENT SPACES
WITHIN THE BUILDING



NOTE: Each opening shall have a free area of not less than one square inch per 1,000 Btu/h of the total input rating of all equipment in the enclosure, but not less than 100 square inches.

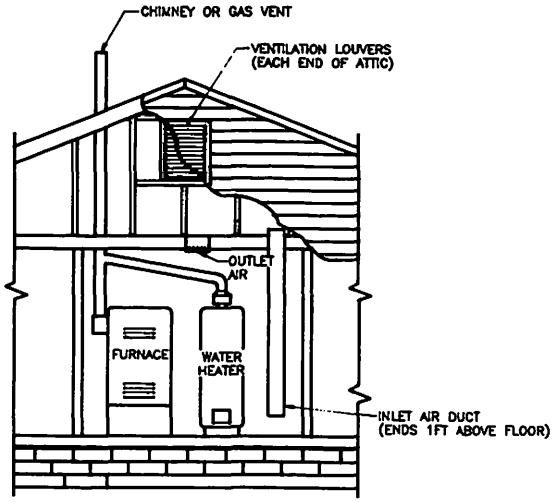
Figure No. M-1503.1
EQUIPMENT LOCATED IN CONFINED SPACES
ALL AIR TAKEN FROM OUTDOORS



NOTE: Each air duct opening shall have a free area of not less than one square inch per 2,000 Btu/h of the total input rating of all equipment in the enclosure.

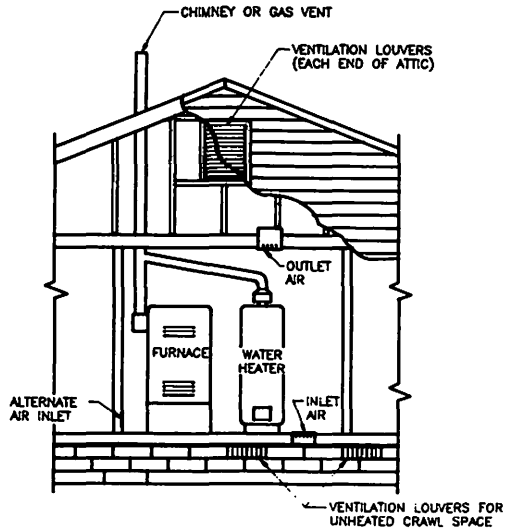
If the equipment room is located against an outside wall and the air openings communicate directly with the outdoors, each opening shall have a free area of not less than one square inch per 4,000 Btu/h of the total input rating of all equipment in the enclosure.

Figure No. M-1503.3
EQUIPMENT LOCATED IN CONFINED SPACES
ALL AIR FROM OUTDOORS THROUGH VENTILATED ATTIC



NOTE: The inlet and outlet air openings shall each have a free area of not less than one square inch per 4,000 Btu/h of the total input rating of all equipment in the enclosure.

Figure No. 1503.4
EQUIPMENT LOCATED IN CONFINED SPACES
INLET AIR FROM VENTILATED
CRAWL SPACE AND OUTLET AIR TO VENTILATED ATTIC



NOTE: The inlet and outlet air openings shall each have a free area of not less than one square inch per 4,000 Btu/h of the total input rating of all equipment in the enclosure.

SECTION M-1504—COMBINED USE OF INDOOR AND OUTDOOR AIR

M-1504.1 General: When the space in which fuel-burning appliances are located does not meet the criterion for indoor air specified in Section M-1502, combustion air supplied by a combined use of indoor and outdoor air shall be supplied through openings and ducts extending to the appliance room or to the vicinity of the appliance.

M-1504.2 Openings and supply ducts: Two openings for ventilation shall be located and sized in accordance with Section M-1502.2. In addition, there shall be one opening directly communicating with the outdoors or to such spaces (crawlspace or attic) that freely communicate with the outdoors. This opening shall have free area of at least 1-square inch per 5,000 Btu/h of total input of all appliances in the space. Ducts shall be of the same minimum cross-sectional area as the required free area of the opening. Ducts admitting outdoor air shall be connected to the return air side of the heating system.

CHAPTER 16
EQUIPMENT VENTING

SECTION M-1601 – GENERAL

Fuel-burning appliances shall be vented to the outside in accordance with their label and manufacturer's installation instructions unless labeled for unvented use. Venting systems shall consist of approved chimneys or vents, or venting assemblies which are integral parts of labeled appliances.

M-1601.1 Draft requirements: A venting system shall satisfy the draft requirement of the equipment in accordance with the manufacturer"s installation instructions and shall be designed and constructed to develop a positive air flow adequate to convey all combustion products to the outside atmosphere.

M-1601.2 Inspection of chimneys: Before connecting a vent connector to a chimney, the chimney passageway shall be examined to ascertain that it is free of obstructions. When inspection reveals that an existing chimney is not safe for the intended application, it shall be rebuilt to conform to Sections R-901 and R-902, lined or relined with a suitable liner, or replaced with a vent or chimney suitable for the equipment to be attached.

M-1601.3 Mechanical draft systems: A mechanical draft system shall be used only with equipment labeled for such use. Provision shall be made to prevent the flow of fuel to the equipment when the draft system is not operating. Forced draft systems and all portions of induced draft systems under positive pressure during operation shall be designed and installed so as to prevent leakage of flue gases into a building.

M-1601.4 Direct vent appliances: Direct vent appliances shall be labeled and shall be installed in accordance with the manufacturer's installation instructions.

M-1601.5 Support: Venting systems shall be adequately supported for the weight of the material used.

M-1601.6 Duct penetrations: Vents or vent connectors shall not extend into or through supply and return air ducts or plenums.

M-1601.7 Firestopping: Vent and chimney installations shall be fire-stopped in accordance with Section R-402.7.

M-1601.8 Unused openings: Unused openings in any venting system shall be closed or capped.

SECTION M-1602—VENT COMPONENTS

M-1602.1 Draft hoods: Draft hoods shall be located in the same room or space as the combustion air openings for the appliances.

M-1602.2 Vent dampers

M-1602.2.1 Manually operated: Manually operated dampers shall not be installed except in connectors or chimneys of solid fuel-burning appliances.

M-1602.2.2 Automatically operated: Automatically operated dampers shall be installed in accordance with the terms of their label, and shall be installed to prevent firing of the burner unless the damper is opened to a safe position. Automatic dampers shall conform to the applicable ANSI standard Z21.66, Z21.67 or Z21.68, as listed in Section S-26.1602.

M-1602.3 Draft regulators: Draft regulators shall be provided for oil fired appliances required to be connected to a chimney unless the appliance is labeled for use without a draft regulator.

Draft regulators provided for solid fuel burning appliances to reduce draft intensity shall be installed and set in accordance with the manufacturer's installation instructions.

Where required, draft regulators shall be installed in the same room or enclosure as the appliance such that no difference in pressure between the air at the regulator and the combustion air supply will exist.

SECTION M-1603—CHIMNEY AND VENT CONNECTORS

M-1603.1 General: Connectors shall be used to connect fuel-burning appliances to a vertical chimney or vent unless the chimney or vent is attached directly to the appliance.

M-1603.2 Connectors for gas appliances: Connectors for labeled gas appliances and appliances equipped with a labeled gas burner and draft hood shall be of Type B or Type L vent material, or single-wall metal pipe not thinner than 28 gage galvanized steel. Connectors for Category II, III, and IV equipment shall be as specified by the equipment manufacturer.

M-1603.3 Connectors for oil and solid fuel appliances: Connectors for oil and solid fuel burning appliances shall be fabricated from factory-built chimney material, Type L vent material, or single-wall metal pipe having resistance to corrosion and heat, and thickness not less than that of galvanized pipe as specified in Table No. M-1603.3.

Table No. M-1603.3
THICKNESS FOR SINGLE-WALL METAL PIPE CONNECTORS

DIAMETER OF CONNECTOR (INCHES)	SHEET METAL GAGE NUMBER
LESS THAN 6	26
6 TO 10	24

M-1603.4 Installation: Vent and chimney connectors shall be installed in accordance with the manufacturer's installation instructions and within the space that the appliance is located. Appliances shall be located as close as practical to the vent or chimney. Connectors shall be as short and straight as possible and constructed with a rise of not less than 1/4-inch to the foot run. Connectors shall be securely supported and joints shall be fastened with sheet metal screws, rivets, or by other approved means.

Devices that obstruct the flow of flue gases shall not be installed in a connector unless labeled or approved for such installations.

M-1603.4.1 Location: When the connector serving a gas appliance with a draft hood is located in nonconditioned space, that portion of the connector shall be labeled Type B or Type L vent material, or be provided with equivalent insulation.

M-1603.4.2 Floor, ceiling and wall penetrations: A chimney connector or vent connector shall not pass through any floor, ceiling, wall, or partition unless the connector is labeled for wall pass-through, or is routed through a device labeled for wall pass-through and is installed in accordance with the conditions of its label. Connectors for labeled gas appliances with draft hoods. and oil appliances labeled for Type L vents, passing through walls or partitions shall be inaccordance with the following:

1. Type B or Type L vent material for gas appliances, Type L vent material for oil appliances, shall be installed with not less than labeled clearances to combustible material.
2. Single-wall metal pipe shall be guarded by a ventilated metal thimble not less than 4-inches larger in diameter than the vent connector.

M-1603.4.3 Length: The horizontal run of an uninsulated connector to a natural draft chimney shall not exceed 75 percent of the height of the vertical portion of the chimney above the connector. The horizontal run of an insulated connector to a natural draft chimney shall not exceed 100 percent of the height of the vertical portion of the chimney above the connector. The horizontal length, design and construction of combined connector, or connector to a manifold joining two or more appliances to a chimney, shall be determined in accordance with approved engineering methods.

M-1603.4.4 Size: A connector shall be not smaller than the flue collar of the appliance unless otherwise approved according to the manufacturer's installation instructions.

M-1603.4.5 Clearance: Connectors shall be installed with clearance to combustibles as set forth in Table No. M-1603.4.5. Reduced clearances to combustible material shall be in accordance with Table No. M-1005b and Figure No. M-1005.

M-1603.4.6 Access: The entire length of a connector shall be accessible for inspection, cleaning and replacement unless labeled materials are used and concealment is approved by the building official.

M-1603.4.7 Fireplace connection: An appliance shall not be connected to a chimney flue serving a fireplace unless the fireplace opening is sealed or the chimney flue which vents the fireplace is permanently sealed below the connection.

TABLE NO. M-1603.4.5
CHIMNEY AND VENT CONNECTOR
CLEARANCES FROM COMBUSTIBLE MATERIALS[1]

Type of Connector	Minimum Clearance (inches)
Single-Wall Metal Pipe Connectors	
Gas Appliances without Draft Hoods	18
Oil and Solid-Fuel Appliances	18
Unlabeled Gas Appliances with Draft Hoods	9
Oil Appliances Labeled for Use with Type L Vents	9
Labeled Gas Appliances with Draft Hoods[3]	6
Type L Vent Piping Connectors	
Gas Appliances without Draft Hoods	9
Oil and Solid-Fuel Appliances	9
Unlabeled Gas Appliances with Draft Hoods	6
Oil Appliances Labeled for Use with Type L Vents	—[2]
Labeled Gas Appliances with Draft Hoods	—[3]
Type B Gas Vent Piping Connectors	
Labeled Gas Appliances with Draft Hoods	—[3]

[1]These clearances apply unless the label of an appliance specifies a different clearance. Reduction in clearance shall be provided as in Table No. M-1005b.

[2]If labeled Type L vent piping is used, the clearance shall be in accordance with the vent label.

[3]If labeled Type B or Type L vent piping is used, the clearance shall be in accordance with the vent label.

SECTION M-1604 – VENTS

M-1604.1 Type of Vent Required: Appliances shall be provided with a labeled venting system as set forth in Table No. M-1604.1.

M-1604.2 Termination

M-1604.2.1 Through the roof: Vents passing through a roof shall extend through flashing and terminate in accordance with the manufacturer's recommendations.

M-1604.2.2 Natural draft appliances: Unless otherwise approved according to the manufacturer's installation instructions, vents for natural draft appliances shall terminate at an elevation at least 5-feet above the highest connected appliance outlet, and natural draft gas vents serving wall furnaces shall terminate at an elevation at least 12-feet above the bottom of the furnace.

M-1604.2.3 Type B or BW vent: Type B or BW gas vents shall conform to UL 441, as listed in Section S-26.1604. Such vents shall terminate in accordance with its listing.

M-1604.2.4 Type L vent: Type L venting systems shall conform to UL 641 as listed in Section S-26-1604. Such vents shall terminate in accordance with its listing.

Table No. M-1604.1
VENT SELECTION CHART

Type B Gas	Type BW Gas	Special Gas Vent Systems	Type L Oil, etc.
All labeled gas appliances with draft hoods, and other Category I gas appliance vents labeled for use with Type B gas vents	Vented wall furnaces labeled for use with Type BW vents	Category II, III, and IV gas appliances, according to manufacturer's recommendations and as labeled	Oil burning appliances labeled for use with Type L vents; gas appliances labeled for use with Type B vents.

M-1604.2.5 Direct vent appliances: The vent terminal of a direct vent appliance with an input of 50,000 Btu/h or less shall be located not less than 9-inches from any opening through which vent gases could enter a building. The vent terminal of a direct vent appliance having an input over 50,000 Btu/h shall be located not less than 12-inches from any such opening. The bottom of a vent terminal and an air intake shall be located at least 12-inches above grade.

M-1604.2.6 Mechanical draft systems: Mechanical draft systems other than direct vent systems shall be installed in accordance with the manufacturer's installation instructions or the following requirements:

1. The vent terminal shall be located not less than 3-feet above any forced air inlet located within 10-feet.
2. The vent terminal shall be located not less than 4-feet below, 4-feet horizontally from, or 1-foot above any door, window, or gravity air inlet into a dwelling.
3. The vent terminal shall be located not less than 2-feet from an adjacent building.
4. The bottom of the vent terminal shall be located at least 12-inches above finished ground level.

M-1604.3 Installation: Type B, Type BW, and Type L vents shall be installed in accordance with the terms of their label and manufacturer's installation instructions. Venting systems for labeled Category II, III, and IV gas appliances shall be installed in accordance with the appliance manufacturer's installation instructions.

M-1604.3.1 Size of single appliance venting systems: An individual vent for a single appliance shall have a cross-sectional area equal to or greater than the area of the connector to the appliance, but not less than 7-square inches except where the vent is an integral part of a labeled appliance. Vents shall be sized according to Table Nos. M-1604.3.1a and M-1604.3.1b for a single Category I gas appliance or according to NC State Building Code, Volume VI-Gas, as listed in Section S-26.1604, or by other approved methods.

M-1604.3.2 Size of multiple appliance venting systems: Two or more labeled appliances connected to a common natural draft venting system shall comply with the following requirements:

1. Vents shall be sized according to Table Nos. M-1604.3.2a, M-1604.3.2b, and M-1604.3.2c for two or more Category I gas appliances, or according to N.C. State Building Code, Volume VI–Gas, as listed in Section S-26.1604, or by other approved methods.
2. Appliances which are connected to common venting systems shall be located on the same floor of the dwelling except engineered systems as provided in Section M-1601.
3. Inlets to common venting systems shall be offset such that no portion of an inlet is opposite another inlet.
4. Connectors serving appliances operating under natural draft shall not be connected into any portion of a mechanical draft system operating under positive pressure.
5. Unless labeled for such connection, solid fuel-burning appliances shall not be connected to a vent serving another appliance burning other fuels.
6. When two or more vent connectors enter a common gas vent, the smaller connector shall enter at the highest level consistent with the available headroom and clearance to combustible material.

M-1604.3.3 Size of solid fuel vents: Unless otherwise approved according to the manufacturer's installation instructions, the cross-sectional areas of a flue connected to a solid fuel burning appliance shall be not less than the area of the flue collar or connector but not larger than three times the area of the flue collar.

SECTION M-1605—MASONRY AND FACTORY-BUILT CHIMNEYS

M-1605.1 General: Masonry and factory-built chimneys shall be built and installed in accordance with Sections R-901 and R-902, respectively.

M-1605.2 Installation of factory-built chimneys: Factory-built chimneys and chimney units shall be installed in accordance with the manufacturer's installation instructions such that flue gas temperatures in the chimney shall not exceed the limits specified in their label. Factory-built chimneys for use with wood-burning appliances shall be Type HT or labeled for 2100°F flue gases.

M-1605.3 Masonry chimney connection: A chimney connector shall enter a masonry chimney not less than 6-inches from the bottom of the chimney, except that if 6-inches are not available, a cleanout shall be provided by installing a capped tee in the connector next to the chimney. A connector entering a masonry chimney shall extend through, but not beyond the wall and shall be flush with the inner face of the liner. Connectors, or thimbles, when used, shall be firmly cemented into the masonry.

M-1605.4 Size of masonry chimneys: The effective area of a natural draft chimney flue for one appliance shall be not less than the area of the connector to the appliance. Chimneys connected to more than one appliance shall be not less than the area of the largest connector plus 50 percent of the areas of additional vent connectors.

M-1605.4.1 Size of chimney for single gas appliance: Masonry chimneys serving a single Category I gas appliance shall be sized in accordance with Table Nos. M-1605.4.1a and M-1605.4.1b or North Carolina State Building Code, Volume VI–Gas, as listed in Section S-26.1605, or by other approved methods.

M-1605.4.2 Size of chimney for multiple gas appliance: Venting of multiple gas appliances through masonry chimneys shall conform to Section M-1604.3.2, except that masonry chimneys serving multiple Category I gas appliances shall be sized in accordance with Table Nos. M-1605.4.2a, M-1605.4.2b, M-1605.4.2c and M-1605.4.2d or North Carolina State Building Code, Volume VI–Gas, as listed in Section S-26.1605, or by other approved methods.

Notes for Single Appliance Vents. (See Table Nos. M-1604.3.1a, M-1604.3.1b, M-1605.4.1a, and M-1605.4.1b.

1. If the vent size determined from the tables is smaller than the appliance draft hood outlet or flue collar, the smaller size may be used provided:
   a. The total vent height "H" is at least 10 ft.
   b. Vents for appliance draft hood outlets or flue collars 12 inches in diameter or smaller are not reduced more than one size.
   c. Vents for appliance draft hood outlets or flue collars above 12 inches in diameter are not reduced more than two sizes.
   d. The maximum capacity listed in the tables for a fan-assisted appliance is reduced by 10% (0.90 X maximum capacity).
   e. The draft hood outlet is greater than 4 inches in diameter. Do not connect a 3-inch diameter vent to a 4-inch diameter draft hood outlet. This provision does not apply to fan-assisted appliances.
2. Single appliance venting configurations with zero lateral lengths in Table Nos. M-1604.3.1a and M-1604.3.1b are assumed to have no elbows in the vent system. For all other vent configurations with indicated lateral lengths, the vent system is assumed to have two 90°elbows. For each additional 90° elbow, or equivalent beyond two, the maximum capacity listed in the venting table should be reduced by 10 % (0.90 X maximum capacity). Two 45° elbows are equivalent to one 90° elbow.
3. Zero (0) lateral "L" applies only to a straight vertical vent attached to a top outlet draft hood or flue collar.
4. Use sea level input rating when determining maximum capacity for high altitude installation. Use actual input for determining minimum capacity for high altitude installation.
5. Numbers followed by an asterisk (*) indicate the possibility of continuous condensation, depending on locality. Consult local serving gas supplier and/or local codes.
6. For appliances with more than one input rate, the minimum vent capacity detrmined from the tables shall be less than the lowest appliance input rating and the maximum vent capacity determined from the tables shall be greater than the highest appliance input rating.
7. Listed corrugated metallic chimney liner systems in masonry chimneys shall be sized by Table Nos. M-1604.3.1a and M-1604.3.1b for Type B vents with the maximum capacity reduced by 20% (.80 X maximum capacity and the minimum capacity as shown in Table Nos. M-1604.3.1a and M-1604.3.1b. Corrugated metal vent systems installed with bends or offsets require additional reduction of the vent maximum capacity (See note 2).
8. If the vertical vent has a larger diameter than the vent connector, use the vertical vent diameter to determine the minimum vent capacity and the connector diameter to determine the maximum vent capacity. The flow area of the vertical vent, however, shall not exceed seven times the flow area of the appliance categorized vent area, flue collar area, or draft hood outlet area unless designed in accordance with approved engineering methods.
9. DELETED
10. Do not upsize vent connectors more than two sizes greater than the appliance categorized vent diameter, flue collar diameter, or draft hood outlet diameter.
11. In a single run of vent or vent connector, more than one diameter and type are permitted to be used provided that the sizes and the types are permitted by the tables.
12. For additional information on vent sizing, see the Chapter on Chimney, Gas Vents and Fireplace Systems in the ASHRAE Equipment Handbook.

TABLE M-1604.3.1a
CAPACITY OF TYPE B DOUBLE-WALL VENTS WITH TYPE B DOUBLE-WALL CONNECTOR SERVING A SINGLE CATEGORY 1 APPLIANCE

Vent and Connector Diameter - D (Inches)

Appliance Input Rating In Thousands of Btu Per Hour

		3"			4"			5"			6"			7"		
Height H (ft)	Lateral L (ft)	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	0	78	46	0	152	86	0	251	141	0	375	205	0	524	285
	2	13	51	36	18	97	67	27	157	105	32	232	157	44	321	217
	4	21	49	34	30	94	64	39	153	103	50	227	153	66	316	211
	6	25	46	32	36	91	61	47	149	100	59	223	149	78	310	205
8	0	0	84	50	0	165	94	0	276	155	0	415	235	0	583	320
	2	12	57	40	16	109	75	25	178	120	28	263	180	42	365	247
	5	23	53	38	32	103	71	42	171	115	53	255	173	70	356	237
	8	28	49	35	39	98	66	51	164	109	64	247	165	84	347	227
10	0	0	88	53	0	175	100	0	295	166	0	447	255	0	631	345
	2	12	61	42	17	118	81	23	194	129	26	289	195	40	402	273
	5	23	57	40	32	113	77	41	187	124	52	280	188	68	392	263
	10	30	51	36	41	104	70	54	176	115	67	267	175	88	376	245
15	0	0	94	58	0	191	112	0	327	187	0	502	285	0	716	390
	2	11	69	48	15	136	93	20	226	150	22	339	225	38	475	316
	5	22	65	45	30	130	87	39	219	142	49	330	217	64	463	300
	10	29	59	41	40	121	82	51	206	135	64	315	208	84	445	288
	15	35	53	37	48	112	76	61	195	128	76	301	198	98	429	275
20	0	0	97	61	0	202	119	0	349	202	0	540	307	0	776	430
	2	10	75	51	14	149	100	18	250	166	20	377	249	33	531	346
	5	21	71	48	29	143	96	38	242	160	47	367	241	62	519	337
	10	28	64	44	38	133	89	50	229	150	62	351	228	81	499	321
	15	34	58	40	46	124	84	59	217	142	73	337	217	94	481	308
	20	48	52	35	55	116	78	69	206	134	84	322	206	107	464	295

TABLE M-1604.3.1a (Continued)
CAPACITY OF TYPE B DOUBLE-WALL VENTS WITH TYPE B DOUBLE-WALL CONNECTOR SERVING A SINGLE CATEGORY 1 APPLIANCE

Vent and Connector Diameter - D (Inches)

Appliance Input Rating In Thousands of Btu Per Hour

		8"			9"			10"			12"			14"		
Height H (ft)	Lateral L (ft)	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	0	698	370	0	897	470	0	1121	570	0	1645	850	0	2267	1170
	2	53	425	285	63	543	370	75	675	455	103	982	650	138	1346	890
	4	79	419	279	93	536	362	110	668	445	147	975	640	191	1338	880
	6	93	413	273	110	530	354	128	661	435	171	967	630	219	1330	870
8	0	0	780	415	0	1006	537	0	1261	660	0	1858	970	0	2571	1320
	2	50	483	322	60	619	418	71	770	515	98	1124	745	130	1543	1020
	5	83	473	313	99	607	407	115	758	503	154	1110	733	199	1528	1010
	8	99	463	303	117	596	396	137	746	490	180	1097	720	231	1514	1000
10	0	0	847	450	0	1096	585	0	1377	720	0	2036	1060	0	2825	1450
	2	48	533	355	57	684	457	68	852	560	93	1244	850	124	1713	1130
	5	81	522	346	95	671	446	112	839	547	149	1229	829	192	1696	1105
	10	104	504	330	122	651	427	142	817	525	187	1204	795	238	1669	1080
15	0	0	970	525	0	1263	682	0	1596	840	0	2380	1240	0	3323	1720
	2	45	633	414	53	815	544	63	1019	675	86	1495	985	114	2062	1350
	5	76	620	403	90	800	529	105	1003	660	140	1476	967	182	2041	1327
	10	99	600	386	116	777	507	135	977	635	177	1446	936	227	2009	1289
	15	115	580	373	134	755	491	155	953	610	202	1418	905	257	1976	1250
20	0	0	1057	575	0	1384	752	0	1756	930	0	2637	1350	0	3701	1900
	2	41	711	470	50	917	612	59	1150	755	81	1694	1100	107	2343	1520
	5	73	697	460	86	902	599	101	1133	738	135	1674	1079	174	2320	1498
	10	95	675	443	112	877	576	130	1105	710	172	1641	1045	220	2282	1460
	15	111	654	427	129	853	557	150	1078	688	195	1609	1018	248	2245	1425
	20	125	634	410	145	830	537	167	1052	665	217	1578	990	273	2210	1390

TABLE M-1604.3.1a (Continued)
CAPACITY OF TYPE B DOUBLE-WALL VENTS WITH TYPE B DOUBLE-WALL CONNECTOR SERVING A SINGLE CATEGORY 1 APPLIANCE

Vent and Connector Diameter - D (Inches)

Appliance Input Rating In Thousands of Btu Per Hour

Height H (ft)	Lateral L (ft)	16"			18"			20"			22"			24"		
		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	0	2983	1530	0	3802	1960	0	4721	2430	0	5737	2950	0	6853	3520
	2	178	1769	1170	225	2250	1480	296	2782	1850	360	3377	2220	426	4030	2670
	4	242	1761	1160	300	2242	1475	390	2774	1835	469	3370	2215	555	4023	2660
	6	276	1753	1150	341	2235	1470	437	2767	1820	523	3363	2210	618	4017	2650
8	0	0	3399	1740	0	4333	2220	0	5387	2750	0	6555	3360	0	7838	4010
	2	168	2030	1340	212	2584	1700	278	3196	2110	336	3882	2560	401	4634	3050
	5	251	2013	1330	311	2563	1685	398	3180	2090	476	3863	2545	562	4612	3040
	8	289	2000	1320	354	2552	1670	450	3163	2070	537	3850	2530	630	4602	3030
10	0	0	3742	1925	0	4782	2450	0	5955	3050	0	7254	3710	0	8682	4450
	2	161	2256	1480	202	2868	1890	264	3556	2340	319	4322	2840	378	5153	3390
	5	243	2238	1461	300	2849	1871	382	3536	2318	458	4301	2818	540	5132	3371
	10	298	2209	1430	364	2818	1840	459	3504	2280	546	4268	2780	641	5099	3340
15	0	0	4423	2270	0	5678	2900	0	7099	3620	0	8665	4410	0	10393	5300
	2	147	2719	1770	186	3467	2260	239	4304	2800	290	5232	3410	346	6251	4080
	5	229	2696	1748	283	3442	2235	355	4278	2777	426	5204	3385	501	6222	4057
	10	283	2659	1712	346	3402	2193	432	4234	2739	510	5159	3343	599	6175	4019
	15	318	2623	1675	385	3363	2150	479	4192	2700	564	5115	3300	665	6129	3980
20	0	0	4948	2520	0	6376	3250	0	7988	4060	0	9785	4980	0	11753	6000
	2	139	3097	2000	175	3955	2570	220	4916	3200	269	5983	3910	321	7154	4700
	5	219	3071	1978	270	3926	2544	337	4885	3174	403	5950	3880	475	7119	4662
	10	273	3029	1940	334	3880	2500	413	4835	3130	489	5896	3830	573	7063	4600
	15	306	2988	1910	372	3835	2465	459	4786	3090	541	5844	3795	631	7007	4575
	20	335	2948	1880	404	3791	2430	495	4737	3050	585	5792	3760	689	6953	4550

TABLE M-1604.3.1a (Continued)
CAPACITY OF TYPE B DOUBLE-WALL VENTS WITH TYPE B DOUBLE-WALL CONNECTOR SERVING A SINGLE CATEGORY 1 APPLIANCE

Vent and Connector Diameter - D (Inches)

Appliance Input Rating In Thousands of Btu Per Hour

		3"			4"			5"			6"			7"		
Height H (ft)	Lateral L (ft)	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
30	0	0	100	64	0	213	128	0	374	220	0	587	336	0	853	475
	2	9	81	56	13	166	112	14	283	185	18	432	280	27	613	394
	5	21	77	54	28	160	108	36	275	176	45	421	273	58	600	385
	10	27	70	50	37	150	102	48	262	171	59	405	261	77	580	371
	15	33	64	NR	44	141	96	57	249	163	70	389	249	90	560	357
	20	56	58	NR	53	132	90	66	237	154	80	374	237	102	542	343
	30	NR	NR	NR	73	113	NR	88	214	NR	104	346	219	131	507	321
50	0	0	101	67	0	216	134	0	397	232	0	633	363	0	932	518
	2	8	86	61	11	183	122	14	320	206	15	497	314	22	715	445
	5	20	82	NR	27	177	119	35	312	200	43	487	308	55	702	438
	10	26	76	NR	35	168	114	45	299	190	56	471	298	73	681	426
	15	59	70	NR	42	158	NR	54	287	180	66	455	288	85	662	413
	20	NR	NR	NR	50	149	NR	63	275	169	76	440	278	97	642	401
	30	NR	NR	NR	69	131	NR	84	250	NR	99	410	259	123	605	376
100	0	NR	NR	NR	0	218	NR	0	407	NR	0	665	400	0	997	560
	2	NR	NR	NR	10	194	NR	12	354	NR	13	566	375	18	831	510
	5	NR	NR	NR	26	189	NR	33	347	NR	40	557	369	52	820	504
	10	NR	NR	NR	33	182	NR	43	335	NR	53	542	361	68	801	493
	15	NR	NR	NR	40	174	NR	50	321	NR	62	528	353	80	782	482
	20	NR	NR	NR	47	166	NR	59	311	NR	71	513	344	90	763	471
	30	NR	NR	NR	NR	NR	NR	78	290	NR	92	483	NR	115	726	449
	50	NR	NR	NR	NR	NR	NR	NR	NR	NR	147	428	NR	180	651	405

TABLE M-1604.3.1a (Continued)
CAPACITY OF TYPE B DOUBLE-WALL VENTS WITH TYPE B DOUBLE-WALL CONNECTOR SERVING A SINGLE CATEGORY 1 APPLIANCE

Vent and Connector Diameter - D (Inches)

Appliance Input Rating In Thousands of Btu Per Hour

		8"			9"			10"			12"			14"		
Height H (ft)	Lateral L (ft)	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
30	0	0	1173	650	0	1548	855	0	1977	1060	0	3004	1550	0	4252	2170
	2	33	826	535	42	1072	700	54	1351	865	74	2004	1310	98	2786	1800
	5	69	811	524	82	1055	688	96	1332	851	127	1981	1289	164	2759	1775
	10	91	788	507	107	1028	668	125	1301	829	164	1944	1254	209	2716	1733
	15	105	765	490	124	1002	648	143	1272	807	187	1908	1220	237	2674	1692
	20	119	743	473	139	977	628	160	1243	784	207	1873	1185	260	2633	1650
	30	149	702	444	171	929	594	195	1189	745	246	1807	1130	305	2555	1585
50	0	0	1297	708	0	1730	952	0	2231	1195	0	3441	1825	0	4934	2550
	2	26	975	615	33	1276	813	41	1620	1010	66	2431	1513	86	3409	2125
	5	65	960	605	77	1259	798	90	1600	996	118	2406	1495	151	3380	2102
	10	86	935	589	101	1230	773	118	1567	972	154	2366	1466	196	3332	2064
	15	100	911	572	117	1203	747	136	1536	948	177	2327	1437	222	3285	2026
	20	113	888	556	131	1176	722	151	1505	924	195	2288	1408	244	3239	1987
	30	141	844	522	161	1125	670	183	1446	876	232	2214	1349	287	3150	1910
100	0	0	1411	770	0	1908	1040	0	2491	1310	0	3925	2050	0	5729	2950
	2	21	1155	700	25	1536	935	30	1975	1170	44	3027	1820	72	4313	2550
	5	60	1141	692	71	1519	926	82	1955	1159	107	3002	1803	136	4282	2531
	10	80	1118	679	94	1492	910	108	1923	1142	142	2961	1775	180	4231	2500
	15	93	1095	666	109	1465	895	126	1892	1124	163	2920	1747	206	4182	2469
	20	105	1073	653	122	1438	880	141	1861	1107	181	2880	1719	226	4133	2438
	30	131	1029	627	149	1387	849	170	1802	1071	215	2803	1663	265	4037	2375
	50	197	944	575	217	1288	787	241	1688	1000	292	2657	1550	350	3856	2250

TABLE M-1604.3.1a (Continued)
CAPACITY OF TYPE B DOUBLE-WALL VENTS WITH TYPE B DOUBLE-WALL CONNECTOR SERVING A SINGLE CATEGORY 1 APPLIANCE

Vent and Connector Diameter - D (Inches)

Appliance Input Rating In Thousands of Btu Per Hour

Height H (ft)	Lateral L (ft)	16"			18"			20"			22"			24"		
		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
30	0	0	5725	2920	0	7420	3770	0	9341	4750	0	11483	5850	0	13848	7060
	2	127	3696	2380	159	4734	3050	199	5900	3810	241	7194	4650	285	8617	5600
	5	206	3666	2350	252	4701	3020	312	5863	3783	373	7155	4622	439	8574	5552
	10	259	3617	2300	316	4647	2970	386	5803	3739	456	7090	4574	535	8505	5471
	15	292	3570	2250	354	4594	2920	431	5744	3695	507	7026	4527	590	8437	5391
	20	319	3523	2200	384	4542	2870	467	5686	3650	548	6964	4480	639	8370	5310
	30	369	3433	2130	440	4442	2785	540	5574	3565	635	6842	4375	739	8239	5225
50	0	0	6711	3440	0	8774	4460	0	11129	5635	0	13767	6940	0	16694	8430
	2	113	4554	2840	141	5864	3670	171	7339	4630	209	8980	5695	251	10788	6860
	5	191	4520	2813	234	5826	3639	283	7295	4597	336	8933	5654	394	10737	6818
	10	243	4464	2767	295	5763	3585	355	7224	4542	419	8855	5585	491	10652	6749
	15	274	4409	2721	330	5701	3534	396	7155	4511	465	8779	5546	542	10570	6710
	20	300	4356	2675	361	5641	3481	433	7086	4479	506	8704	5506	586	10488	6670
	30	347	4253	2631	412	5523	3431	494	6953	4421	577	8557	5444	672	10328	6603
100	0	0	7914	4050	0	10485	5300	0	13454	6700	0	16817	8600	0	20578	10300
	2	95	5834	3500	120	7591	4600	138	9577	5800	169	11803	7200	204	14264	8800
	5	172	5797	3475	208	7548	4566	245	9528	5769	293	11748	7162	341	14204	8756
	10	223	5737	3434	268	7478	4509	318	9447	5717	374	11658	7100	436	14105	8683
	15	252	5678	3392	304	7409	4451	358	9367	5665	418	11569	7037	487	14007	8610
	20	277	5619	3351	330	7341	4394	387	9289	5613	452	11482	6975	523	13910	8537
	30	319	5505	3267	378	7209	4279	446	9136	5509	514	11310	6850	592	13720	8391
	50	415	5289	3100	486	6956	4050	572	8841	5300	659	10979	6600	752	13354	8100

TABLE M-1604.3.1b
CAPACITY OF TYPE B DOUBLE-WALL VENTS WITH SINGLE WALL METAL CONNECTOR SERVING A SINGLE CATEGORY 1 APPLIANCE

Vent and Connector Diameter - D (Inches)

Appliance Input Rating In Thousands of Btu Per Hour

		3"			4"			5"			6"			7"		
Height H (ft)	Lateral L (ft)	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
	15	NR	NR	NR	NR	NR	72	158	186	124	220	290	192	272	418	269
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
	15	NR	NR	NR	NR	NR	80	155	208	136	216	325	210	264	469	301
	20	NR	NR	NR	NR	NR	NR	186	192	126	254	306	196	309	448	285

TABLE M-1604.3.1b (Continued)
CAPACITY OF TYPE B DOUBLE-WALL VENTS WITH SINGLE WALL METAL CONNECTOR SERVING A SINGLE CATEGORY 1 APPLIANCE

Vent and Connector Diameter - D (Inches)

Appliance Input Rating In Thousands of Btu Per Hour

		8"			9"			10"			12"		
Height H (ft)	Lateral L (ft)	FAN		NAT	FAN		NAT	FAN		NAT	FAN		NAT
		Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max
6	0	211	695	369	267	894	469	371	1118	569	537	1639	849
	2	201	423	284	251	541	368	347	673	453	498	979	648
	4	237	416	277	295	533	360	409	664	443	584	971	638
	6	263	409	271	327	526	352	449	656	433	638	962	627
8	0	206	777	414	258	1002	536	360	1257	658	521	1852	967
	2	197	482	321	246	617	417	339	768	513	486	1120	743
	5	245	470	311	305	604	404	418	754	500	598	1104	730
	8	280	458	300	344	591	392	470	740	486	665	1089	715
10	0	202	844	449	253	1093	584	351	1373	718	507	2031	1057
	2	193	531	354	242	681	456	332	849	559	475	1242	848
	5	241	518	344	299	667	443	409	834	544	584	1224	825
	10	296	497	325	363	643	423	492	808	520	688	1194	788
15	0	195	966	523	244	1259	681	336	1591	838	488	2374	1237
	2	187	631	413	232	812	543	319	1015	673	457	1491	983
	5	231	616	400	287	795	526	392	997	657	562	1469	963
	10	284	592	381	349	768	501	470	966	628	664	1433	928
	15	334	568	367	404	742	484	540	937	601	750	1399	894
20	0	190	1053	573	238	1379	750	326	1751	927	473	2631	1346
	2	182	708	468	227	914	611	309	1146	754	443	1689	1098
	5	224	692	457	279	896	596	381	1126	734	547	1665	1074
	10	277	666	437	339	866	570	457	1092	702	646	1626	1037
	15	325	640	419	393	838	549	526	1060	677	730	1587	1005
	20	374	616	400	448	810	526	592	1028	651	808	1550	973

TABLE M-1604.3.1b (Continued)
CAPACITY OF TYPE B DOUBLE-WALL VENTS WITH SINGLE WALL METAL CONNECTOR SERVING A SINGLE CATEGORY 1 APPLIANCE

Vent and Connector Diameter - D (Inches)

Appliance Input Rating In Thousands of Btu Per Hour

		3"			4"			5"			6"			7"		
Height H (ft)	Lateral L (ft)	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
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	367
	15	NR	NR	NR	115	131	NR	151	239	157	208	377	242	255	547	349
	20	NR	NR	NR	NR	NR	NR	181	223	NR	246	357	228	298	524	333
	30	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	389	477	305
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
	15	NR	NR	NR	112	148	NR	145	275	174	199	441	280	244	646	405
	20	NR	NR	NR	NR	NR	NR	176	257	NR	236	420	267	285	622	389
	30	NR	NR	NR	NR	NR	NR	NR	NR	NR	315	376	NR	373	573	NR
100	0	NR	NR	NR	49	214	NR	69	403	NR	100	659	395	131	991	555
	2	NR	NR	NR	51	192	NR	70	351	NR	98	563	373	125	828	508
	5	NR	NR	NR	67	186	NR	90	342	NR	125	551	366	156	813	501
	10	NR	NR	NR	85	175	NR	113	324	NR	153	532	354	191	789	486
	15	NR	NR	NR	132	162	NR	138	310	NR	188	511	343	230	764	473
	20	NR	NR	NR	NR	NR	NR	168	295	NR	224	487	NR	270	739	458
	30	NR	NR	NR	NR	NR	NR	231	264	NR	301	448	NR	355	685	NR
	50	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	540	584	NR

TABLE M-1604.3.1b (Continued)
CAPACITY OF TYPE B DOUBLE-WALL VENTS WITH SINGLE WALL METAL CONNECTOR SERVING A SINGLE CATEGORY 1 APPLIANCE

Vent and Connector Diameter - D (Inches)

Appliance Input Rating In Thousands of Btu Per Hour

		8"			9"			10"			12"		
Height H (ft)	Lateral L (ft)	FAN		NAT	FAN		NAT	FAN		NAT	FAN		NAT
		Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max
30	0	184	1168	647	229	1542	852	312	1971	1056	454	2996	1545
	2	175	823	533	219	1069	698	296	1346	863	424	1999	1308
	5	215	806	521	269	1049	684	366	1324	846	524	1971	1283
	10	265	777	501	327	1017	662	440	1287	821	620	1927	1243
	15	312	750	481	379	985	638	507	1251	794	702	1884	1205
	20	360	723	461	433	955	615	570	1216	768	780	1841	1166
	30	461	670	426	541	895	574	704	1147	720	937	1759	1101
50	0	176	1292	704	220	1724	948	295	2223	1189	428	3432	1818
	2	168	971	613	209	1273	811	280	1615	1007	401	2426	1509
	5	204	953	602	257	1252	795	347	1591	991	496	2396	1490
	10	253	923	583	313	1217	765	418	1551	963	589	2347	1455
	15	299	894	562	363	1183	736	481	1512	934	668	2299	1421
	20	345	866	543	415	1150	708	544	1473	906	741	2251	1387
	30	442	809	502	521	1086	649	674	1399	848	892	2159	1318
100	0	166	1404	765	207	1900	1033	273	2479	1300	395	3912	2042
	2	158	1152	698	196	1532	933	259	1970	1168	371	3021	1817
	5	194	1134	688	240	1511	921	322	1945	1153	460	2990	1796
	10	238	1104	672	293	1477	902	389	1905	1133	547	2938	1763
	15	281	1075	656	342	1443	884	447	1865	1110	618	2888	1730
	20	325	1046	639	391	1410	864	507	1825	1087	690	2838	1696
	30	418	988	NR	491	1343	824	631	1747	1041	834	2739	1627
	50	617	866	NR	711	1205	NR	895	1591	NR	1138	2547	1489

Notes for Multiple Appliance Vents (See Table Nos. M-1604.3.2a, M-1604.3.2b, M-1604.3.2c, M-1605.4.2a, M-1605.4.2b, M-1605.4.2c, and M-1605.4.2d)

1. The common venting Tables were generated using a vent connector horizontal length of 1-1/2 ft (18 inches) for each inch of connector diameter as follows:

CONNECTOR DIAMETER (INCHES)	MAXIMUM CONNECTOR HORIZONTAL LENGTH (FEET)
3	4-1/2
4	6
5	7-1/2
6	9
7	10-1/2
8	12
9	13-1/2
10	15
12	18
14	21
16	24
18	27
20	30
22	33
24	36

2. The vent connector should be routed to the vent utilizing the shortest possible route. Longer connectors than those listed above are possible under the following conditions:
   a. The maximum capacity of the vent connector shall be reduced 10% for each additional multiple of the length listed above. For example, the maximum length listed above for a 4-inch connector is 6 ft. With a connector length greater than 6 ft but not exceeding 12 ft, the maximum capacity must be reduced by 10% (0.90 x maximum vent connector capacity.) With a connector length greater than12 ft but not exceeding 18 ft, the maximum capacity must be reduced by 20% (0.80 x maximum vent capacity).
   b. The minimum capacity shall be determined by referring to the corresponding single appliance table (Table Nos M-1604.3.1a, M-1604.3.1b, M-1605.4.1a and M-1605.4.1b). In this case, for each appliance the entire vent connector and common vent from the appliance to the vent termination would be treated as a single appliance vent, as if the other appliances were not present.
3. If vent connectors are combined prior to entering the common vent, the maximum common vent capacity listed in the common venting tables must be reduced by 10% (0.90 x maximum common vent capacity). The length of the common vent connector manifold (L_0) shall not exceed 1-1/2 ft (18 inches) for each inch of common vent connector manifold diameter.
4. If the common vertical vent is offset, the maximum common vent capacity listed in the common venting tables shall be reduced by 20% (0.80 x maximum common vent capacity), the equivalent of two 90° elbows. The horizontal length of the common vent offset shall not exceed 1-1/2 ft (18 inches) for each inch of common vent diameter.

5. Excluding elbows counted in (4) above, each additional elbow in excess of two reduces the maximum capacity of that portion of the venting system by 10%. Two 45° elbows are equivalent to one 90° elbow.
6. The common vent diameter must always be at least as large as the largest vent connector diameter.
7. Interconnection fittings must be the same size as the common vent.
8. Use sea level input rating when determining maximum capacity for high altitude installation. Use actual input for determining minimum capacity for high altitude installation.
9. For multiple units of gas utilization equipment all located on one floor, available total height "H" is measured from the highest draft hood outlet or flue collar up to the level of the cap or terminal. Connector rise "R" is measured from the draft hood outlet or flue collar to the level where the vent gas streams come together. (Not applicable to multistory).
10. For multistory installations, available total height for each segment of the system "H" is the vertical distance between the highest draft hood outlet or flue collar entering that segment and the centerline of the next higher interconnection tee.
11.The size of the lowest connector and of the vertical vent leading to the lowest interconnection of a multistory system must be in accordance with Table No. M-1604.3.1a, for available total height "H" up to the lowest interconnection.
12. Vertical common vents shall have no offsets when used in multistory systems.
13. When two or more appliances are connected to a vertical vent the flow area of the largest section of vertical vent shall not exceed seven times the flow area of the smallest appliance flue collar or draft hood outlet unless designed in accordance with approved engineering methods.
14. For appliances with more than one input rate, the minimum vent capacity determined from the tables shall be less than the lowest appliance input rating and the maximum vent capacity determined from the tables shall be greater than the highest appliance input rating.
15. Listed, corrugated metallic chimney liner systems in masonry chimneys shall be sized by using Table No. 1604.3.1a and M-1604.3.1b for Type B vents with the maximum capacity reduced by 20% (.80 x maximum capacity) and the minimum capacity as shown in Table Nos. M-1604.3.2a, M-1604.3.2b and M-1604.3.2c. Corrugated metal vent systems installed with bends or offsets require additional reduction of the vent maximum capacity (See note 5).
16. DELETED
17. Do not upsize vent connectors more than two sizes greater than the appliance categorized vent diameter, flue collar diameter, or draft hood outlet diameter.
18.For a multiple appliance vent system, all combinations of single-wall and double-wall metal vent connectors are allowed provided the appropriate venting table is used to size each vent connector. The common vent must be sized using the appropriate venting table with single-wall metal vent connectors.

TABLE M-1604.3.2a
VENT CONNECTOR CAPACITY

THOUSANDS OF BTU PER HOUR
CAPACITY OF TYPE B DOUBLE-WALL VENTS WITH TYPE B DOUBLE-WALL CONNECTORS SERVING TWO OR MORE CATEGORY 1 APPLIANCES

Vent Connector Diameter–D

Vent Height H (ft)	Connector Rise R (ft)	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	1	22	37	26	35	66	46	46	106	72	58	164	104	77	225	142
	2	23	41	31	37	75	55	48	121	86	60	183	124	79	253	168
	3	24	44	35	38	81	62	49	132	96	62	199	139	82	275	189
8	1	22	40	27	35	72	48	49	114	76	64	176	109	84	243	148
	2	23	44	32	36	80	57	51	128	90	66	195	129	86	269	175
	3	24	47	36	37	87	64	53	139	101	67	210	145	88	290	198
10	1	22	43	28	34	78	50	49	123	78	65	189	113	89	257	154
	2	23	47	33	36	86	59	51	136	93	67	206	134	91	282	182
	3	24	50	37	37	92	67	52	146	104	69	220	150	94	303	205
15	1	21	50	30	33	89	53	47	142	83	64	220	120	88	298	163
	2	22	53	35	35	96	63	49	153	99	66	235	142	91	320	193
	3	24	55	40	36	102	71	51	163	111	68	248	160	93	339	218
20	1	21	54	31	33	99	56	46	157	87	62	246	125	86	334	171
	2	22	57	37	34	105	66	48	167	104	64	259	149	89	354	202
	3	23	60	42	35	110	74	50	176	116	66	271	168	91	371	228
30	1	20	62	33	31	113	59	45	181	93	60	288	134	83	391	182
	2	21	64	39	33	118	70	47	190	110	62	299	158	85	408	215
	3	22	66	44	34	123	79	48	198	124	64	309	178	88	423	242
50	1	19	71	36	30	133	64	43	216	101	57	349	145	78	477	197
	2	21	73	43	32	137	76	45	223	119	59	358	172	81	490	234
	3	22	75	48	33	141	86	46	229	134	61	366	194	83	502	263
100	1	18	82	37	28	158	66	40	262	104	53	442	150	73	611	204
	2	19	83	44	30	161	79	42	267	123	55	447	178	75	619	242
	3	20	84	50	31	163	89	44	272	138	57	452	200	78	627	272

TABLE M-1604.3.2a (Continued)
VENT CONNECTOR CAPACITY

THOUSANDS OF BTU PER HOUR
CAPACITY OF TYPE B DOUBLE-WALL VENTS WITH TYPE B DOUBLE-WALL CONNECTORS SERVING TWO OR MORE CATEGORY 1 APPLIANCES

Vent Connector Diameter–D

		8"			9"			10"					12"			14"		
Vent Height H (ft)	Connector Rise R (ft)	FAN		NAT	FAN		NAT	FAN		NAT	Vent Height H (ft)	Connector Rise R (ft)	FAN		NAT	FAN		NAT
		Min	Max	Max	Min	Max	Max	Min	Max	Max			Min	Max	Max	Min	Max	Max
6	1	92	296	185	109	376	237	128	466	289	6	2	174	764	496	223	1046	653
	2	95	333	220	112	424	282	131	526	345		4	180	897	616	230	1231	827
	3	97	363	248	114	463	317	134	575	386		6	NA	NA	NA	NA	NA	NA
8	1	100	320	194	118	408	248	138	507	303	8	2	186	822	516	238	1126	696
	2	103	356	230	121	454	294	141	564	358		4	192	952	644	244	1307	884
	3	105	384	258	123	492	330	143	612	402		6	198	1050	772	252	1445	1072
10	1	106	341	200	125	436	257	146	542	314	10	2	196	870	536	249	1195	730
	2	109	374	238	128	479	305	149	596	372		4	201	997	664	256	1371	924
	3	111	402	268	131	515	342	152	642	417		6	207	1095	792	263	1509	1118
15	1	110	389	214	134	493	273	162	609	333	15	2	214	967	568	272	1334	790
	2	112	419	253	137	532	323	165	658	394		4	221	1085	712	279	1499	1006
	3	115	445	286	140	565	365	167	700	444		6	228	1181	856	286	1632	1222
20	1	107	436	224	131	552	285	158	681	347	20	2	223	1051	596	291	1443	840
	2	110	463	265	134	587	339	161	725	414		4	230	1162	748	298	1597	1064
	3	113	486	300	137	618	518	164	764	466		6	237	1253	900	307	1726	1288
30	1	103	512	238	125	649	305	151	802	372	30	2	216	1217	632	286	1664	910
	2	105	535	282	129	679	360	155	840	439		4	223	1316	792	294	1802	1160
	3	108	555	317	132	706	405	158	874	494		6	231	1400	952	303	1920	1410
50	1	97	627	257	120	797	330	144	984	403	50	2	206	1479	689	273	2023	1007
	2	100	645	306	123	820	392	148	1014	478		4	213	1561	860	281	2139	1291
	3	103	661	343	126	842	441	151	1043	538		6	221	1631	1031	290	2242	1575
100	1	91	810	266	112	1038	341	135	1285	417	100	2	192	1923	712	254	2644	1050
	2	94	822	316	115	1054	405	139	1306	494		4	200	1984	888	263	2731	1346
	3	97	834	355	118	1069	455	142	1327	555		6	208	2035	1064	272	2811	1642

TABLE 1604.3.2a
VENT CONNECTOR CAPACITY

THOUSANDS OF BTU PER HOUR
CAPACITY OF TYPE B DOUBLE-WALL VENTS WITH TYPE B DOUBLE-WALL CONNECTORS SERVING TWO OR MORE CATEGORY 1 APPLIANCES

Vent Connector Diameter–D

		16"			18"			20"			22"			24"		
Vent Height	Connector Rise	FAN		NAT	FAN		NAT	FAN		NAT	FAN		NAT	FAN		NAT
H (ft)	R (ft)	Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max
6	2	281	1371	853	346	1772	1080	NA	NA	NA	NA	NA	NA	NA	NA	NA
	4	287	1617	1081	352	2069	1370	NA	NA	NA	NA	NA	NA	NA	NA	NA
	6	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
8	2	298	1478	910	365	1920	1150	NA	NA	NA	NA	NA	NA	NA	NA	NA
	4	305	1719	1150	372	2211	1460	471	2737	1800	560	3319	2180	662	3957	2590
	6	313	1902	1390	380	2434	1770	478	3018	2180	568	3665	2640	669	4373	3130
10	2	311	1570	955	379	2049	1205	NA	NA	NA	NA	NA	NA	NA	NA	NA
	4	318	1804	1205	387	2332	1535	486	2887	1890	581	3502	2280	686	4175	2710
	6	325	1989	1455	395	2556	1865	494	3169	2290	589	3849	2760	694	4593	3270
15	2	336	1760	1030	408	2317	1305	NA	NA	NA	NA	NA	NA	NA	NA	NA
	4	344	1978	1320	416	2579	1665	523	3197	2060	624	3881	2490	734	4631	2960
	6	351	2157	1610	424	2796	2025	533	3470	2510	634	4216	3030	743	5035	3600
20	2	357	1911	1095	430	2533	1385	NA	NA	NA	NA	NA	NA	NA	NA	NA
	4	365	2116	1395	438	2778	1765	554	3447	2180	661	4190	2630	772	5005	3130
	6	373	2287	1695	450	2984	2145	567	3708	2650	671	4511	3190	785	5392	3790
30	2	367	2183	1190	461	2891	1540	NA	NA	NA	NA	NA	NA	NA	NA	NA
	4	376	2366	1510	474	3110	1920	619	3840	2365	728	4681	2860	847	5606	3410
	6	384	2524	1830	485	3299	2340	632	4080	2875	741	4976	3480	860	5961	4150
50	2	350	2659	1315	435	3548	1665	NA	NA	NA	NA	NA	NA	NA	NA	NA
	4	359	2814	1685	447	3730	2135	580	4601	2633	709	5569	3185	851	6633	3790
	6	369	2951	2055	461	3893	2605	594	4808	3208	724	5826	3885	867	6943	4620
100	2	326	3490	1370	402	4707	1740	NA	NA	NA	NA	NA	NA	NA	NA	NA
	4	336	3606	1760	414	4842	2220	523	5982	2750	639	7254	3330	769	8650	3950
	6	346	3714	2150	426	4968	2700	539	6143	3350	654	7453	4070	786	8892	4810

TABLE M-1604.3.2b
COMMON VENT CAPACITY

CAPACITY OF TYPE B DOUBLE-WALL VENTS WITH TYPE B DOUBLE-WALL CONNECTORS SERVING TWO OR MORE CATEGORY 1 APPLIANCES

Combined Appliance Input Rating in Thousands of Btu Per Hour

	4"			5"			6"			7"		
Vent Height H (ft)	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	92	81	65	140	116	103	204	161	147	309	248	200
8	101	90	73	155	129	114	224	178	163	339	275	223
10	110	97	79	169	141	124	243	194	178	367	299	242
15	125	112	91	195	164	144	283	228	206	427	352	280
20	136	123	102	215	183	160	314	255	229	475	394	310
30	152	138	118	244	210	185	361	297	266	547	459	360
50	167	153	134	279	244	214	421	353	310	641	547	423
100	175	163	NR	311	277	NR	489	421	NR	751	658	479

TABLE M-1604.3.2b (Continued)
COMMON VENT CAPACITY

CAPACITY OF TYPE B DOUBLE-WALL VENTS WITH TYPE B DOUBLE-WALL CONNECTORS SERVING TWO OR MORE CATEGORY 1 APPLIANCES

Combined Appliance Input Rating in Thousands of Btu Per Hour

	8"			9"			10"			12"			14"		
Vent Height H ((ft)	FAN +NAT	FAN+ +NAT	FAN+ +NAT	FAN +NAT	FAN +NAT	FAN +NAT	FAN +NAT	FAN +NAT	FAN +NAT	FAN +FAN	FAN +NAT	NAT +NAT	FAN +FAN	FAN +NAT	NAT +NAT
6	404	314	260	547	434	335	672	520	410	900	696	588	1284	990	815
8	444	348	290	602	480	378	740	577	465	994	773	652	1423	1103	912
10	477	377	315	649	522	405	800	627	495	1076	841	712	1542	1200	995
15	556	444	365	753	612	465	924	733	565	1247	986	825	1794	1410	1158
20	621	499	405	842	688	523	1035	826	640	1405	1116	916	2006	1588	1290
30	720	585	470	979	808	605	1209	975	740	1658	1327	1025	2373	1892	1525
50	854	706	550	1164	977	705	1451	1188	860	2024	1640	1280	2911	2347	1863
100	1025	873	625	1408	1215	800	1784	1502	975	2569	2131	1670	3732	3076	2450

TABLE M-1604.3.2b (Continued)
COMMON VENT CAPACITY

CAPACITY OF TYPE B DOUBLE-WALL VENTS WITH TYPE B DOUBLE-WALL CONNECTORS SERVING TWO OR MORE CATEGORY 1 APPLIANCES

	16"			18"			20"			22"			24"		
	Combined Appliance Input Rating in Thousands of Btu Per Hour														
Vent Height H ((ft)	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	1735	1336	1065	2253	1732	1345	2838	2180	1660	3488	2677	1970	4206	3226	2390
8	1927	1491	1190	2507	1936	1510	3162	2439	1860	3890	2998	2200	4695	3616	2680
10	2093	1625	1300	2727	2113	1645	3444	2665	2030	4241	3278	2400	5123	3957	2920
15	2440	1910	1510	3184	2484	1910	4026	3133	2360	4971	3862	2790	6016	4670	3400
20	2722	2147	1690	3561	2798	2140	4548	3552	2640	5573	4352	3120	6749	5261	3800
30	3220	2558	1990	4197	3326	2520	5303	4193	3110	6539	5157	3680	7940	6247	4480
50	3964	3183	2430	5184	4149	3075	6567	5240	3800	8116	6458	4500	9837	7813	5475
100	5125	4202	3200	6749	5509	4050	8597	6986	5000	10681	8648	5920	13004	10499	7200

TABLE M-1604.3.2c
VENT CONNECTOR CAPACITY

THOUSANDS OF BTU PER HOUR

CAPACITY OF TYPE B DOUBLE-WALL VENT WITH SINGLE-WALL CONNECTORS SERVING TWO OR MORE CATEGORY 1 APPLIANCES

Vent Connector Diameter–D (inches)

		3"			4"			5"			6"		
Appliance Input Rating Limits in Thousands of Btu Per Hour													
Vent Height H (ft)	Connector Rise R (ft)	FAN		NAT	FAN		NAT	FAN		NAT	FAN		NAT
		Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max
6	1	NR	NR	26	NR	NR	46	NR	NR	71	NR	NR	102
	2	NR	NR	31	NR	NR	55	NR	NR	85	168	182	123
	3	NR	NR	34	NR	NR	62	121	131	95	174	198	138
15	1	NR	NR	29	79	87	52	116	138	81	177	214	116
	2	NR	NR	34	83	94	62	121	150	97	185	230	138
	3	NR	NR	39	87	100	70	127	160	109	193	243	157
30	1	47	60	31	77	110	57	113	175	89	169	278	129
	2	50	62	37	81	115	67	117	185	106	177	290	152
	3	54	64	42	85	119	76	122	193	120	185	300	172
50	1	46	69	33	75	128	60	109	207	96	162	336	137
	2	49	71	40	79	132	72	114	215	113	170	345	164
	3	53	72	45	83	136	82	119	221	128	178	353	186

TABLE M-1604.3.2c
VENT CONNECTOR CAPACITY

THOUSANDS OF BTU PER HOUR

CAPACITY OF TYPE B DOUBLE-WALL VENTS WITH SINGLE-WALL CONNECTORS SERVING TWO OR MORE CATEGORY 1 APPLIANCES
Vent Connector Diameter–D (inches)

		7"			8"			9"			10"		
Vent Height H (ft)	Connector Rise R (ft)	FAN		NAT	FAN		NAT	FAN		NAT	FAN		NAT
		Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max
6	1	207	223	140	262	293	183	325	373	234	447	463	286
	2	215	251	167	271	331	219	334	422	281	458	524	344
	3	222	273	188	279	361	247	344	462	316	468	574	385
15	1	238	291	158	312	380	208	397	482	266	556	596	324
	2	246	314	189	321	411	248	407	522	317	568	646	387
	3	255	333	215	331	438	281	418	557	360	579	690	437
30	1	226	380	175	296	497	230	378	630	294	528	779	358
	2	236	397	208	307	521	274	389	662	349	541	819	425
	3	244	412	235	316	542	309	400	690	394	555	855	482
50	1	217	460	188	284	604	245	364	768	314	507	951	384
	2	226	473	223	294	623	293	376	793	375	520	983	458
	3	235	486	252	304	640	331	387	816	424	535	1013	518

TABLE M-1604.3.2c
COMMON VENT CAPACITY

CAPACITY OF TYPE B DOUBLE-WALL VENTS WITH SINGLE-WALL CONNECTORS SERVING TWO OR MORE CATEGORY 1 APPLIANCES

Common Vent Diameter–D (inches)

	4"			5"			6"			7"		
	Combined Appliance Input Rating in Thousands of Btu Per Hour											
Vent Height H (ft)	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
8	98	87	71	151	126	112	218	173	159	331	269	218
10	106	94	76	163	137	120	237	189	174	357	292	236
15	121	108	88	189	159	140	275	221	200	416	343	274
20	131	118	98	208	177	155	305	247	223	463	383	302
30	145	132	113	236	202	179	350	286	257	533	446	349
50	159	145	128	268	233	204	406	337	296	622	529	410

TABLE M-1604.3.2c (Continued)
COMMON VENT CAPACITY

CAPACITY OF TYPE B DOUBLE-WALL VENTS WITH SINGLE-WALL CONNECTORS SERVING TWO OR MORE CATEGORY 1 APPLIANCES

	8"			9"			10"		
	Combined Appliance Input Rating in Thousands of Btu Per Hour								
Vent Height H (ft)	FAN +FAN	FAN +NAT	NAT +NAT	FAN +FAN	FAN +NAT	NAT +NAT	FAN +FAN	FAN +NAT	NAT +NAT
6	398	310	257	541	429	332	665	515	407
8	436	342	285	592	473	373	730	569	460
10	467	369	309	638	512	398	787	617	487
15	544	434	357	738	599	456	905	718	553
20	606	487	395	824	673	512	1013	808	626
30	703	570	459	958	790	593	1183	952	723
50	833	686	535	1139	954	689	1418	1157	838

TABLE M-1605.4.1a
CAPACITY OF MASONRY CHIMNEY WITH TYPE B DOUBLE-WALL VENT CONNECTOR SERVING A SINGLE CATEGORY 1 APPLIANCE

Connector Diameter-D (inches)

To be used with chimney area within the size limits at bottom.

		3"			4"			5"			6"			7"		
Appliance Input Rating in Thousands of Btu Per Hour																
Height H (ft)	**Lateral L (ft)**	**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	104	317	180
	5	NR	NR	25	NR	NR	49	NR	NR	82	NR	NR	117	NR	NR	165
10	2	NR	NR	31	NR	NR	61	NR	NR	103	NR	NR	162	99	405	221
	5	NR	NR	28	NR	NR	57	NR	NR	96	NR	NR	148	133	389	204
	10	NR	NR	25	NR	NR	50	NR	NR	87	NR	NR	139	NR	NR	181
15	2	NR	NR	35	NR	NR	67	NR	NR	114	NR	NR	179	85	475	250
	5	NR	NR	33	NR	NR	62	NR	NR	107	NR	NR	164	28	457	231
	10	NR	NR	28	NR	NR	55	NR	NR	97	NR	NR	153	157	429	216
	15	NR	NR	NR	NR	NR	48	NR	NR	89	NR	NR	141	NR	NR	201
20	2	NR	NR	36	NR	NR	74	NR	NR	124	NR	NR	201	91	522	274
	5	NR	NR	36	NR	NR	68	NR	NR	116	NR	NR	184	124	503	254
	10	NR	NR	NR	NR	NR	60	NR	NR	107	NR	NR	172	153	474	237
	15	NR	NR	NR	NR	NR	NR	NR	NR	97	NR	NR	159	178	448	220
	20	NR	NR	NR	NR	NR	NR	NR	NR	83	NR	NR	148	NR	NR	206

TABLE M-1605.4.1a (Continued)
CAPACITY OF MASONRY CHIMNEY WITH TYPE B DOUBLE-WALL VENT CONNECTOR SERVING A SINGLE CATEGORY 1 APPLIANCE

Connector Diameter-D (inches)

To be used with chimney area within the size limits at bottom.

		3"			4"			5"			6"			7"		
Appliance Input Rating in Thousands of Btu Per Hour																
Height H (ft)	Lateral L (ft)	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
30	2	NR	NR	41	NR	NR	82	NR	NR	137	NR	NR	216	87	581	303
	5	NR	NR	NR	NR	NR	76	NR	NR	128	NR	NR	198	118	561	281
	10	NR	NR	NR	NR	NR	67	NR	NR	115	NR	NR	184	146	532	263
	15	NR	NR	NR	NR	NR	NR	NR	NR	107	NR	NR	171	NR	NR	243
	20	NR	NR	NR	NR	NR	NR	NR	NR	91	NR	NR	159	NR	NR	227
	30	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	188
50	2	NR	NR	NR	NR	NR	92	NR	NR	161	NR	NR	251	81	629	351
	5	NR	NR	NR	NR	NR	NR	NR	NR	151	NR	NR	230	NR	NR	323
	10	NR	NR	NR	NR	NR	NR	NR	NR	138	NR	NR	215	NR	NR	304
	15	NR	NR	NR	NR	NR	NR	NR	NR	127	NR	NR	199	NR	NR	282
	20	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	185	NR	NR	264
	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		

TABLE M-1605.4.1a (Continued)
CAPACITY OF MASONRY CHIMNEY WITH TYPE B DOUBLE-WALL VENT CONNECTORS SERVING A SINGLE CATEGORY 1 APPLIANCE

Connector Diameter-D (inches)

To be used with chimney area within the size limits at bottom.

		8"			9"			10"			12"		
Appliance Input Rating in Thousands of Btu Per Hour													
Height H (ft)	**Lateral L (ft)**	**FAN**		**NAT**	**FAN**		**NAT**	**FAN**		**NAT**	**FAN**		**NAT**
		Min	**Max**	**Max**	**Min**	**Max**	**Max**	**Min**	**Max**	**Max**	**Min**	**Max**	**Max**
6	2	128	405	247	158	508	320	190	625	401	288	877	581
	5	NR	NR	231	205	494	298	244	611	376	363	863	561
10	2	123	519	298	150	655	388	182	810	491	273	1144	724
	5	163	502	277	196	638	365	234	791	466	343	1124	712
	10	197	477	263	235	610	347	279	762	444	414	1093	668
15	2	117	613	336	143	779	441	173	968	562	260	1376	841
	5	156	594	313	188	759	416	224	946	533	327	1352	828
	10	190	565	296	226	727	394	266	912	567	394	1315	777
	15	221	538	281	263	698	375	310	880	485	451	1280	742
20	2	113	678	375	138	867	491	167	1083	627	249	1548	953
	5	151	658	350	182	845	463	217	1059	597	315	1523	933
	10	184	627	332	219	811	440	258	1022	566	380	1482	879
	15	213	598	314	253	780	418	299	987	541	436	1443	840
	20	248	572	296	293	750	397	342	955	513	490	1406	807

TABLE M-1605.4.1a (Continued)
CAPACITY OF MASONRY CHIMNEY WITH TYPE B DOUBLE-WALL VENT CONNECTORS SERVING A SINGLE CATEGORY 1 APPLIANCE

Connector Diameter-D (inches)

To be used with chimney area within the size limits at bottom.

		8"			9"			10"			12"		
Appliance Input Rating in Thousands of Btu Per Hour													
Height H (ft)	**Lateral L (ft)**	**FAN**		**NAT**	**FAN**		**NAT**	**FAN**		**NAT**	**FAN**		**NAT**
		Min	**Max**	**Max**	**Min**	**Max**	**Max**	**Min**	**Max**	**Max**	**Min**	**Max**	**Max**
30	2	107	762	421	131	985	558	158	1240	717	234	1793	1112
	5	144	741	393	174	962	526	207	1216	683	299	1766	1094
	10	175	709	373	209	927	500	247	1176	648	358	1721	1025
	15	203	678	353	240	893	476	285	1139	621	412	1679	981
	20	236	649	332	278	860	450	326	1103	592	465	1638	940
	30	NR	NR	288	357	801	416	412	1035	555	573	1560	877
50	2	100	840	477	122	1106	633	146	1413	812	214	2080	1243
	5	136	819	445	164	1083	596	195	1387	774	279	2052	1225
	10	166	786	424	199	1047	567	234	1347	733	331	2006	1147
	15	192	755	400	227	1010	539	266	1307	702	382	1961	1099
	20	NR	NR	376	261	977	511	305	1269	669	431	1916	1050
	30	NR	NR	327	NR	NR	468	388	1196	623	533	1832	984
Minimum Internal Area of Chimney Square Inches		63			78			95			132		
Maximum Internal Area of Chimney Square Inches		352			445			550			792		

TABLE M-1605.4.1b
CAPACITY OF MASONRY CHIMNEY WITH SINGLE WALL VENT CONNECTORS SERVING A SINGLE CATEGORY 1 APPLIANCE

Connector Diameter-D (inches)

To be used with chimney area within the size limits at bottom.

		3"			4"			5"			6"			7"		
Appliance Input Rating in Thousands of Btu Per Hour																
Height H (ft)	**Lateral L (ft)**	**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	81	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	NR	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

TABLE M-1605.4.1b (Continued)
CAPACITY OF MASONRY CHIMNEY WITH SINGLE WALL VENT CONNECTORS SERVING A SINGLE CATEGORY 1 APPLIANCE

Connector Diameter-D (inches)

To be used with chimney area within the size limits at bottom.

		3"			4"			5"			6"			7"		
Appliance Input Rating in Thousands of Btu Per Hour																
Height H (ft)	**Lateral L (ft)**	**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**
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	558	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	88	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		

TABLE M-1605.4.1b (Continued)
CAPACITY OF MASONRY CHIMNEY WITH SINGLE WALL VENT CONNECTORS SERVING A SINGLE CATEGORY 1 APPLIANCE

Connector Diameter-D (inches)

To be used with chimney area within the size limits at bottom.

		8"			9"			10"			12"		
Appliance Input Rating in Thousands of Btu Per Hour													
Height H (ft)	Lateral L (ft)	FAN Min	FAN Max	NAT Max	FAN Min	FAN Max	NAT Max	FAN Min	FAN Max	NAT Max	FAN Min	FAN Max	NAT Max
6	2	222	404	247	279	507	319	385	624	400	553	876	580
	5	NR	NR	230	NR	NR	297	474	609	375	678	861	560
10	2	216	518	297	271	654	387	373	808	490	536	1142	722
	5	269	500	276	334	635	364	459	789	465	657	1121	710
	10	328	474	261	403	606	345	547	758	441	771	1088	665
15	2	211	611	335	264	776	440	362	965	560	520	1373	840
	5	261	591	312	325	755	414	444	942	531	637	1348	825
	10	319	561	294	392	722	392	531	907	504	749	1309	774
	15	373	532	278	452	692	372	606	873	481	841	1272	738
20	2	206	675	374	258	864	490	252	1079	625	508	1544	950
	5	255	655	348	317	842	461	433	1055	594	623	1518	930
	10	312	622	330	382	806	437	517	1016	562	733	1475	875
	15	365	592	311	442	773	414	591	979	536	823	1434	835
	20	NR	NR	292	501	741	392	663	944	510	911	1394	800
30	2	200	759	420	249	982	556	340	1237	715	489	1789	1110
	5	245	737	391	306	958	524	417	1210	680	600	1760	1090
	10	300	703	370	370	920	496	500	1168	644	708	1713	1020
	15	352	670	349	428	884	471	572	1128	615	798	1668	975
	20	NR	NR	327	485	850	445	643	1089	585	883	1624	932
	30	NR	NR	281	604	785	408	787	1015	544	1055	1539	865
50	2	191	837	475	238	1103	631	323	1408	810	463	2076	1240
	5	235	814	442	293	1078	593	398	1381	770	571	2044	1220
	10	287	779	420	355	1038	562	477	1337	728	674	1994	1140
	15	NR	NR	395	410	1000	533	546	1294	695	761	1945	1090
	20	NR	NR	370	467	964	504	616	1251	660	844	1898	1040
	30	NR	NR	318	NR	NR	458	756	1172	610	1009	1805	970
Minimum Internal Area of Chimney Square Inches		63			78			95			132		
Maximum Internal Area of Chimney Square Inches		352			445			550			792		

TABLE M-1605.4.2a
VENT CONNECTOR CAPACITY

CAPACITY OF MASONRY CHIMNEY WITH TYPE B DOUBLE-WALL CONNECTORS SERVING TWO OR MORE CATEGORY 1 APPLIANCES

Vent Connector Diameter–D (Inches)

		3"			4"			5"			6"		
Vent Height H (ft)	Connector Rise R (ft)	FAN		NAT	FAN		NAT	FAN		NAT	FAN		NAT
		Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max
6	1	NR	NR	21	56	62	40	75	106	67	96	194	101
	2	36	43	28	58	79	52	78	133	85	99	230	124
	3	38	49	34	60	92	61	80	155	97	102	262	143
15	1	34	48	23	54	93	44	78	154	74	106	277	114
	2	36	55	31	56	105	55	81	174	89	109	299	134
	3	38	59	35	59	115	64	84	189	102	112	319	153
30	1	33	54	25	53	111	48	75	192	82	102	357	127
	2	35	60	32	55	122	58	79	208	95	106	376	145
	3	37	64	36	57	131	66	82	221	107	109	392	163
50	1	33	52	26	51	116	49	74	209	82	99	405	133
	2	35	59	31	54	127	58	78	225	96	103	421	152
	3	37	64	37	56	135	66	80	237	108	106	435	170

TABLE M-1605.4.2a
VENT CONNECTOR CAPACITY

CAPACITY OF MASONRY CHIMNEY WITH TYPE B DOUBLE-WALL CONNECTORS SERVING TWO OR MORE CATEGORY 1 APPLIANCES

Vent Connector Diameter–D (Inches)

		7"			8"			9"			10"		
Appliance Input Rating Limits in Thousands of Btu Per Hour													
Vent Height H (ft)	**Connector Rise R (ft)**	**FAN**		**NAT**	**FAN**		**NAT**	**FAN**		**NAT**	**FAN**		**NAT**
		Min	**Max**	**Max**	**Min**	**Max**	**Max**	**Min**	**Max**	**Max**	**Min**	**Max**	**Max**
6	1	130	274	141	158	370	201	190	479	253	225	599	319
	2	134	324	173	162	436	232	194	562	330	230	694	378
	3	137	369	203	166	491	270	198	633	349	234	795	439
15	1	148	384	174	186	511	229	228	658	297	280	824	375
	2	152	419	192	190	558	260	233	718	339	286	900	432
	3	156	448	215	194	597	292	238	760	382	292	960	486
30	1	142	504	187	178	680	255	219	883	337	206	1115	432
	2	147	531	209	183	715	287	224	928	378	272	1171	484
	3	151	554	233	188	746	317	229	968	418	279	1220	535
50	1	138	582	198	173	798	271	212	1049	362	256	1334	462
	2	143	604	222	178	827	304	218	1085	400	263	1379	510
	3	147	624	247	182	854	334	223	1118	439	270	1421	558

TABLE M-1605.4.2b
COMMON CHIMNEY CAPACITY

CAPACITY OF MASONRY CHIMNEY WITH TYPE B DOUBLE-WALL CONNECTORS SERVING TWO OR MORE CATEGORY 1 APPLIANCES

Minimum Internal Area of Chimney, Square Inches

	12"			19"			28"			38"		
	Combined Appliance Input Rating in Thousands of Btu Per Hour											
Vent Height H (ft)	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	74	25	NR	119	46	NR	178	71	NR	257	103
8	NR	80	28	NR	130	53	NR	193	82	NR	279	119
10	NR	84	31	NR	138	56	NR	207	90	NR	299	131
15	NR	90	36	NR	152	67	NR	233	106	NR	334	152
20	NR	92	41	NR	159	75	NR	250	122	NR	368	172
30	NR	91	NR	NR	165	NR	NR	270	137	NR	404	198
50	NR	85	NR	NR	163	NR	NR	284	NR	NR	435	NR

TABLE M-1605.4.2b
COMMON CHIMNEY CAPACITY

CAPACITY OF MASONRY CHIMNEY WITH TYPE B DOUBLE-WALL CONNECTORS SERVING TWO OR MORE CATEGORY 1 APPLIANCES

Minimum Internal Area of Chimney, Square Inches

	50"			63"			78"			113"		
	Combined Appliance Input Rating in Thousands of Btu Per Hour											
Vent Height H (ft)	**FAN +FAN**	**FAN +NAT**	**NAT +NAT**	**FAN +FAN**	**FAN +NAT**	**NAT +NAT**	**FAN +NAT**	**FAN +NAT**	**NAT +NAT**	**FAN +FAN**	**FAN +NAT**	**NAT +NAT**
6	NR	351	143	NR	458	188	NR	582	246	NR	853	NR
8	NR	384	163	NR	501	218	NR	636	278	NR	937	408
10	NR	409	177	NR	538	236	NR	686	302	NR	1010	454
15	NR	467	212	NR	611	283	NR	781	365	NR	1156	546
20	NR	508	243	NR	668	325	NR	858	419	NR	1286	648
30	NR	564	278	NR	747	381	NR	969	496	NR	1473	749
50	NR	620	328	NR	831	461	NR	1089	606	NR	1692	922

TABLE M-1605.4.2c
VENT CONNECTOR CAPACITY

CAPACITY OF MASONRY CHIMNEY WITH SINGLE-WALL CONNECTORS SERVING TWO OR MORE CATEGORY 1 APPLIANCES

THOUSANDS OF BTU PER HOUR
Vent Connector Diameter–D (inches)

Vent Height H (ft)	Connector Rise R (ft)	3"			4"			5"			6"		
		FAN		NAT	FAN		NAT	FAN		NAT	FAN		NAT
		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
	2	NR	NR	28	NR	NR	52	NR	NR	84	186	227	123
	3	NR	NR	34	NR	NR	61	134	153	97	193	258	142
15	1	NR	NR	23	NR	NR	43	129	151	73	199	271	112
	2	NR	NR	30	92	103	54	135	170	88	207	295	132
	3	NR	NR	34	96	112	63	141	185	101	215	315	151
30	1	NR	NR	24	86	108	47	126	187	80	193	347	124
	2	NR	NR	31	91	119	57	132	203	93	201	366	142
	3	NR	NR	35	95	127	65	138	216	105	209	381	160
50	1	NR	NR	25	85	113	48	124	204	80	188	392	130
	2	NR	NR	31	89	123	57	130	218	94	196	408	149
	3	NR	NR	35	94	131	65	136	231	106	205	422	167

TABLE M-1605.4.2c (Continued)
VENT CONNECTOR CAPACITY

CAPACITY OF MASONRY CHIMNEY WITH SINGLE-WALL CONNECTORS SERVING TWO OR MORE CATEGORY 1 APPLIANCES

THOUSANDS OF BTU PER HOUR
Vent Connector Diameter–D (inches)

Vent Height H (ft)	Connector Rise R (ft)	7"			8"			9"			10"		
		FAN		NAT	FAN		NAT	FAN		NAT	FAN		NAT
		Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max
6	1	231	271	140	292	366	200	362	474	252	499	594	283
	2	239	321	172	301	432	231	373	557	299	509	696	331
	3	247	365	202	309	491	269	381	634	348	519	793	375
15	1	268	376	171	349	502	225	445	646	291	623	808	360
	2	277	411	189	359	548	256	456	706	334	634	884	402
	3	286	439	213	368	586	289	466	755	378	646	945	437
30	1	259	492	183	338	665	250	430	864	330	600	1089	455
	2	269	518	205	348	699	282	442	908	372	613	1145	490
	3	277	540	229	358	729	312	452	946	412	626	1193	521
50	1	252	567	194	328	778	265	417	1022	355	582	1302	537
	2	262	588	218	339	806	298	429	1058	393	596	1346	567
	3	271	607	243	349	831	328	440	1090	431	610	1386	595

TABLE M-1605.4.2d
COMMON CHIMNEY CAPACITY

CAPACITY OF MASONRY CHIMNEY WITH SINGLE-WALL CONNECTORS SERVING TWO OR MORE CATEGORY 1 APPLIANCES

Minimum Internal Area of Chimney, Square Inches

	12"			19"			28"			38"		
	Combined Appliance Input Rating in Thousands of Btu Per Hour											
Vent Height H (ft)	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
8	NR	79	28	NR	128	52	NR	190	81	NR	276	118
10	NR	83	31	NR	136	56	NR	205	89	NR	295	129
15	NR	88	36	NR	149	66	NR	230	105	NR	335	150
20	NR	90	40	NR	157	74	NR	247	120	NR	362	170
30	NR	90	NR	NR	162	NR	NR	266	135	NR	398	195
50	NR	83	NR	NR	160	NR	NR	280	NR	NR	429	NR

TABLE M-1605.4.2d (Continued)
COMMON CHIMNEY CAPACITY

CAPACITY OF MASONRY CHIMNEY WITH SINGLE-WALL CONNECTORS SERVING TWO OR MORE CATEGORY 1 APPLIANCES

Minimum Internal Area of Chimney, Square Inches

	50"			63"			78"			113"		
	Combined Appliance Input Rating in Thousands of Btu Per Hour											
Vent Height H (ft)	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	348	142	NR	455	187	NR	579	245	NR	846	NR
8	NR	380	162	NR	497	217	NR	633	277	NR	928	405
10	NR	405	175	NR	532	234	NR	680	300	NR	1000	450
15	NR	460	210	NR	602	280	NR	772	360	NR	1139	540
20	NR	503	240	NR	661	321	NR	849	415	NR	1264	640
30	NR	558	275	NR	739	377	NR	957	490	NR	1447	740
50	NR	612	325	NR	821	456	NR	1076	600	NR	1672	910

Chapter 17
FUEL-GAS SUPPLY SYSTEMS

SECTION M -1701 – GENERAL

Fuel-gas supply systems extending from the point of delivery to the connection with each gas utilization appliance shall conform to the requirements of this chapter. For private individual LPG systems, the point of delivery is the outlet of the first stage pressure regulator. For all other fuel gas supply systems, the point of delivery is the outlet of the gas service meter.

SECTION M-1702 – AUTHORITY TO RENDER GAS SERVICE

Gas service shall not be rendered until approval by final inspection in compliance with Section R-111.

SECTION M-1703—GAS METERS

M-1703.1 Accessible and Acceptable 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.

M-1703.2 Support: Gas meters shall be securely supported or connected to rigid piping.

SECTION M-1704—GAS PIPING MATERIALS

M-1704.1 Approved types: Pipe and tubing materials shall conform to Table No. M-1704.1, or other approved materials.

M-1704.2 Prohibited piping materials: Pipe, tubing, or fittings constructed of the following materials shall be prohibited unless part of a labeled equipment assembly:

1. Ductile or cast iron pipe and fitting.
2. Plastic pipe and fittings shall not be used within or beneath a building.
3. Copper and brass pipe and tubing, with the exception of tin lined copper tubing, shall not be used if the gas contains an average of 0.3 grains of hydrogen sulfide per 100 standard cubic feet of gas.
4. Bushings shall not be used in piping systems

M-1704.3 Used materials: Before reusing pipe, tubing, fittings, valves, etc., removed from an existing fuel-gas installation shall be thoroughly cleaned, inspected and ascertained to be equivalent to new material.

Table No. M-1704.1
GAS SUPPLY PIPING MATERIALS

MATERIAL	STANDARD	APPROVED JOINTS	NOTES
Black Steel	ASTM A53, A106	Welded, Threaded, Flanged	Schedule 40 pipe, malleable black or galvanized fittings only. Paint with one coat exterior paint if outside above grade. Protect in accordance with Section M-1707.1.2 if outside below grade.
Galvanized Steel Pipe	ASTM A53	Thread or Flanged	Schedule 40 pipe, malleable black fittings only. Protect in accordance with Section M-1707.1.2 if outside below grade.
Corrugated Stainless Steel Tubing	ANSI/AGA LC 1	Proprietary Mechanical Fittings	Labeled system. Install per manufacturer's installation instructions. Above grade use only.
Soft Copper, Type K or L Tubing	ASTM B75, B88, B280 B68	Flared or Brazed	Mark as per Section M-1707.8 when used above grade.
Copper or Brass Pipe	ASTM B42, B43, B302	Threaded or Flared	None
Plastic Pipe	ASTM D2513	Solvent Cement, Adhesive, Heat Fusion, Compression Couplings, Flanged	Use only underground, outside of building

SECTION M-1705—GAS VALVES

M-1705.1 Approved type: Gas valves shall be labeled for fuel gas service and compatible with the gas piping served. Manually operated gas valves shall conform to ANSI Z21.15, as listed in Section S-26.1705, or as approved.

M-1705.2 Size: Gas valves shall be equivalent in nominal size to the piping served.

M-1705.3 Shutoff valve: Accessible shutoff valves shall be installed within 6-feet of an appliance, within the same room and upstream from the union connection. When an appliance connector is used, the valve shall be installed upstream of the connector. Shutoff valves located adjacent to, inside or under an appliance shall be accessible.

M-1705.4 Log Lighter: Gas outlets located in fireplaces shall be controlled by labeled valves located in the same room outside the hearth and not more than 6-feet from the outlets. Where gas piping on the discharge side of the valve penetrated the masonry hearth or walls, it shall be encased in a metal sleeve. The space between the gas pipe and the sleeve shall be sealed with a high-temperature compound to prevent hot embers from endangering adjacent combustible surfaces. This does not apply to gas logs.

M-1705.5 Quick-disconnect devices: Gas utilization equipment may be connected to the building piping by means of a labeled quick-disconnect device. When installed indoors, a manual shutoff valve shall be installed upstream of the quick-disconnect device. Gas convenience outlets conforming to AGA Requirement 7-90, as listed in Section S-26.1705, shall not require a manual valve upstream of the device.

SECTION M-1706—PIPING JOINTS AND CONNECTIONS

M-1706.1 General: The type of piping joint used shall be suitable for the pressure-temperature conditions and compatible with the piping material.

M-1706.2 Pipe joints: Pipe joint compound or tape shall be used on male threads only.

M-1706.3 Tubing joints: Tubing joints shall be made with approved or labeled gas tubing fittings, or be brazed with a material having a melting point in excess of 1000°F. Brazing alloys shall not contain phosphorus. Flared joints shall be made with the proper flaring tool that will produce a flare compatible with the approved fittings. Other approved joints shall be installed in accordance with the manufacturers recommendations.

M-1706.4 Metallic fittings: Fittings used with steel pipe shall be steel, brass, or bronze. Fittings used with copper or brass pipe shall be copper, brass, or bronze. Brass or bronze fittings, if exposed to soil, shall have a minimum 80 percent copper content. Fittings such as couplings, propriety type joints, saddle tees, gland-type compression fittings, and flared, flareless, or compression type tubing fittings shall be:

1. Used within the service conditions anticipated with respect to vibration, fatigue, and thermal expansion or contraction.
2. Installed and supported to prevent separation of the joint by gas pressure or external force.

M-1706.5 Plastic joints and fittings: Plastic pipe, tubing and fittings shall be joined by solvent-cement, adhesive or heat-fusion methods, or by means of compression couplings or flanges in accordance with the manufacturer's recommendations. The following shall apply to joints in plastic pipe and tubing:

1. Plastic pipe or tubing shall not be threaded.
2. The joint shall be designed and installed so that the longitudinal pull-out resistance of the joint will be at least equal to the tensile strength of the plastic piping material.
3. Solvent-cement joints, adhesive joints, and heat-fusion joints shall be made in accordance with procedures specified by the manufacturer.
4. Solvent-cement or heat-fusion joints shall not be made between different types of plastics.
5. Heat-fusion or mechanical joints shall be used when joining polyethylene pipe, tubing, or fittings.
6. Flanges or special joints shall be used in accordance with the manufacturer's instructions.

7. When compression type mechanical joints are used, the gasket material in the fitting shall be compatible with the plastic piping, and a one-piece internal rigid tubular stiffener shall be used with the fitting.

M-1706.6 Appliance connection: Gas appliances and equipment shall be connected to the building piping by rigid metallic pipes, semi-rigid metallic tubing, or a labeled gas appliance connector, having a diameter not less than the nominal inlet connection to the appliance in accordance with their label. Appliance connectors shall be not more than 6-feet in length, and shall not be concealed within or run through walls, floors or partitions.

SECTION M-1707—GAS PIPING INSTALLATION

M-1707.1 Underground piping: Underground gas piping shall be installed to protect it from settlement, shifting, contact or damage resulting from proximity to structures.

M-1707.1.1 Minimum depth: Underground metallic piping systems shall be installed at a minimum of 10-inches below grade. Plastic piping systems shall be installed at a minimum of 10-inches below grade. If minimum depths cannot be maintained, the piping system shall be installed in conduit or shielded in an approved manner.

M-1707.1.2 Protection against corrosion: Gas piping in contact with material which will corrode the piping shall be protected by approved corrosion control practices. Field wrapping shall be limited to short sections and fittings that must be stripped for threading or welding. Galvanizing shall not be deemed equivalent protection. When dissimilar metals are joined underground, dielectric fittings or couplings shall be used.

M-1707.1.3 Connection of plastic and metallic piping: Connections between metallic and plastic piping shall be made only underground, outside of the building, and with approved transition fittings.

M-1707.1.4 Piping through foundation wall: Penetrations through foundation or basement walls of a dwelling shall be encased in a sleeve. The annular space between the gas piping and the sleeve shall be sealed at the foundation or basement wall to prevent entry of gas or water.

M-1707.1.5 Piping beneath buildings: Fuel gas piping located beneath buildings shall be encased in conduit which is capable of withstanding superimposed loads. The terminal point where the conduit enters the building shall be sealed to prevent the possible entrance of any gas leakage. The conduit shall extend at least 4-inches outside the building and be vented above grade to the outside. This section shall not apply to piping in ventilated crawl spaces.

M-1707.1.6 Tracer for nonmetallic buried piping: A No 18 copper tracer wire or other approved conductor shall be installed adjacent to underground nonmetallic gas piping and shall be accessible or terminate above grade at each end.

M-1707.2 Piping in buildings

M-1707.2.1 Drilling and notching: Where necessary, wood-framed structural members shall be drilled or notched as provided in Sections R-402.5, R-402.5.1, R-602.5, R-602.6, R-702.5 and R-702.6.

M-1707.2.2 Sediment trap: If a sediment trap is not incorporated as a part of the gas utilization equipment, a sediment trap shall be installed 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.

M-1707.2.3 Prohibited locations: Gas piping shall not be run in or through supply and return air ducts, plenums, clothes, chutes, chimneys, vents, dumbwaiters, or elevator shafts. This provision shall not apply to ducts used to provide combustion air in accordance with Chapter 15.

M-1707.2.4 Piping in concealed locations: Portions of gas piping systems installed in concealed locations shall not have unions or running threads. Concealed tubing joints shall be brazed in accordance with Section M-1706.3.

M-1707.2.5 Piping in concrete slabs: Gas piping embedded in concrete slabs shall be surrounded with a minimum of 1 1/2-inches of concrete and shall not be in physical contact with reinforcing or other metallic components. Piping shall not be embedded in concrete slabs containing quickset additives or cinder aggregate. All piping, fittings, and risers shall be protected against corrosion in accordance with Section M-1707.1.2.

M-1707.2.6 Hangers and supports: Hangers and supports shall be of sufficient strength to support the piping, and shall be fabricated of materials compatible with the piping material. Piping shall be supported at intervals not exceeding the spacings specified in Table No. M-1707.2.6.

MATERIAL	MAXIMUM SPACING (FEET)
Rigid pipe, 3/4-inch diameter and under	10
Rigid pipe, 1-inch diameter and over	12
Tubing, 1-1/2-inch diameter and under	6

M-1707.3 Aboveground outside piping: Piping installed aboveground outside of the building shall be securely supported and protected from physical damage. Piping which penetrates outside walls shall be protected against corrosion. Piping which penetrated masonry or concrete walls or chemically treated lumber shall be sleeved with the annular space between the pipe and sleeve sealed.

M-1707.4 Gas pipe turn

M-1707.4.1 Metallic tubing bends: Metallic tubing shall conform with the following:

1. Bends shall be made only with bending equipment and procedures intended for that purpose.
2. All bends shall be smooth and free from buckling, cracks, or other mechanical damage.

3. The inside radius of a bend shall be not less than 6 times the outside diameter of the tubing.
4. Corrugated stainless steel tubing bends shall be in compliance with the manufacturer's installation instructions.

M-1707.4.2 Plastic pipe bends:

1. Plastic pipe shall not be damaged and the internal diameter of the pipe shall not be effectively reduced.

2. The inside radius of a bend shall be not less than 25 times the inside diameter of the pipe.

3. When the piping manufacturer specifies the use of special bending equipment or procedures, such equipment or procedures shall be used.

M-1707.5 Piping in Partitions and Walls: Concealed piping shall not be located in solid walls or partitions. Copper tubing may be run vertically in a hollow wall or partition. A metallic sleeve or equivalent means shall be used to protect the tubing where it passes through a wood plate or other structural item. The sleeve shall extend a minimum of 4 inches on each side of the structural member. Iron piping may be used for the sleeve. Tubing shall have some slack and not be rigidly secured. These provisions do not apply to encased tubing which passes through walls or partitions. Concealed tubing joints are prohibited. When tubing is run horizontally inside a hollow wall or partition, it shall be protected by means of a pipe sleeve or equivalent along the entire length of tubing in the wall or partition.

M-1707.6 Purging: The fuel-gas piping system shall be purged prior to placing in service. Piping shall not be purged into the combustion chamber of an appliance.

M-1707.7 Cap all outlets: Each outlet, including those with a valve or cock outlet, shall be closed gas-tight with a threaded plug or cap immediately after installation and shall be left closed until the gas utilization equipment is connected thereto. Outlets shall be closed gas-tight when equipment is disconnected. This requirement shall not apply to labeled quick-disconnect devices or gas convenience outlets as provided in Section M-1705.5.

M-1707.8 Pipe Identification: Where other than black steel pipe is used, piping shall be marked "GAS" in black letters on yellow labels at approximately 6-feet intervals where exposed and at the beginning and at the end of each section. Piping from multiple meter installations shall be plainly marked by the installer so that the piping system supplied by each meter can be readily identified to the dwelling number. All piping in the 2-psi portion of the system shall be marked at the beginning, all ends and at approximately 6-foot intervals along its exposed length designating 2-psi gas pressure.

M-1707.9 Electrical bonding and grounding: Each above ground portion of a metallic gas piping system upstream from the appliance shutoff valve shall be electrically continuous and bonded to a grounding electrode in accordance with Part VI of this code. Gas piping shall not be used as a grounding electrode.

Fuel-gas piping or components shall not be used as electrical circuits except that low-voltage (50 volts or less) control circuits, ignition circuits, and electronic flame detection device circuits may make use of piping or components for a part of an electrical circuit.

SECTION M-1708—GAS PIPE SIZING

M-1708 Required gas supply: All fuel-gas pipe shall be sized to supply the required demand of the attached appliances. The cubic feet per hour of gas required shall be obtained by dividing the specified Btu/hr input of an appliance by the average Btu heating value per cubic foot of gas being supplied. Where the rating of the gas appliance to be installed has not been specified, Table No. M-1708.1 or other approved sources shall be to estimate the requirement in Btu/hr.

M-1708.2 Required size: Fuel-gas pipe operating under low pressure (0.5 psig or less) shall be sized using the following procedure, or according to the N.C. State Building Code, Volume VI–Gas, as listed in Section S-26.1708 or by other approved methods:

1. Measure the length of pipe from the point of delivery to the most remote outlet or appliance connection.
2. From Table No. M-1708.2, select the column showing that distance or the next longer distance.
3. Determine gas demand for the most remote section of piping and locate in this column. If the exact figure is not shown, choose the next larger figure. The required pipe or tubing size for that section is shown in the left hand column.
4. Repeat Step 3 above for each section of piping, working back toward the point of delivery.

SECTION M-1708.3 REGULATORS

M-1708.3.1 Gas Pressure Regulators: Pounds-to-inches regulators installed between the medium pressure and low pressure sections shall have 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.

Table No. M-1708.1
APPROXIMATE DEMAND OF TYPICAL RESIDENTIAL GAS APPLIANCES

APPLIANCE	DEMAND (Btu/hr)
Range with Oven	65,000
Built-in Top Burner Section	40,000
Built-in Oven Section	25,000
Storage Water Heater-up to 30 gallon	30,000
Storage Water Heater-40 to 50 gallon	50,000
Clothes Dryer	35,000
Fireplace Log Lighter	25,000
Barbecue	50,000

M-1708.3.2 Regulator Vent: Pounds-to-inches regulators installed indoors shall be equiped with a separate vent to the outside or a vent limiting device shall be mounted horizontally with the limiting device facing upwards. Regulator vents to the outside shall be at least the same size as the vent connection to the regulator, and the vent terminal shall be turned down to prevent the entrance of water.

M-1708.3.3 Shutoff Valve: An approved gas valve shall be installed immediately upstream from each pound-to-inches regulator.

TABLE No. M-1708.2a
SIZE OF GAS PIPE
Maximum Capacity of Pipe in Cubic Feet of Gas Per Hour
Based on a Pressure Drop of 0.5-in Water Column,
0.6 Specific Gravity Gas and Schedule 40 Pipe

	Nominal Pipe Size/Internal Diameter (in)									
Length	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	4	6
in feet	.622	.824	1.049	1.380	1.610	2.067	2.469	3.068	4.026	6.065
10	175	360	680	1,400	2,100	3,950	6,300	11,000	23,000	69,600
20	120	250	465	950	1,460	2,750	4,350	7,700	15,800	49,300
30	97	200	375	770	1,180	2,200	3,520	6,250	12,800	40,200
40	82	170	320	660	990	1,900	3,000	5,300	10,900	34,800
50	73	151	285	580	900	1,680	2,650	4,750	9,700	31,200
60	66	138	260	530	810	1,520	2,400	4,300	8,800	28,400
70	61	125	240	490	750	1,400	2,250	3,900	8,100	26,300
80	57	118	220	460	690	1,300	2,050	3,700	7,500	24,600
90	53	110	205	430	650	1,220	1,950	3,450	7,200	23,200
100	50	103	195	400	620	1,150	1,850	3,250	6,700	22,000
125	44	93	175	360	550	1,020	1,650	2,950	6,000	19,700
150	40	84	160	325	500	950	1,500	2,650	5,500	18,000
175	37	77	145	300	460	850	1,370	2,450	5,000	16,000
200	35	72	135	280	430	800	1,280	2,280	4,600	15,600
225	25	57	115	253	392	793	1,230	2,200	4,475	14,688
250	24	54	109	240	372	752	1,185	2,175	4,350	13,934
275	23	52	104	229	355	717	1,140	2,050	4,225	13,286
300	22	50	100	219	340	686	1,090	1,975	4,100	12,720
350	20	46	92	203	314	635	1,043	1,897	3,969	11,777
400	19	43	86	190	294	594	975	1,775	3,712	11,016
450	18	41	81	179	277	560	920	1,673	3,500	10,386
500	17	38	77	170	263	532	872	1,588	3,320	9,853
550	16	37	74	162	251	507	832	1,514	3,166	9,394
600	15	35	71	155	240	485	796	1,449	3,031	8,994
700	14	33	65	143	222	449	737	1,342	2,806	8,327
800	13	30	61	134	208	420	690	1,255	2,625	7,789
900	13	29	58	126	196	396	650	1,183	2,475	7,344
1,000	12	27	55	120	186	376	617	1,123	2,348	6,967

TABLE No. M-1708.2b
SIZE OF GAS TUBING
Maximum Capacity of Tubing in Cubic Feet of Gas Per Hour Based on a Pressure Drop of 0.5-in Water Column and 0.6 Specific Gravity Gas

Length in feet	Tubing Size OD (in)						
	3/8	1/2	5/8	3/4	7/8	1 1/8	1 3/8
10	28	66	126	218	341	705	1251
20	19	44	85	146	229	473	840
30	15	35	67	116	181	375	665
40	13	30	57	98	154	318	564
50	11	26	50	86	135	280	496
60	10	24	45	78	122	252	447
70	9	22	41	71	111	230	409
80	9	20	38	66	103	213	379
90	8	19	36	62	96	199	354
100	8	18	34	58	91	188	333
120	7	16	30	52	82	169	300
140	6	15	28	48	75	155	274
160	6	13	26	44	69	143	254
180	5	13	24	41	65	134	237
200	5	12	23	39	61	126	224
220	5	11	21	37	58	119	212
240	5	11	20	35	55	113	201
260	4	10	19	34	52	108	192
280	4	10	19	32	50	104	184
300	4	9	18	31	48	100	177
320	4	9	17	30	47	96	171
340	4	9	17	29	45	93	165
360	4	8	16	28	43	90	159
380	4	8	16	27	42	87	155
400	3	8	15	26	41	85	150

TABLE No. M-1708.2c
SIZE OF PLASTIC PIPE (0.062" WALL)
Maximum Capacity of Plastic Pipe
In Cubic Feet Of Gas Per Hour
Based on a Pressure Drop of 0.5-in Water Column and 0.6 Specific Gravity Gas

Length In Feet	Tubing Size OD (in)			
	3/8 (.062 wall)	1/2 (.062 wall)	5/8 (.062 wall)	7/8 (.062 wall)
10	16	47	103	310
20	11	32	69	208
30	8	25	55	165
40	7	21	46	140
50	6	19	41	123
60	6	17	37	111
70	5	15	34	101
80	5	14	31	94
90	4	13	29	88
100	4	13	27	83
125	4	11	24	73
150	3	10	22	65
175	3	9	20	60
200	3	8	18	55
225	3	8	17	52
250	2	7	16	49

Limited to applications covered under Table No. M-1704.1.
(Capacities based upon Mueller Formula for low pressure installations of smooth tubing under 1 psi)

TABLE No. M-1708.2d
SIZE OF PLASTIC PIPE (0.090" & 0.099" WALL)
Maximum Capacity of Plastic Pipe
In Cubic Feet of Gas Per Hour
Based on a Pressure Drop of 0.5-in Water Column and 0.6 Specific Gravity Gas

Length In Feet	Tubing Size OD (in)			
	5/8 (.090 wall)	7/8 (.090 wall)	1 1/8 (.099 wall	1 1/8 (.090 wall)
10	73	242	536	581
20	49	163	360	390
30	39	129	285	309
40	33	109	242	262
50	29	96	213	230
60	26	87	191	207
70	24	79	175	190
80	22	73	162	176
90	21	69	152	164
100	19	64	143	154
125	17	57	126	136
150	15	51	113	122
175	14	47	103	112
200	13	43	96	104
225	12	40	90	97
250	11	38	84	91
275	11	36	80	86
300	10	34	76	82
325	10	33	72	78
350	9	31	69	75
375	9	30	67	72
400	9	29	64	70
500	8	25	57	61
600	7	23	51	55
700	6	21	47	50
800	6	20	43	47
900	5	18	40	44
1000	5	17	38	41

Limited to applications covered under Table No. M-1704.1.
(Capacities based upon Mueller Formula for low pressure installation of smooth tubing under 1 psi)

TABLE No. M-1708.2e
SIZE OF PLASTIC GAS PIPE
Maximum Capacity of Plastic Pipe in Cubic Feet of Gas Per Hour (Based upon a pressure drop of 0.5-in Water Column, 0.6 Specific Gravity Gas and Wall Thickness as specified in Table.)

Length In Feet	Pipe Size OD (in)					
	1/2 (.090 Wall)	3/4 (.095 Wall)	1 (.119 Wall)	1 1/4 (.166 Wall)	1 1/2 (.173 Wall)	2 (.216 Wall)
10	212	437	807	1428	2192	4079
20	143	293	542	959	1471	2705
30	113	232	429	759	1165	2142
40	96	197	364	644	988	1816
50	84	173	320	566	869	1597
60	76	156	288	510	782	1438
70	69	143	264	467	716	1316
80	64	132	244	432	663	1219
90	60	124	228	404	620	1139
100	57	116	215	380	583	1072
125	50	102	189	344	513	943
150	45	92	170	301	462	849
175	41	84	156	275	423	777
200	38	78	144	255	391	720
225	35	73	135	238	366	672
250	33	69	127	224	344	633
275	32	65	120	212	326	599
300	30	62	114	202	310	570
325	29	59	109	193	296	544
350	28	57	104	185	284	522
375	26	54	100	178	273	501
400	25	52	97	171	263	483
500	22	46	85	151	231	425
600	20	42	77	136	208	383
700	18	38	70	124	190	350
800	17	35	65	115	176	324
900	16	33	61	107	165	303
1000	15	31	57	101	155	285

Limited to applications covered under Table No. M-1704.1.
(Capacities based upon Mueller formula for low pressure installations of smooth tubing under 1 psig)

SECTION M-1709–2 PSI PIPING SYSTEM

M-1709.1 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 No. 1709.1a, 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 this 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 1709.1a 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 1709.1b.

TABLE No. M-1709.1a
SIZE OF GAS TUBING
Maximum Capacity of Tubing in Cubic Feet of Gas Per Hour
Based on a Pressure Drop of 1.5 psi and 0.6
Specific Gravity Gas

Length (ft)	OD of Tubing (in)			
	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. M-1709.1b
SIZE OF GAS PIPE
Maximum Capacity of Pipe in Cubic Feet of Gas Per Hour
Based on a Pressure Drop of 1.5 psi,
0.6 Specific Gravity Gas and Schedule 40 Pipe

Length (ft)	Nominal Diamerter (in)	
	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

M-1709.2 Piping Size From Regulator

To determine the size of piping between each consumer's MP regulator and the appliance or appliance regulator, proceed as follows:

1. Measure the length of piping from the consumer's MP regulator to the most remote outlet served by such regulator.
2. In the first vertical column in Table No. M-1709.2 select the horizontal line showing that distance or the next longer distance if the table does not give the exact length.

TABLE No. M-1709.2
SIZE OF GAS TUBING
Maximum Capacity of Tubing in Cubic Feet of Gas Per Hour
Based on a Pressure Drop of 1-in Water Column
and 0.6 Specific Gravity Gas

Length (ft)	OD of Tubing (in)			
	3/8	1/2	5/8	7/8
2	97	207	433	1111
4	65	139	290	746
6	52	110	230	591
8	44	93	195	501
10	39	82	171	440
15	31	65	136	349
20	26	55	115	296
25	23	48	101	260
30	21	44	91	234
40	17	37	77	198
50	15	32	68	175
75	12	26	54	139
100	10	22	46	117

SECTION M-1710–LIQUEFIED PETROLEUM GAS SYSTEMS

M-1710.1 Pressure regulating valves: Pressure regulating valves for LPG systems shall be labeled in accordance with UL 144, as listed in Section S-26.1710.

M-1710.2 Location of containers: Location of undiluted liquefied petroleum gas containers shall be the responsibility of the North Carolina Department of Agriculture.

M-1710.3 LP Pipe Sizing: Pipe and tubing shall be sized in accordance with Section M-1708.2 using Table Nos. 1710.3a and 1710.3b.

SECTION M-1711–TESTING

M-1711.1 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 system 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 M-1711.2. Any new fittings installed before the new shut-off valve shall be soap tested at the operating pressure of the existing piping system.

Table No. M-1710.3a
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 No. M-1710.3b
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

M-1711.2 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.

M-1711.3 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 necessay apparatus for conducting the pressure test shall be furnished by the installer.

Chapter 18
FUEL OIL SUPPLY SYSTEMS

SECTION M-1801 – OIL TANKS

M-1801.1 Materials: Fuel oil supply tanks shall be fabricated from steel or other approved materials.

M-1801.2 Aboveground tanks: The maximum amount of fuel oil stored above ground or inside of a building shall be 660 gallons. The supply tank shall be securely supported on rigid noncombustible supports to prevent settling or shifting.

M-1801.2.1 Tanks within buildings: Supply tanks for use inside of buildings shall be of such size and shape to permit installation and removal from dwellings as whole units. Supply tanks larger than 10 gallons shall be placed not less than 5-feet to an adjoining property line. Such tanks shall be suitably protected from the weather and from physical damage.

M-1801.2.2 Outside aboveground tanks: Tanks installed outside above ground shall be a minimum of 5-feet to an ajoining property line. Such tanks shall be suitably protected from the weather and from physical damage.

M-1801.3 Underground tanks: Excavations for underground tanks shall not undermine the foundations of existing structures. The clearance from any part of the tank to the nearest wall of any basement, pit, or property line shall be not less than 1-foot. Tanks shall be set on and surrounded with noncorrosive inert materials such as clean earth, sand, or gravel well tamped in place. Tanks shall be covered with not less than 1-foot of earth. Corrosion protection shall be provided in accordance with Section M-1803.7.

M-1801.4 Multiple tanks: Cross connection of two supply tanks shall be permitted in accordance with section M-1803.6.

M-1801.5 Oil gauges: Inside tanks shall be provided with a device to indicate when the oil in the tank has reached a predetermined safe level. Glass gauges or any gauge or any gauge subject to breakage that could result in the escape of oil from the tank shall not be used.

SECTION M-1802—OIL PIPING, FITTING AND CONNECTIONS

M-1802.1 Materials: Piping shall consist of steel pipe, copper tubing, steel tubing conforming to ASTM A539, as listed in Section S-26.1802, or other approved materials. Aluminum tubing shall not be used between the fuel-oil tank and the burner units.

M-1802.2 Joints and fittings: Piping shall be connected with standard fittings compatible with the piping material. Cast iron fittings shall not be used for oil piping. Unions requiring gaskets or packings, right or left couplings, and sweat fittings employing solder having a melting point less

than 1000°F shall not be used for oil piping. Threaded joints and connections shall be made tight with suitable lubricant or pipe thread compound.

M-1802.3 Flexible connectors: Flexible metal hose used where rigid connections are impractical or to reduce the effect of jarring and vibration, shall be labeled and shall be installed in compliance with its label and the manufacturer's installation instructions. Connectors made from combustible materials shall not be used inside of buildings or above ground outside of buildings.

SECTION M-1803—INSTALLATION

M-1803.1 General: Piping shall be installed in a manner to avoid placing stresses on the piping, and to accommodate expansion and contraction of the piping system.

M-1803.2 Supply piping: Supply piping used in the installation of oil burners and appliances shall be not smaller than 3/8-inch pipe or 3/8-inch OD tubing. Copper tubing and fittings shall be minimum Type L.

M-1803.3 Fill piping: Fill piping shall terminate outside of dwellings at a point at least 2-feet from any dwelling opening at the same or lower level. Fill openings shall be equipped with a tight metal cover designed to discourage tampering.

M-1803.4 Vent piping: Vent piping shall be of adequate size to avoid pressure build-up in the tank during filling, but shall be no smaller than 1-1/4-inch pipe. Vent piping shall be laid to drain towards the tank without sags or traps in which liquid can collect. Vent pipes shall not be cross connected with fill pipes, lines from burners, or overflow lines from auxiliary tanks. The lower end of a vent pipe shall enter the tank through the top and shall extend into the tank not more than 1-inch.

M-1803.5 Vent termination: Vent piping shall terminate outside of buildings at a point not less than 2-feet, measured vertically or horizontally, from any building opening. Outer ends of vent piping shall terminate in a weather-proof cap or fitting having an unobstructed area at least equal to the cross-sectional area of the vent pipe, and shall be located sufficiently above the ground to avoid being obstructed with snow and ice.

M-1803.6 Cross connection of tanks: Cross connection of two supply tanks, not exceeding 660 gallons aggregate capacity, with gravity flow from one tank to another, shall be acceptable providing that the two tanks are on the same horizontal plane.

M-1803.7 Corrosion Protection: Underground tanks and buried piping shall be protected by corrosion resistant coatings, special alloys, fiber glass reinforced plastic, or other approved systems.

SECTION M-1804—OIL PUMPS AND VALVES

M-1804.1 Pumps: Oil pumps that are not part of a labeled burner shall be positive displacement types that automatically shut off the oil supply when stopped. Automatic pumps shall be labeled and shall be installed in compliance with their label.

M-1804.2 Shutoff valves: A readily accessible manual shutoff valve shall be installed between the oil supply tank and the burner. When the shutoff valve is installed in the discharge line of an oil pump, a pressure-relief valve shall be incorporated to bypass or return surplus oil.

M-1804.3 Maximum pressure: Pressure at the oil supply inlet to an appliance shall be not greater than 3-psi unless the appliance is approved for a higher inlet pressure.

M-1804.4 Relief valves: Fuel-oil lines incorporating heaters shall be provided with relief valves that will discharge to a return line when excess pressure exists.

Chapter 19
MISCELLANEOUS APPLIANCES

SECTION M-1901 – RANGES AND OVENS

M-1901.1 Clearances: Freestanding or built in ranges have a vertical clearance above the cooking top of not less than 30-inches to unprotected combustible material. When the underside of such combustible material is protected with noncombustible material, the distance shall not be less than 24-inches.

M-1901.2 Gas ranges and ovens: Gas ranges and ovens shall be labeled and shall conform to ANSI Z21.1, as listed in Section S-26.1901.

M-1901.3 Built-in units: Built-in household cooking appliances shall be labeled and shall be installed in accordance with the manufacturer's installation instructions. The installation shall not interfere with combustion air or accessibility for operation and servicing.

M-1901.4 Range hood: Range hoods shall be vented to the outdoors by a single-wall pipe constructed of galvanized steel, stainless steel, copper or other material approved by the building official for the use intended. Vents serving range hoods shall not terminate in an attic or crawl space or any area inside the building. Labeled unvented range hoods shall be installed in accordance with the terms of their label.

SECTION M-1902 – OPEN-TOP GAS BROILER UNITS

M-1902.1 General: Open-top gas broiler units shall be labeled and shall be installed in accordance with the manufacturer's installation instructions. Open-top gas broiler units shall conform to ANSI Z21.1, as listed in Section S-26.1902.

M-1902.2 Overhead ventilating hoods: Domestic open-top broiler units shall be provided with a metal ventilating hood, not less than 28 gauge, with a clearance of not less than 1/4-inch between the hood and the underside of combustible material or cabinets. A clearance of at least 24-inches shall be maintained between the cooking surface and the combustible material or cabinet. The hood shall be at least as wide as the broiler unit and shall extend over the entire unit. Broiler units incorporating an integral exhaust system, and labeled for use without a ventilating hood, need not be provided with a ventilating hood.

SECTION M-1903 – OUTDOOR GAS COOKING APPLIANCES

Outdoor gas cooking appliances shall be labeled and shall be installed in accordance with the manufacturer's installation instructions. Outdoor gas cooking appliances shall conform to ANSI Z21.54 and Z21.58, as listed in Section S-26.1903.

SECTION M-1904 – CLOTHES DRYERS

M-1904.1 General: Gas clothes dryers shall be labeled and shall be installed in accordance with the manufacturer's installation instructions. Gas clothes dryers shall conform to ANSI Z21.5.1, as listed in Section S-26.1904.

M-1904.2 Closet installation: Gas clothes dryers installed in closets shall be labeled for such installations and no other fuel-burning appliance shall be installed in the same closet.

M-1904.3 Clothes dryer exhaust: Dryer vent systems shall be independent of all other systems and shall convey the products of combustion and moisture to the outdoors. Vents shall not be connected with sheet-metal screws or other fastening means which extend into the vent. Exhaust vents shall be equipped with a back-draft damper. All concealed vents and vents located within a fire-rated wall, partition, floor or roof assembly shall be constructed of minimum 0.016-inch thick rigid metal duct or other non-combustible material with joints running in the direction of air flow. Non-combustible flexible duct may be used when installed without dips or kinks.

M-1904.3.1 Exhaust vent size: The minimum diameter of the exhaust vent shall be as recommended by the manufacturer or in accordance with Section M-1904.3.2, but shall not be less than the diameter of the appliance outlet.

M-1904.3.2 Length limitation: The maximum length of a 4-inch diameter exhaust vent shall not exceed 45 feet from the dryer location to wall or roof termination, and shall terminate with a full opening exhaust hood. A reduction in maximum length of 2.5 feet for each 45-degree bend and 10-feet for each 90-degree bend shall apply. The maximum length shall not exceed 30 feet from the dryer location to the wall or roof termination when a louvered outlet or 2 1/2-inch wall or roof cap is installed. For installations where this length limitation is exceeded, the maximum vent diameter shall be 5-inches with a minimum 4-inch exhaust termination.

M-1904.3.3 Termination: Exhaust vent caps shall terminate as recommended by the manufacturer, but shall not be less than 12 inches above grade.

SECTION M-1905 – WATER HEATERS

Water heaters shall be labeled and shall be installed in accordance with the manufacturer's installation instructions and Section P-2408 of this code.

SECTION M-1906 – VENTED DECORATIVE APPLIANCES

M-1906.1 General: Vented decorative appliances shall comply with other requirements of this code applying to gas heating equipment and heating appliances. Vented decorative appliances shall conform to ANSI Z21.50, as listed in Section S-26.1906.

M-1906.2 Installation: Vented decorative appliances shall be labeled and shall be installed in accordance with the manufacturer's installation instructions.

M-1906.3 Gas logs: Labeled gas logs shall be installed in solid-fuel burning fireplaces in accordance with the provisions of this section. Gas logs equipped with a pilot shall have a labeled safety shutoff valve.

M-1906.4 Combustion and circulating air: Combustion and circulating air shall be provided in accordance with Chapter 15.

SECTION M-1907 – GAS LIGHTS

M-1907.1 Clearances: Enclosed gas lights shall be labeled and shall be installed in accordance with the manufacturer's installation instructions.

M-1907.2 Mounting on buildings: Gas lights designed for wall or ceiling mounting shall be securely attached to substantial structures in such a manner that they are not dependent on the gas piping for support.

M-1907.3 Mounting on posts: Gas lights designed for post mounting shall be securely and rigidly attached to a post. Posts shall be rigidly mounted. The strength and rigidity of posts greater than 3-feet in height shall be at least equivalent to that of a 2-1/2-inch diameter post constructed of 14 gage steel, or 1-inch Schedule 40 steel pipe. Posts 3-feet or less in height shall not be smaller than a 3/4-inch Schedule 40 steel pipe. Drain openings shall be provided near the base of posts when there is a possibility of water collecting inside them.

M-1907.4 Gas appliance pressure regulator: When a gas appliance pressure regulator is not supplied with a gas light, a pressure regulator shall be installed in the service line of the line to the gas light. For multiple installations, one regulator used to serve several gas lights shall be of adequate capacity.

SECTION M-1908 – POOL HEATERS

M-1908.1 Location: Pool heaters shall be located or protected to guard against accidental contact of hot surfaces by persons.

M-1908.2 Clearances: In no case shall the clearances be such as to interfere with combustion air, draft hood or flue terminal relief, or accessibility for servicing.

M-1908.3 Temperature and pressure limiting devices: Pool heaters shall have relief valves, controls or devices to limit excessive temperature and pressure.

M-1908.4 Bypass valves: If an integral bypass system is not provided as a part of the pool heater, a bypass line and valve shall be installed between the inlet and outlet piping for use in adjusting the flow of water through the heater.

M-1908.5 Venting: Pool heaters shall be installed with the venting means supplied by the manufacturer and in accordance with the manufacturer's installation instructions. Pool heaters for indoor installations shall be vented in accordance with Chapter 16 of this code.

SECTION M-1909 – SAUNA HEATERS

M-1909.1 Locations and protection: Sauna heaters shall be protected from accidental contact by persons with a guard or barrier of material having a low thermal conductivity, such as wood. The guard shall have no substantial effect on the transfer of heat from the heater to the room.

M-1909.2 Installation: Sauna heaters shall be labeled and shall be installed in accordance with the manufacturer's installation instructions.

M-1909.3 Connection of gas-fired heaters: The provisions of Chapter 17 shall apply to gas connections. When access to controls is form an adjacent room, connections shall be made in that location.

M-1909.4 Combustion air: Combustion air for gas fired sauna heaters shall not be taken form inside the sauna room. Adequate combustion air and venting for a non-direct vent type heater shall be provided in accordance with Chapters 15 and 16, respectively.

M-1909.5 Controls: Sauna heaters shall be equipped with a thermostat that will limit room temperature to no greater than 194F. If the thermostat is not an integral part of the heater, the heat sensing element shall be located within 6-inches of the ceiling.

SECTION M-1910 – SOLAR ENERGY SYSTEMS

M-1910.1 General: This section provides for construction, installation, alteration, and repair of equipment and systems utilizing solar energy to provide space heating or cooling, hot water heating, and swimming pool heating.

M-1910.2 Installation

M-1910.2.1 Access: Solar energy collectors, controls, dampers, fans, blowers, and pumps shall be accessible for inspection, maintenance, repair, and replacement.

M-1910.2.2 Roof mounted collectors: The roof shall be constructed to support the loads imposed by roof mounted solar collectors. Roof mounted solar collectors that serve as a roof covering shall conform to the requirements for roof coverings in Chapter 8 of this code. When mounted on or above the roof coverings, the collectors and supportive structure shall be constructed of noncombustible materials or fire-retardant treated wood equivalent to that required for the roof construction.

M-1910.2.3 Pressure and temperature relief: System components containing fluids shall be protected against pressures and temperatures exceeding design limits with pressure and temperature relief valves. Relief devices shall be installed in sections of the system in which excessive temperatures or pressures may develop such that a section cannot be valved off or isolated form a relief device.

M-1910.2.4 Vacuum relief: System components that may be subjected to pressure drops below atmospheric pressure during operation or shutdown shall be designed to withstand the pressures, or shall be protected by a vacuum relief valve.

M-1910.2.5 Protection from freezing: System components shall be protected from damage by freezing of heat transfer liquids at the lowest ambient temperatures during operation.

M-1910.2.6 Expansion tanks: Expansion tanks in solar energy systems shall be installed in accordance with Section M-1303.

M-1910.2.7 Roof penetrations: All roof penetrations shall be adequately flashed and waterproofed in accordance with Chapter 8 of this code.

M-1910.3 Labeling

M-1910.3.1 Collectors: Collectors shall be labeled to show the manufacturer's name, model, serial number, collector weight, serial number, maximum and minimum allowable operating temperatures and pressures, and the type of heat transfer fluids allowed.

M-1910.3.2 Thermal storage units: Pressurized thermal storage units shall be labeled to show the manufacturer's name, model, serial number, maximum and minimum allowable operating temperatures and pressures, and the type of heat transfer fluids allowed.

M-1910.4 Prohibited heat transfer fluids: Flammable gases and liquids shall not be used as heat transfer fluids.

SECTION M-1911 – CNG RESIDENTIAL FUELING FACILITIES

Residential fueling facilities for compressed natural gas vehicular fuel systems shall be installed in accordance with NFiPA 52, as listed in Section S-26.1911.

Part V – Plumbing

Chapter 20
GENERAL PLUMBING REQUIREMENTS AND DEFINITIONS

SECTION P-2001 – GENERAL

P-2001.1 Application: The provisions of this part shall establish the general scope of the plumbing system and equipment requirements of this code and the definitions of terms related thereto. The use of materials or methods of construction not specified in this chapter accomplishing the purposes intended by this code and approved by the building official in accordance with Section R-108 shall be accepted as complying with this code. Plumbing materials and systems shall conform to the provisions of this chapter, Chapters 21 through 24 and the standards specified in Table No. P-2001.1, as applicable.

Table No. P-2001.1
PLUMBING STANDARDS
(As listed in Section S-26.2001)

ANSI A112.1.2	ASME/ANSI A112.19.8M
ANSI B16.12	ASME/ANSI A112.21.1M
ANSI B16.22	ASME/ANSI B16.3
ANSI B16.26	ASME/ANSI B16.4
ANSI Z21.10.1	ASME/ANSI B16.15
ANSI Z21.10.3	ASME/ANSI B16.29
ANSI Z21.12	ASSE/ANSI 1001
ANSI Z21.13	ASSE/ANSI 1002
ANSI Z21.22	ASSE/ANSI 1003
ANSI Z21.24	ASSE/ANSI 1006
ANSI Z21.41	ASSE/ANSI 1007
ANSI Z21.45	ASSE/ANSI 1008
ANSI Z124.1	ASSE/ANSI 1010
ANSI Z124.2	ASSE/ANSI 1011
ANSI Z124.3	ASSE/ANSI 1014
ANSI Z124.4	ASSE/ANSI 1016
ANSI Z124.6	ASSE/ANSI 1019
ANSI/NSF 14	ASSE/ANSI 1023
ASME A112.18.1M	ASSE/ANSI 1025
ASME B16.18	ASSE/ANSI 1037
ASME B16.23	ASTM A53
ASME/ANSI A112.19.1M	ASTM A74
ASME/ANSI A112.19.2M	ASTM A126
ASME/ANSI A112.19.3M	ASTM A197
ASME/ANSI A112.19.5	ASTM A377
ASME/ANSI A112.19.6	ASTM A525
ASME/ANSI A112.19.7M	ASTM B32

(Continued)

Table No. P-2001.1 (Continued)
PLUMBING STANDARDS
(As listed in Section S-26.2001)

ASTM B42	ASTM D2672
ASTM B43	ASTM D2737
ASTM B75	ASTM D2751
ASTM B88	ASTM D2846
ASTM B135	ASTM D2949
ASTM B152	ASTM D3000
ASTM B306	ASTM 3034
ASTM B447	ASTM D3212
ASTM C14	ASTM D3122
ASTM C425	ASTM D3261
ASTM C564	ASTM D3309
ASTM C700	ASTM F402
ASTM D1527	ASTM F409
ASTM D1785	ASTM F438
ASTM D1861	ASTM F439
ASTM D2104	ASTM F441
ASTM D2235	ASTM F442
ASTM D2239	ASTM F493
ASTM D2241	ASTM F628
ASTM D2282	ASTM F656
ASTM D2321	ASTM F845
ASTM D2447	ASTM F891
ASTM D2466	CISPI HS 74
ASTM D2467	CISPI HSN
ASTM D2468	CISPI 301
ASTM D2564	CSA B602M
ASTM D2609	FS QQ-L-201f-2
ASTM D2661	UL 174
ASTM D2662	UL441
ASTM D2665	UL 726
ASTM D2666	UL 732

P-2001.2 Connection: Plumbing fixtures, drains and appliances used to receive or discharge liquid wastes or sewage shall be connected to the drainage system of the building or premises in accordance with the requirements of this code.

P-2001.3 Existing systems: Where existing plumbing installations are to be altered or repaired, necessary deviations may be permitted, provided such deviations conform to the intent of the code and are first approved by the building official.

SECTION P-2002 – INDIVIDUAL WATER SUPPLY AND SEWAGE DISPOSAL

The water-distribution and drainage system of any building or premises where plumbing fixtures are installed shall be connected to a public water-supply or sewer system, respectively, if available. Where

either a public water-supply or sewer system, or both, are not available, or connection thereto is not feasible, an individual water-supply or individual (private) sewage-disposal system, or both, shall be provided.

SECTION P-2003 – STRUCTURAL AND PIPING PROTECTION

P-2003.1 General: In the process of installing or repairing any part of a plumbing and drainage installation, the finished floors, walls, ceilings, tile work or any other part of the building or premises which must be changed or replaced shall be left in a safe structural condition in accordance with the requirements of the building portion of this code.

P-2003.2 Drilling and notching: Wood-framed structural members shall not be drilled, notched or altered in any manner except as provided in Sections R-402.5, R-402.5.1, R-602.5, R-602.6, R-702.5 and R-702.6.

P-2003.3 Breakage and corrosion: Pipes passing under or through walls shall be protected from breakage. Pipes passing through or under cinder or concrete or other corrosive material shall be protected against external corrosion by protective coating, wrapping or other means which prevent such corrosion.

P-2003.4 Sleeves: Annular spaces between sleeves and pipes shall be filled or tightly caulked as approved by the administrative authority.

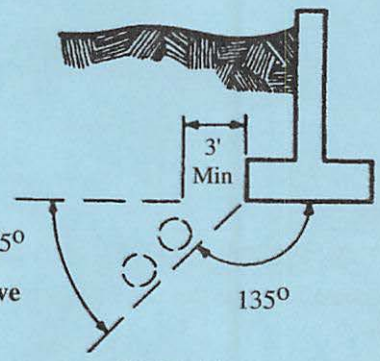
Annular spaces between sleeves and pipes in fire-rated assemblies shall be filled or tightly caulked in accordance with the building portion of this code.

P-2003.5 Pipes through footings or foundation walls: DELETED

P-2003.6 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° F in accordance with ASTM C-177.

Note: These provisions are minimum requirementst which have been found suitable for normal weather conditions. Abnormally low temperatures for extended peroids may require additional provisions to prevent freezing.

Figure No. P-2003.7
PIPE LOCATION WITH RESPECT TO FOOTINGS



P-2003.7 Depth: Piping installed deeper than and parallel to footings or bearing walls shall be 45 degrees therefrom (see Figure No. P-2003.7) except as may be approved by the administrative authority.

P-2003.8 Waterproofing of openings: Joints at the roof, around vent pipes, shall be made water-tight by the use of lead, copper, galvanized iron or other approved flashings or flashing material or approved elastomeric material. Exterior wall openings shall be made water-tight.

SECTION P-2004 – EXCAVATIONS

Excavations required for the installation of a building drainage system shall be open trench work and shall be kept open until the piping has been inspected, tested and approved.

SECTION P-2005 – SUPPORT

Support for piping shall be provided in accordance with the following:

1. Piping shall be supported so as to ensure alignment and prevent sagging.
2. Piping in the ground shall be laid on a firm bed for its entire length, except where support is otherwise provided.
3. Hangers and anchors shall be of sufficient strength to maintain their proportional share of the weight of pipe and contents.
4. Piping shall be supported at distances not to exceed those indicated in Table No. P-2005.
5. Hangers shall be of a material which is compatible with the pipe it supports and will not promote galvanic action.

Table No. P-2005
PIPING SUPPORT

PIPE MATERIAL	MAXIMUM HORIZONTAL SPACING	MAXIMUM VERTICAL SPACING
Cast-iron soil pipe	5' except may be 10' where 10' lengths of pipe are installed.	Base and each story height but not to exceed 15'0"
Threaded-steel pipe	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
Plastic pipe and tube, hot- and cold-water, rigid	3' 0"	Each story height
Plastic pipe and tube, hot- and cold water, flexible	32"	Each story height

SECTION P-2006 – JOINTS AND CONNECTIONS

Pipe-joint compound used on threads shall be insoluble materials compatible with the type of service.

SECTION P-2007 – MORTAR

Rigid mortar or similar joints shall not be used with concrete or clay building sewers.

SECTION P-2008 – SLIP JOINTS

In drainage piping, slip joints may be used on both sides of the trap and in the trap seal. Slip joints in water piping may be used on the exposed fixture supply only. All slip joints shall be accessible.

SECTION P-2009 – GROUND, FLARED, FERRULE

Brass or copper ground joint, flared or ferrule-type connections which allow adjustment of tubing, but provide a rigid joint when made up, shall not be considered as slip joints.

SECTION P-2010 – UNIONS

Approved unions may be used in drainage work when accessibly located in the trap seal or between a fixture and its trap, in the vent system, except underground or in wet vents, and at any point in the water-supply system.

SECTION P-2011 – FLANGED CONNECTIONS

Fixture connections between drainage pipes, water closets and similar fixtures shall be made by means of approved flanges. The connection shall be bolted with an approved gasket, washer or setting compound between the fixtures and the flange. The floor flange shall be set on the finish floor and fastened to an approved firm base. *

Bends or stubs shall be cut off so as to present a smooth surface level with the top of the flange.

SECTION P-2012 – WATERPROOFING OF OPENINGS

Roof and exterior wall penetrations shall be made water-tight. Counterflashing shall not restrict the required internal cross-sectional area of any vent.

SECTION P-2013 – WORKMANSHIP

Valves, pipes and fittings shall be installed in correct relationship to the direction of the flow.

Burred ends shall be reamed to the full bore of the pipe.

SECTION P-2014 – INSPECTION AND TESTS

P-2014.1 Inspection required: New plumbing work and parts of existing systems affected by new work or alterations shall be inspected by the administrative authority to ensure compliance with the requirements of this code.

P-2014.2 Concealment: A plumbing or drainage system, or part thereof, shall not be covered, concealed or put into use until it has been tested, inspected and approved by the administrative authority.

P-2014.3 Responsibility of permittee: Test equipment, materials and labor shall be furnished by the permittee.

*

SECTION P-2015 – BUILDING SEWERS

The building sewer shall be water-tight.

SECTION P-2016 – DEFINITIONS

For the purpose of the plumbing requirements, the following terms shall be defined as follows and as set forth in Section R-118:

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Accessible and readily accessible: See Section R-118.

Administrative authority: The individual official, board, department or agency established and authorized by a state, county, city or other political subdivision created by law to administer and enforce the provisions of this code as adopted or amended.

Air admittance valve: A one-way valve designed to allow air into the plumbing drainage system when a negative pressure develops in the piping. This device shall close by gravity and seal the terminal under conditions of positive internal pressure.

Air break, drainage system: An arrangement in which a discharge pipe from a fixture, appliance or device drains indirectly into a receptor below the flood-level rim of the receptor.

Air gap, drainage system: The unobstructed vertical distance through free atmosphere between the outlet of a waste pipe and the flood-level rim of the fixture or receptor into which it is discharging.

Air gap, water-distribution system: The unobstructed vertical distance through free atmosphere between the lowest opening from a water supply discharge to the flood-level rim of a plumbing fixture.

Anchors: See "Supports."

Antisiphon: A term applied to valves or mechanical devices that eliminate siphonage.

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

Backflow, drainage: A reversal of flow in the drainage system.

Backflow preventer: A device or means to prevent backflow.

Backflow preventer, reduced-pressure-zone type: A backflow-prevention device consisting of two independently acting check valves, internally force loaded to a normally closed position and separated by an intermediate chamber (or zone) in which there is an automatic relief means of venting to atmosphere internally loaded to a normally open position between two tightly closing shutoff valves and with means for testing for tightness of the checks and opening of relief means.

Backflow, water distribution: The flow of water or other liquids into the potable water-supply piping from any sources other than its intended source. Back-siphonage is one type of backflow.

Back-siphonage: The flowing back of used or contaminated water from piping into a potable water-supply pipe due to a negative pressure in such pipe.

Backwater valve: A device installed in a drain or pipe to prevent backflow of sewage.

Ball cock: A valve that is used inside a gravity-type water closet flush tank to control the supply of water into the tank. It may also be called a flush-tank fill valve or water control.

Bend: A drainage fitting, designed to provide a change in direction of a drain pipe of less than the angle specified by the amount necessary to establish the desired slope of the line (see "Elbow" and "Sweep").

Branch: Any part of the piping system other than a riser, main or stack.

Branch, fixture: See "Fixture branch, drainage."

Branch, horizontal: See "Horizontal branch, drainage."

Branch interval: A distance along a soil or waste stack corresponding to a story height, but not less than 8 feet, within which the horizontal branches from one floor or story of a building are connected to the stack.

Branch main: A water-distribution pipe which extends horizontally off a main or riser to convey water to branches or fixture groups.

Branch vent: A vent connecting two or more individual vents with a vent stack or stack vent.

Building drain: That part of the lowest piping of a drainage system which receives the discharge from soil, waste and other drainage pipes inside the walls of the building and conveys it to the building sewer 10 feet outside the building wall.

Building sewer: that part of the horizontal piping of a drainage system which extends from the ends of the building drain and which receives the discharge of the building drain and conveys it to a public sewer, private sewer, individual sewage-disposal system or other part of disposal.

Cleanout: An accessible opening in the drainage system used for the removal of possible obstruction.

Common vent: A single pipe venting two trap arms within the same branch interval, either back-to-back or one above the other.

Continuous waste: A drain from two or more similar adjacent fixtures connected to a single trap.

Cross connection: Any connection between two otherwise separate piping systems whereby there may be a flow from one system to the other.

Dead end: A branch leading from a DWV system terminating at a developed length of 2 feet or more. Dead ends shall be prohibited except as an approved part of a rough-in for future connection.

Developed length: The length of a pipeline measured along the center line of the pipe and fittings.

Diameter: Unless specifically stated, the term "diameter" is the nominal diameter as designated by the approved material standard.

Drain: Any pipe which carries soil and water-borne wastes in a building drainage system.

Drainage fitting: A pipe fitting designed to provide connections in the drainage system which have provisions for establishing the desired slope in the system. These fittings are made from a variety of both metals and plastics. The methods of coupling provide for required slope in the system (see "Durham fitting").

Durham fitting: A special type of drainage fitting for use in the "Durham Systems" installations in which the joints are made with recessed and tapers screw fittings, as opposed to bell and spigot lead/okum or solvent/cemented or soldered joints. The tapping is at an angle (not 90 degrees) to provide for proper slope in otherwise rigid connections.

Durham system: A term used to describe soil or waste systems where all piping is of threaded pipe, tube or other such rigid construction using recessed drainage fittings to correspond to the types of piping.

DWV: Abbreviated term for drain, waste and vent piping as used in common plumbing practice.

Effective opening: The minimum cross-sectional area at the point of water-supply discharge, measured or expressed in terms of (1) diameter of a circle, (2) if the opening is not circular, the diameter of a circle of equivalent cross-sectional area. (This is applicable to air gap.)

Elbow: A pressure pipe fitting designed to provide an exact change in direction of a pipe run. An elbow provides a sharp turn in the flow path (see "Bend" and "Sweep").

Equivalent length: For determining friction losses in a piping system, the effect of a particular fitting equal to the friction loss through a straight piping length of the same nominal diameter. See Table No. E.1, Appendix E.

Existing work: Existing work is a plumbing system or any part thereof which has been installed prior to the effective date of this code.

Fixture: See "Plumbing fixture."

Fixture branch, drainage: A drain serving one or more fixtures which discharges into another portion of the drainage system.

Fixture branch, water-supply: A water-supply pipe between the fixture supply and a main water-distribution pipe or fixture group main.

Fixture drain: The drain from the trap of a fixture to the junction of that drain with any other drain pipe.

Fixture fitting: Any device to control or guide the flow of water into or convey water from fixtures.

Fixture group main: The main water-distribution pipe (or secondary branch) serving a plumbing fixture grouping such as a bath, kitchen or laundry area to which two or more individual fixture branch pipes are connected.

Fixture supply: The water-supply pipe connecting a fixture or fixture fitting to a fixture branch.

Fixture unit, drainage (d.f.u.): A measure of probable discharge into the drainage system by various types of plumbing fixtures, used to size DWV piping systems. The drainage fixture-unit value for a particular fixture depends on its volume rate of drainage discharge, on the time duration of a single drainage operation, and on the average time between successive operations. See Table No. P-2205.

Fixture unit, water-supply (w.s.f.u.): A measure of the probable hydraulic demand on the water supply by various types of plumbing fixtures, used to size water-piping systems. The water-supply fixture-unit value for a particular fixture depends on its volume rate of supply, on the time duration of a single supply operation, and on the average time between successive operations. See Table No. P-2406.2.

Flood-level rim: The edge of the receptor or fixture from which water overflows.

Floor drain: A plumbing fixture for recess in the floor having a floor-level strainer intended for the purpose of the collection and disposal of waste water used in cleaning the floor and for the collection and disposal of accidental spillage to the floor.

Flow pressure: The static pressure reading in the water-supply pipe near the faucet or water outlet while the faucet or water outlet is open and flowing at capacity.

Flushometer tank: A device integrated within an air accumulator vessel which is designed to discharge a predetermined quantity of water to fixtures for flushing purposes.

Flushometer valve: A flushometer valve is a device which discharges a predetermined quantity of water to fixtures for flushing purposes and is actuated by direct water pressure.

Flush valve: A device located at the bottom of a flush tank that is operated to flush water closets.

Fullway valve: A valve that in the full open position has an opening cross-sectional area equal to a minimum of 85 percent of the cross-sectional area of the connecting pipe.

Grade, piping: See "Slope."

Hangers: See "Supports."

Horizontal branch, drainage: A drain pipe extending laterally from a soil or waste stack or building drain, which receives the discharge from one or more fixture drains.

Horizontal pipe: Any pipe or fitting which makes an angle of less than 45 degrees with the horizontal.

Hot water: Water that is supplied to plumbing fixtures and appliances at a temperature between 120 degrees F. and 140 degrees F.

Indirect waste pipe: A waste pipe which discharges into the drainage system through an air gap into a trap, fixture or receptor.

Individual sewage disposal system: A system for disposal of sewage by means of a septic tank or mechanical treatment, designed for use apart from a public sewer to serve a single establishment or building.

Individual vent: A pipe installed to vent a single-fixture drain that connects with the vent system above or terminates independently outside the building.

Individual water supply: A supply other than an approved public water supply which serves one or more families.

Main: The principal pipe artery to which branches may be connected.

Main sewer: See "Public sewer."

Manifold water distribution systems: A fabricated piping arrangement in which a large supply main is fitted with multiple branches in close proximity in which water is distributed separately to fixtures from each branch.

Offset: A combination of fittings which makes two changes in direction bringing one section of the pipe out of line but into a line parallel with the other section.

Pitch: See "Slope."

Plumbing: For the purpose of this code, plumbing refers to those installations, repairs, maintenance and alterations regulated by this part.

Plumbing appliance: An energized household appliance with plumbing connections, such as a dishwasher, food-waste grinder, clothes washer or water heater.

Plumbing appurtenance: A device or assembly which is an adjunct to the basic plumbing system and demands no additional water supply nor adds any discharge load to the system. It is presumed that it performs some useful function in the operation, maintenance, servicing, economy or safety of the plumbing system. Examples include filters, relief valves and aerators.

Plumbing fixture: A receptor or device which requires both a water-supply connection and a discharge to the drainage system, such as water closets, lavatories, bathtubs and sinks. Plumbing appliances as a special class of fixture are further defined.

Plumbing system: Includes the water supply and distribution pipes, plumbing fixtures, supports and appurtenances; soil, waste and vent pipes; sanitary drains and building sewers to an approved point of disposal.

Potable water: Water that is safe to drink.

Pressure-relief valve: A pressure-actuated valve held closed by a spring or other means and designed to automatically relieve pressure at the pressure at which it is set.

Public sewer: A common sewer directly controlled by public authority.

Public water main: A water-supply pipe for public use controlled by public authority.

Quick-closing valve: A valve or faucet that closes automatically when released manually or controlled by mechanical means for fast-action closing.

Receptor: A fixture or device which receives the discharge from indirect waste pipes.

Relief valve, pressure: A safety device that automatically releases water from a supply system due to an excess build-up of pressure.

Relief valve, vacuum: A device to prevent excessive build-up of vacuum in a pressure vessel.

Riser: A water pipe which extends vertically one full story or more to convey water to branches or to a group of fixtures.

Rough-in: The installation of all parts of the plumbing system which must be completed prior to the installation of fixtures. This includes DWV, water supply and built-in fixture supports.

Sanitary sewer: A sewer which carries sewage and excludes storm, surface and groundwater.

Septic tank: A water-tight receptor which receives the discharge of a building sanitary drainage system and is constructed so as to separate solids from the liquid, digest organic matter through a period of detention, and allow the liquids to discharge into the soil outside of the tank through a system of open joint or perforated piping or a seepage pit.

Sewage: Any liquid waste containing animal matter, vegetable matter or other impurity in suspension or solution.

Sewage pump: A permanently installed mechanical device for removing sewage or liquid waste from a sump.

Shall: The term, when used in the code, is construed as mandatory.

Side vent: A vent connecting to the drain pipe through a fitting at an angle less than 45 degrees to the horizontal.

Slip joint: A mechanical-type joint used primarily on fixture traps. The joint tightness is obtained by compressing a friction-type washer such as

rubber, nylon, neoprene, lead or special packing material against the pipe by the tightening of a (slip) nut.

Slope (also fall, grade, pitch): The fall of a line of pipe in reference to a horizontal plane. In plumbing, it is expressed as the fall in a fraction of an inch per length of pipe.

Soil stack (or pipe): A pipe which conveys sewage containing fecal material.

Stack: Any main vertical DWV line, including offsets, that extends one or more stories as directly as possible to its vent terminal.

Stack vent: The extension of soil or waste stack above the highest horizontal drain connected.

Stack venting: A method of venting a fixture or fixtures through the soil or waste stack without individual fixture vents.

Storm sewer (drain): A pipe used for conveying rainwater, surface water, condensate, cooling water or similar liquid wastes.

Sump: A tank or pit which receives sewage or waste, located below the normal grade of the gravity system and which must be emptied by mechanical means.

Sump pump: A pump installed to empty a sump. The pump is chosen to handle the type material to be pumped — either clear water waste or soil-type sewage. The pump is selected for the specific head and volume of the load and is usually operated by level controllers.

Supports: Devices for supporting, hanging and securing pipes, fixtures and equipment.

Sweep: A drainage fitting designed to provide a change in direction of a drain pipe of less than the angle specified by the amount necessary to establish the desired slope of the line. Sweeps provide a longer turning radius than bends and a less turbulent flow pattern (see "Bend" and "Elbow").

Temperature- and pressure-relief (T and P) valve: A combination relief valve designed to function as both a temperature-relief and pressure-relief valve.

Temperature-relief valve: A temperature-actuated valve designed to automatically discharge at the temperature at which it is set.

Trap: A fitting, either separate or built into a fixture, which provides a liquid seal to prevent the emission of sewer gases without materially affecting the flow of sewage or waste water through it.

Trap arm: That portion of a fixture drain between a trap weir and the vent fitting.

Trap primer: A device or system of piping to maintain a water seal in a trap, typically installed where infrequent use of the trap would result in evaporation of the trap seal, such as floor drains.

Trap seal: The trap seal is the maximum vertical depth of liquid that a trap will retain, measured between the crown weir and the top of the dip of the trap.

Vacuum breakers: A device which prevents back-siphonage of water by admitting atmospheric pressure through ports to the discharge side of the device.

Vent stack: A vertical vent pipe installed to provide circulation of air to and from the drainage system and which extends through one or more stories.

Vent system: Piping installed to equalize pneumatic pressure in a drainage system to prevent trap seal loss or blow-back due to siphonage or back pressure.

Vertical pipe: Any pipe or fitting which makes an angle of 45 degrees or more with the horizontal.

Waste: Liquid-borne waste free of fecal matter.

Waste pipe (or stack): Piping which conveys only liquid sewage not containing fecal material.

Water-distribution system: Piping which conveys water from the service to the plumbing fixtures, appliances, appurtenances, equipment, devices or other systems served, including fittings and control valves.

Water heater: A closed vessel in which water is heated by the combustion of fuels, electricity or any other source and is withdrawn for use external to the vessel at pressures not exceeding 160 psig, including the apparatus by which heat is generated, and all controls and devices necessary to prevent water temperatures from exceeding 210 degrees F. Note that Section P-2403.2 limits the maximum average static pressure of the water distribution system to 80 psig.

Water main: A water-supply pipe for public use.

Water outlet: A valved discharge opening, including a hose bibb, through which water is removed from the potable water system supplying water to a plumbing fixture or plumbing appliance which requires either an air gap or backflow prevention device for protection of the supply system.

Water-service pipe: the 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 21
PLUMBING MATERIALS

SECTION P-2101 — ABOVE GROUND WATER DISTRIBUTION PIPING

Materials for water-distribution pipes and tubing shall be brass, copper water tube minimum Type M, cast-iron pressure pipe, galvanized steel, chlorinated polyvinyl chloride (CPVC) or polybutylene (PB) plastic pipe or tubing, all to be installed with approved fittings. The minimum pressure rating for plastic pipe or tubing shall be 100 psi at 180 degrees F.

SECTION P-2102 — MATERIALS EVALUATION AND LISTING

All plastic pipes, plastic plumbing pipe components and related plastic materials shall be evaluated and listed as conforming to ANSI/NSF Standard 14, listed in Section S-26.2001, by and approved agency. The approved agent shall maintain periodic evaluations of production of listed products or materials, and their listing shall state that the products or materials meet ANSI/NSF Standard 14.

Chapter 22
PLUMBING, DRAINAGE, WASTE AND VENT SYSTEMS (DWV)

SECTION P-2201 – GENERAL

Plumbing materials shall conform to the requirements of this chapter. The drainage waste and vent (DWV) system shall consist of all piping for conveying wastes from plumbing fixtures, appliances and appurtenances, including fixture traps; above-grade drainage piping; below-grade drains within the building (building drain); below- and above-grade venting systems; and piping to the public sewer or private septic system. No portion of the above-grade DWV system other than vent terminals shall be located outdoors, except in those localities having minimum design temperatures above 32 degrees F. (ASHRAE 97.5 percent column, winter, see Appendix A).

SECTION P-2202 – MATERIALS

P-2202.1 Piping within buildings: Drain, waste and vent (DWV) piping in buildings shall be as shown in Table P-2202.1 or other approved materials having a smooth and uniform bore, except that no galvanized wrought-iron or galvanized steel pipe shall be used underground and shall be kept at least 6 inches above ground. *

P-2202.2 Building sewer: Building sewer piping shall be as shown in Table P-2202.2.

P-2202.3 Fittings: Fittings shall be approved and compatible with the type of piping being used and shall be of a sanitary or DWV design for drainage and wet venting. Waterpipe fittings may be accepted for use in engineer designed systems when the design indicates compliance with Section P-2207.2.1.

Drainage fittings shall have a smooth interior waterway of the same diameter as the piping served. All fittings shall conform to the type of pipe used.

Drainage fittings shall have no ledges, shoulders or reductions which can retard or obstruct drainage flow in the piping. Threaded drainage pipe fittings retard or obstruct drainage flow in the piping. Threaded drainage pipe fittings shall be of the recessed drainage type, black or galvanized.

Drainage fittings shall be designed to maintain 1/4-inch-per-foot grade.

P-2202.4 Other Materials

P-2202.4.1 Sheet lead: Sheet lead for the following uses shall weigh not less than indicated below:

1. Shower pans, 4 psf.
2. Flashing of vent terminals, 3 psf.
3. Prefabricated flashing for vent pipes, 2 1/2 psf.

P-2202.4.2 lead bends and traps: Lead bends and lead traps shall be not less than 1/8-inch wall thickness.

P-2202.4.3 Sheet copper: Sheet copper for the following uses shall weigh not less than indicated below:

1. General use, 12 oz per sq ft.
2. Flashing for vent pipes, 8 oz per sq ft.
3. Flush tank linings, 10 oz per sq ft.

Table No. P-2202.1
DRAIN, WASTE AND VENT PIPING AND FITTING MATERIALS[1]
(As listed in Section S-26.2001)

MATERIAL	STANDARD NO.
Welded and Seamless Steel Pipe (black or galvanized1)	ASTM A53-88a
Cast Iron Soil Pipe and Fittings (hub and spigot)	ASTM A74-87
Cast Iron Fittings (Threaded)	ASTM A126-84
Malleable Iron Fittings (Threaded)	ASTM A197-87
Seamless Copper Pipe, standard sizes	ASTM B42-89
Seamless Red Brass Pipe, standard sizes	ASTM B43-88
Seamless Copper Tube	ASTM B75-86
Seamless Copper Water Tube Type K, L, and M	ASTM B88-88a
ABS-DWV Pipe and Fittings	ASTM D2661-87a
PVC-DWV Pipe and Fittings	ASTM D2665-89a
ABS Sewer Pipe and Fittings	ASTM D2751-83a
Thermo-Plastic Accessible and Replaceable Plastic Tube and Fittings	ASTM F409-88
ABS-DWV SCH. 40 Pipe with Cellular Core	ASTM F628-88
Co-extruded PVC Plastic Pipe with Cellular Core	ASTM F891-88a
Cast Iron Soil Pipe and Fittings (hub and spigot)	CISPI HS74-86
Cast Iron Soil Pipe and Fittings (hubless)	CISPI 301-85
Cast Copper Alloy Solder-Joint Drainage Fittings	ASTM B16.23-84
Copper Drainage Tube (DWV)	ASTM B306-88
Mechanical Couplings for Drain, Waste and Vent Pipe and Sewer Pipe	CSA B602M-90

[1]Section P-2001.1 provides for use of other approved materials in accordance with Section R-108.

Table No. P-2202.2
BUILDING SEWER PIPING[1]
(As listed in Section S-26.2001)

MATERIAL	STANDARD NO.
Cast Iron Pipe and Fittings	ASTM A74-87
Cast Iron Pipe and Fittings	CISPI HS74-86
Cast Iron Soil Pipe and Fittings for Hubless Sanitary System	CISPI 301-85
Seamless Copper Tube	ASTM B75-88
Copper Water Tube	ASTM B88-88a
Concrete Sewer, Storm Drain and Culvert Pipe	ASTM C14-88
Compression Joints for Vitrified Clay Pipe and Fittings	ASTM C425-88
Vitrified Clay Pipe and Fittings	ASTM C700-88
Bituminized Fiber Drain and Sewer Pipe	ASTM D1861-88
Recommended Practice for Underground Installation of Flexible Thermoplastic Sewer Pipe	ASTM D2321-83a
ABS-DWV Pipe and Fittings	ASTM D2661-87a
3.25 G.D. PVC/DWV Pipe and Fittings	ASTM D2949-89
PVC/DWV Pipe and Fittings	ASTM D2665-89a
ABS Sewer Pipe and Fittings	ASTM D2751-83a
Type PSM PVC Sewer Pipe and Fittings	ASTM D3034-89
Joints for Drain and Sewer Plastic Pipe Using Flexible Elastomeric Seals	ASTM D3212-89
ABS Schedule 40 DWV Pipe with Cellular	ASTM F628-88
Co-extruded PVC Schedule 40, PS 50 or PS 100 Plastic Pipe with Cellular	ASTM F891-88a
Copper Drainage Tube (DWV)	ASTM B306-88
Mechanical Couplings for Drain Waste and Vent Pipe and Sewer Pipe	CSA B602m-90

[1]Section P-2001.1 provides for use of other approved materials in accordance with Section R-108.

SECTION P-2203 – JOINTS AND CONNECTIONS

P-2203.1 Tightness: Joints and connections in the DWV system shall be gas-tight and water-tight for the intended use or pressure required by test.

P-2203.2 Prohibited joints: In new construction, no running threads, bands or saddles shall be used in the drainage system. No drainage or vent piping shall be drilled, tapped, burned or welded.

Exception: This requirement may be waived in remodeling where no practical alternative exists.

P-2203.3 Joint requirements, similar piping materials

P-2203.3.1 Cast-iron pipe, caulked joints: Lead-caulked joints for cast-iron hub and spigot soil pipe shall be firmly packed with oakum and filled with molten lead not less than 1 inch deep and shall not extend more than 1/8 inch below the rim of the hub. Lead shall be run in one pouring and shall be caulked tight.

P-2203.3.2 Cast-iron pipe, mechanical joints

P-2203.3.2.1 Hubless pipe: Joints for hubless cast-iron soil pipe shall be made with an approved elastomeric sealing sleeve and stainless steel retaining sleeve.

P-2203.3.2.2 Hub and spigot joints: An approved positive-seal one-piece elastomeric compression-type gasket that is placed in the hub before the spigot is inserted may be used for joining hub and spigot cast-iron soil piping and fittings as an alternate for lead and oakum joints.

P-2203.3.3 Threaded pipe joints: Threaded joints shall conform to American National Taper Pipe Thread. Pipe ends shall be reamed or filed to size and all chips removed.

P-2203.3.4 Soldered joints: Soldered joints in tubing shall be made with fittings approved for DWV piping. Surfaces to be soldered shall be cleaned bright. The joints shall be properly fluxed and made with approved solder.

P-2203.3.5 Clay or cement soil pipe joints: Joints in clay or cement piping shall be made using flexible compression joints, elastomeric rings, preformed bituminous rings, elastomeric couplings, oakum and cement or other approved methods.

P-2203.3.6 Plastic pipe joints: Joints in plastic piping shall be made with approved fittings by solvent cementing, elastomeric gaskets or other approved manufactured system.

P-2203.3.7 Slip joints: Slip joints shall be made using approved gaskets or compression washers. Ground joint connections which allow adjustment of tubing but provide a rigid joint when made up shall not be considered as slip joints. Where a ground joint connection is used and the assembled joint does not permit free movement, the joint need not be accessible.

P-2203.4 Joints between different piping materials

P-2203.4.1 Hub-type cast-iron or vitrified clay to other piping materials: Joints between hub-type drainage piping and other materials, including steel, plastic and copper, may be made with a lead and oakum joint and an approved caulking ferrule of the other material or by a lead and oakum joint directly with the other material omitting the adapter ferrule. Where the outside diameter of the other material matches that of the hub pipe, an elastomeric gasket designed for use with the hub pipe may be used.

P-2203.4.2 Hubless pipe to other hubless piping materials: Joints between hubless drainage piping of any dissimilar materials with similar outside diameters may be made with elastomeric sleeve and stainless steel clamp.

P-2203.4.3 Threaded pipe to cast-iron soil pipe: Joints between threaded pipe and cast-iron soil pipe shall be made with approved adapter fittings.

P-2203.4.4 Threaded pipe to copper or plastic pipe: Joints from threaded pipe to copper or plastic piping shall be as approved by the administrative authority.

P-2203.4.5 Joints between drainage piping and water closets: Joints between drainage piping and water closets or similar fixtures shall be made by means of a closet flange compatible with the drainage system material, securely fastened to a structurally firm base. The inside diameter of the drainage pipe shall not be used as a socket fitting for a 4 x 3 closet flange, unless the closet flange is designed and

approved for such application. The joint shall be bolted, with an approved gasket or setting compound between the fixture and the closet flange.

P-2203.4.6 Flexible adapter fittings: Where a dry vent size is smaller than the drain to which it connects, the reduction may be accomplished by means of an approved elastomeric flexible adapter fitting.

SECTION P-2204 TRENCHING AND BACKFILLING

P-2204.1 Trenching and bedding: Piping shall be installed in trenches so that it rests on solid and continuous bearing. Where overexcavated, the trench shall be backfilled to the proper grade with compacted earth, sand, fine gravel or similar granular material. Piping may not be supported on rocks or blocks at any point. Rocky or unstable soil shall be overexcavated by two or more pipe diameters and brought to the proper grade with suitable compacted granular material.

P-2204.2 Common trench: See Section P-2403.5.1.

P-2204.3 Backfilling: Care shall be exercised in backfilling trenches to avoid rocks, broken concrete, frozen chunks and other rubble until the pipe is covered by at least 12 inches of tamped earth. Backfill shall be placed evenly on both sides of the pipe and tamped to retain proper alignment. Loose earth shall be carefully placed in the trench in 6-inch layers and tamped in place. On private property, puddling of deep trenches is a satisfactory alternate means of obtaining compaction once the pipe has been properly laid, backfilled and tamped to a point 6 inches above the pipe.

P-2204.4 Protection of footings: Trenching installed parallel to footings shall not extend below the 45-degree bearing plane of the bottom edge of a wall or footing.

SECTION P-2205 – DETERMINING DRAINAGE FIXTURE UNITS

The load on DWV-system piping shall be computed in terms of drainage fixture unit (d.f.u.) values in accordance with Table No. P-2205.

Table No. P-2205
DRAINAGE FIXTURE UNIT (d.f.u.) VALUES
FOR VARIOUS PLUMBING FIXTURES

TYPE OF FIXTURE OR GROUP OF FIXTURES	DRAINAGE FIXTURE UNIT VALUE (d.f.u.)[1]
Bar sink	1
Bathtub (with or without shower head and/or whirlpool attachments)	2
Bidet	1
Clothes washer standpipe	2
Dishwasher	2
Floor drain	0[2]
Kitchen sink	2
Lavatory	1
Laundry tub	2
Shower stall	2
Water closet (tank type)	4
Water closet (flushometer tank)	4
Full-bath group with bathtub (with or without shower head and/or whirlpool attachment on the bathtub or shower stall)	6
Half-bath group (water closet plus lavatory)	5
Kitchen group (dishwasher and sink with or without garbage grinder)	3
Lavatory group (clothes washer standpipe and laundry tub)	3
Multiple-bath groups[3]:	
1 1/2 baths	7
2 baths	8
2 1/2 baths	9
3 baths	10
3 1/2 baths	11

[1] For a continuous or semicontinuous flow into a drainage system, such as from a pump or similar device, 1.5 fixture units shall be allowed per gpm of flow. For a fixture not listed, use the highest d.f.u. value for a similar listed fixture.

[2] A floor drain itself adds no hydraulic load. However, used as a receptor, the fixture unit value of the fixture discharging into the receptor shall be applicable.

[3] Add 2 d.f.u. for each additional full bath.

SECTION P-2206 – DRAINAGE SYSTEM

P-2206.1 Drainage fittings and connections: Changes in direction in drainage piping shall be made by the appropriate use of sanitary tees, wyes, elbows, sweeps, 1/4 or 1/8 bends or by a combination of these or equivalent approved drainage fittings.

P-2206.1.1 Horizontal to vertical (single connection): Horizontal drainage lines connecting with a vertical stack shall enter through a wye, tee-wye, bend, sweep, sanitary tee or other approved fitting. Short-pattern fittings or a sanitary tapped tee shall be an acceptable connection for branch lines serving one fixture.

P-2206.1.2 Horizontal to vertical (multiple connection): DELETED.

P-2206.1.3 Horizontal to horizontal: Horizontal drainage lines connecting with other horizontal drainage lines shall enter through 1/8 bends, sweeps, wyes, tee-wyes or equivalent long-pattern or combination fittings.

P-2206.1.4 Vertical to horizontal: Vertical drainage lines connecting with horizontal drainage lines shall enter through 1/8 bends, sweeps, wyes, tee-wyes or other approved fittings of equivalent sweep.

P-2206.1.5 Heel- or side-inlet 1/4 bends, drainage: Heel-inlet 1/4 bends shall be an acceptable means of connection, except where the 1/4 bends serves a water closet a low-heel inlet shall not be used as a dry-vented connection. Side-inlet 1/4 bends shall be an acceptable means of connection for both drainage, wet-venting and stack-venting arrangements.

P-2206.1.6 Heel- or side-inlet 1/4 bends, venting: A heel-inlet or side-inlet 1/4 bends, or any arrangement of pipe and fittings producing a similar effect, shall be acceptable as a dry vent when the inlet is placed in a vertical position. The inlet may be placed in a horizontal position only where the entire fitting is part of a wet vent arrangement.

P-2206.1.7 Water closet connection between flange and pipe: A 3-inch 1/4 bends or bend shall be acceptable for water closet or similar connections, provided a 4-inch by 3-inch flange is installed to receive the closet fixture horn. Alternately, a 3-inch by 4-inch 1/4 bend shall be acceptable with a 4-inch flange.

P-2206.1.8 Dead ends: Dead ends shall be prohibited except where necessary to extend a cleanout or as an approved part of a rough-in of 2 feet or more.

P-2206.2 Drainage pipe cleanouts

P-2206.2.1 Materials: Cleanouts shall conform to standards acceptable to the administrative authority. Plugs shall be brass, approved plastic or equivalent.

P-2206.2.2 Spacing: Cleanouts shall be installed not more than 75 feet apart in horizontal drainage lines of 4-inch nominal diameter or less.

P-2206.2.3 Underground drainage cleanouts: When installed in underground drains, cleanouts shall be extended vertically to or above finished grade either inside or outside the building.

P-2206.2.4 Change of direction: Cleanouts shall be installed at each change in direction of the drainage system greater than 45 degrees.

Exception: One cleanout shall be required for every three 45 degree changes located in series (a long sweep is equivalent to two 45 degree bends).

P-2206.2.5 Accessibility: Cleanouts shall be accessible. Minimum clearance in front of cleanouts shall be 18 inches on 3-inch and larger pipes, and 12 inches on smaller pipes. Concealed cleanouts shall be provided with access of sufficient size to permit removal of the cleanout plug and rodding of the system. Cleanout plugs shall not be concealed with any permanent finishing material.

P-2206.2.6 Base of stacks: Accessible cleanouts shall be provided near the base of each vertical waste or soil stack. Alternatively, such cleanouts may be installed outside the building within 3 feet of the building wall.

P-2206.2.7 Building drain and building sewer junction: There shall be a cleanout near the junction of the building drain and building sewer. This cleanout may be either inside or outside the building wall, provided it is brought up to finish grade or to the lowest floor level. An accessible interior building drain cleanout, test tee or equivalent within close proximity to the building drain exit point shall fulfill this requirement.

P-2206.2.8 Direction of flow: Cleanouts shall be installed so that the cleanout opens in the direction of the flow of the drainage line.

P-2206.2.9 Cleanout size: Cleanouts shall be of the same nominal size as the pipe up to 4 inches and not less than 4 inches for larger piping.

P-2206.2.10 Cleanout equivalent: A fixture trap or a fixture with integral trap, readily removable without disturbing concealed piping shall be acceptable as a cleanout equivalent.

P-2206.2.11 Connections to cleanouts prohibited: Cleanout openings shall not be used for the installation of new fixtures or floor drains except where approved by the administrative authority and where an acceptable alternate cleanout is provided.

P-2206.3 Horizontal drainage piping slope: Horizontal drainage piping shall be installed in uniform alignment at uniform slopes not less than 1/4 inch per foot for 2 1/2-inch diameter and less, and not less than 1/8 inch per foot for diameters of 3 inches or more.

P-2206.4 Drain pipe sizing: Drain pipes shall be sized according to drainage fixture unit (d.f.u.) loads. The following general procedure may be used:

1. Draw an isometric layout or riser diagram denoting fixtures on the layout.
2. Assign d.f.u. values to each fixture group plus individual fixtures using Table No. P-2205.
3. Starting with the top floor or most remote fixtures, work downstream toward the building drain accumulating d.f.u. values for fixture groups plus individual fixtures for each branch. Where multiple bath groups are being added, use the reduced

d.f.u. values in Table No. P-2205, which take into account probability factors of simultaneous use.

4. Size branches and stacks by equating the assigned d.f.u. values to pipe sizes shown in Table No. P-2206.4.1.
5. Determine the pipe diameter and slope of the building drain and building sewer based upon the accumulated d.f.u. values, using Table No. P-2206.4.2.

P-2206.4.1 Fixture branch and stack sizing:

1. Branches and stacks shall be sized according to Table No. P-2206.4.1. Below-grade drain pipes shall not be less than 2 inches in diameter.
2. Minimum Stack Size. No drain stack shall be smaller than the largest horizontal branch connected.

*

Table No. P-2206.4.1
MAXIMUM FIXTURE UNITS THAT MAY BE CONNECTED TO BRANCHES AND STACKS

NOMINAL PIPE SIZE (Inches)	ANY HORIZONTAL FIXTURE BRANCH	ANY ONE VERTICAL STACK OR DRAIN
1 1/4[1]	—	—
1 1/2[2]	3	4
2[2]	6	10
2 1/2[2]	12	20
3	20[3]	48[4]
4	160	240

[1]1 1/4-inch pipe size limited to a single-fixture drain or trap arm. See Table No. P-2206.6.7.
[2]No water closets
[3]Maximum three water closets.
[4]Maximum six water closets.

P-2206.4.2 Building drain and sewer size and slope: Pipe sizes shall be determined from Table No. P-2206.4.2 on the basis of drainage load in fixture units (d.f.u.) computed from Table No. P-2205.

Table No. P-2206.4.2
MAXIMUM NUMBER OF FIXTURE UNITS THAT MAY BE CONNECTED TO THE BUILDING DRAIN, BUILDING DRAIN BRANCHES OR THE BUILDING SEWER[4]

DIAMETER OF PIPE (Inches)	SLOPE PER FOOT		
	1/8 Inch	1/4 Inch	1/2 Inch
1 1/2[1,2]	—	–[1]	–[1]
2[2]	–	21	27
2 1/2[2]	–	24	31
3[3]	20	42	50
4	180	216	250

[1]1 1/2-inch pipe size limited to a building drain branch serving not more than two waste fixtures, or not more than one waste fixture if serving a pumped discharge fixture or garbage grinder discharge.

[2]No water closets.

[3]Not over three water closets.

[4]Minimum size of building sewer shall be 4 inches.

P-2206.4.3 Provision for future fixtures: When a rough-in is provided for the installation of future fixtures, those provided for shall be included when determining the required sizes of drain and vent pipes. Such future installations shall be terminated with accessible plugged fittings.

P-2206.5 DELETED

P-2206.6 Fixture traps

P-2206.6.1 Design of traps: Traps shall be of standard design, shall have smooth uniform internal waterways, shall be self-cleaning and shall have no interior partitions except where integral with the fixture. They shall be of lead, cast iron, cast or drawn brass, approved plastic or other approved materials. Tubular brass traps shall be not less than No. 20 gauge thickness. Solid connections, slip joints or couplings may be used on the trap inlet, trap outlet, or within the trap seal. Slip joints shall be accessible.

P-2206.6.2 Trap seals: Traps shall have a liquid seal of not less than 2 inches and not more than 4 inches, unless otherwise approved. Traps that could lose their seal due to evaporation because of infrequent use, such as floor drains, may be fitted with a trap primer.

P-2206.6.3 Trap setting and protection: Traps shall be set level with respect to their water seals and shall be protected from freezing. Trap seals shall be protected from siphonage, aspiration or back pressure by an approved system of venting (see Section P-2207).

P-2206.6.4 Building traps: Building traps shall not be installed, except in special cases where sewer gases are extremely corrosive or noxious, as directed by the administrative authority.

P-2206.6.5 Prohibited trap designs: The following types of traps are prohibited:

1. Bell traps.
2. Separate fixture traps with interior partitions.
3. "S" traps.
4. Drum traps.
5. Trap designs with moving parts.

P-2206.6.6 Number of fixtures per trap: Each plumbing fixture shall be separately trapped by a water seal trap placed as close as possible to the fixture outlet, except as otherwise permitted. The vertical distance from the fixture outlet to the trap weir shall not exceed 24 inches. No fixture shall be double trapped. Exceptions to the separate trapping requirements are as follows:

1. Fixtures that have integral traps.
2. One trap may be installed for two or three drains from kitchen sinks, laundry tubs or lavatories adjacent to each other and located in the same room with a continuous waste arrangement. The trap shall be installed at the center fixture when three such fixtures are installed. Common trapped fixture outlets shall not be more than 30 inches apart.
3. No clothes washer or laundry tub shall be discharged to a trap serving a kitchen sink.

4. The connection of a laundry tray waste line may be made into a standpipe for the automatic clothes-washer drain. Standpipes shall be 2 inches in diameter and not be less than 18 inches nor more than 48 inches as measured from the crown weir. The standpipe shall extend 34 inches minimum above base of clothes washer unless recommended otherwise by manufacturer. The outlet of the laundry tray shall be a maximum horizontal distance of 30 inches from the standpipe trap.

P-2206.6.7 Size of fixture traps: Fixture trap size (nominal diameter) shall be sufficient to drain the fixture rapidly and in no case less than given in Table No. P-2206.6.7. No trap, including integral traps, shall be larger than the drainage pipe into which it discharges.

Table No. P-2206.6.7
SIZE OF TRAPS AND TRAP ARMS FOR PLUMBING FIXTURES

PLUMBING FIXTURE	TRAP SIZE MINIMUM (Inches)
Bathtub (with or without shower head and/or whirlpool attachments)	1 1/2
Bidet	1 1/2
Clothes washer standpipe	2
Dishwasher (on separate trap)	1 1/4
Floor drain	2
Kitchen sink (one or two traps, with or without dishwasher and garbage grinder)	1 1/2
Laundry tub (one or more compartments)	1 1/2
Lavatory	1 1/4
Shower	2
Water closet	*

*Consult fixture standards for trap dimensions of specific bowls.

P-2206.7 Trap arms

P-2206.7.1 Maximum length of trap arm: Each fixture trap shall have a protecting vent so located that the maximum developed length of the trap arm is within the requirements of Table No. P-2206.7.1. Minimum trap arm length shall be two pipe diameters (see Section P-2207.2.5).

Table No. P-2206.7.1
MAXIMUM LENGTH OF TRAP ARM

Size of Fixture Drain	Size of Trap	Fall per Foot	Max. Distance From Trap
1 1/4"	1 1/4"	1/4"	3'6"
1 1/2"	1 1/4"	1/4"	5'
1 1/2"	1 1/2"	1/4"	5'
2"	1 1/2"	1/4"	8'
2"	2"	1/4"	6'
3"	3"	1/8"	10'
4"	4"	1/8"	12'

P-2206.7.2 Allowable fall in trap arm: The total fall in trap arm due to pipe slope shall not exceed one pipe diameter, nor shall the vent pipe connection to a fixture drain, except for water closets and similar fixtures, be below the weir of the trap, except as provided in Section P-2206.7.3.

P-2206.7.3 DELETED

P-2206.8 Sumps and ejectors

P-2206.8.1 Sewage ejectors or sewage pumps: A sewage ejector or sewage pump receiving discharge of water closets shall have a minimum discharge capacity of 20 gallons per minute. The ejector or pump shall be capable of passing a 1-1/2-inch-diameter solid ball, and the discharge piping of each ejector or pump shall have a check valve & gate valve and be a minimum of 2 inches.

P-2206.8.2 Building drains below sewer (building subdrains): Building drains which cannot be discharged to the sewer by gravity flow shall be discharged into a tightly covered and vented sump from which the contents shall be lifted and discharged into the building gravity drainage system by automatic pumping equipment or by an equally effective method approved by the administrative authority.

The system of drainage piping below the sewer level shall be installed and vented in a manner similar to that of the gravity system. Only such drains that must be lifted for discharge shall be discharged into sumps. All other drains shall be discharged by gravity.

P-2206.9 Backwater valves: When required, a readily accessible backwater valve shall be installed only in branches of the drainage system subject to backflow of sewage. Drainage piping serving fixtures which have flood level rims located below the elevation of the next upstream manhole cover of the public sewer serving such drainage piping shall be protected from backflow of sewage by installing an approved-type backwater valve. Fixtures above such elevation shall not discharge through the backwater valve.

Backwater valves shall have noncorrosive bearings, seats and self-aligning discs, and shall be so constructed as to ensure a positive mechanical seal. Valve access covers shall be bolted type with gasket unless otherwise approved.

P-2206.10 Existing building sewers and drains: Existing building sewers and drains may be used in connection with new systems when found by examination and/or test to conform to the requirements prescribed by this document.

P-2206.11 New Building Sewers and Drains

P-2206.11.1 Mandatory connection to public sewer: A permit shall not be issued for the installation, alteration or repair of a private sewage disposal system or part thereof where a connection with a public sewer is available. "Available" shall be deemed to be a parcel of land abutting on a street, alley or easement.

P-2206.11.2 Mandatory connection to a sewage system: Plumbing fixtures and drainage piping shall be connected to a public sewer or an approved private or individual sewage disposal system.

Building sewers shall conform to the requirements of this chapter and other related requirements of this code.

P-2206.11.3 Prohibited connections: Rain, surface or subsurface water shall not be connected to or discharge into a drainage system, sanitar;y sewer system or individual sewage disposal system.

Cesspools, septic tanks, seepage pits and drain fields shall not be connected to public sewers or to building sewers leading to public sewers.

P-2206.11.4 Required size: The size of building sewer shall be determined in accordance with Table No. P-2206.4.2.

P-2206.11.5 Installation: Building sewers shall be installed at a uniform slope of not less than 1/4 inch per foot and may be reduced to 1/8 inch per foot in accordance with Section P-2206.4.2. Cleanouts shall be placed near the junction of the building drain and building sewer and at intervals not to exceed 75 feet in straight runs.

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SECTION P-2207 – VENT SYSTEMS

P-2207.1 General: The protection of trap seals from siphonage, aspiration or back pressure shall be accomplished by venting systems designed and installed so that at no time shall trap seals be subjected to a pneumatic pressure differential of more than 1 inch of water column under design load conditions.

P-2207.1.1 Required drain and vent stack: Buildings shall have at least one soil stack running from the building drain up through the building, with the stack vent terminating outdoors above the topmost branch interval per Section P-2207.6. Additional branches may be served by air admittance valves installed in accordance with Sections P-2207.5. Valves shall be sized according to Section P-2207.12.

P-2207.1.2 Minimum vent area: The main vent shall be a minimum of 3 inches. The size of each vent shall be not less than required by Table No. P-2207.7.

P-2207.1.3 Prohibited use: The plumbing vent system shall not be used for purposes other than the venting of the plumbing system.

P-2207.2 Vent slopes and connections

P-2207.2.1 Vent slope: All vent pipes shall be so sloped and connected as to drain back to the soil or waste pipe by gravity. Slope of vent piping shall be arranged to allow condensation and moisture which may form to flow back to the drain line. Vent piping shall be installed and supported so as to not be "trapped" by water or condensate collecting in the trapped area.

P-2207.2.2 Vent connection to a horizontal drain: Where vent pipes connect to a horizontal soil or waste pipe, the vent shall be taken off above the center line of the soil pipe, and the vent pipe shall rise vertically, or at an angle not exceeding 45° from the vertical, to a point at least 6 inches above the flood-level rim of the fixture it is venting before offsetting horizontally or before connecting to the branch vent.

P-2207.2.3 Vent stack connection at base: Vent stacks shall connect full size at their base to the drainage system, below the lowest fixture branch.

P-2207.2.4 Height above flood-level rim: A connection between an individual or branch vent pipe and a vent stack or stack vent shall be made 6 inches above the flood-level rim of the highest fixture on the same floor level served by the vent.

P-2207.2.5 Crown venting prohibited: No vent shall be installed within two pipe diameters of the trap weir.

P-2207.2.6 Water Closets: All fixtures discharging downstream from a water closet shall be individually vented.

P-2207.3 Common vents

P-2207.3.1 Individual vent as common vent: An individual vent installed vertically may be used as a common vent for two fixture traps when both fixture drains connect with the vertical drain or stack at the same level.

P-2207.3.2 Fixtures connected to stack at different levels: A common vent may be used for two waste fixtures connecting at different levels in the stack but within the same branch interval, provided that the portion of the stack that serves as the vertical drain for the upper fixture is one pipe diameter larger than the upper fixture drain, but in no case smaller than the lower fixture drain. The vertical piping between the fixture connections serves as a wet vent for the lower fixture.

P-2207.3.3 Vent headers: Stack vents, vent stacks, individual vents, branch vents and relief vents connected in any combination to a common vent header (larger branch vent) shall be at least 6 inches above the flood-level rim of the highest fixture and terminate in accordance with Section P-2207.6. This header shall be sized in accordance with the requirements of Table No. P-2207.7.

P-2207.4 Mechanical vents: Approved mechanical venting devices shall be permitted for a single fixture or fixture trap where a vertical leg trap arm as described in Section P-2206.7.3 cannot be installed and no other practical alternative exists. The mechanical vent shall be installed a minimum of 6 inches above the flood-level rim of the fixture served and shall be accessible for periodic inspection and/or replacement.

P-2207.5 Air admittance valves: Approved air admittance valves complying with ASSE 1051 as listed in Section S-26.2207 shall be permitted for a single fixture or for multiple fixture traps. The air admittance valve shall be installed to permit free movement of air and not less than 4 inches above the trap arm of the fixture served and shall be accessible for periodic inspection and/or replacement. Valves shall be sized per Section P-2207.12.

P-2207.6 Vent terminals

P-2207.6.1 Location of open vent terminal: No open vent terminal shall be located beneath any door, window or other opening nor shall any such vent terminal be within 10 feet horizontally of such an opening unless it is at least 2 feet above the top of the opening.

P-2207.6.2 Vent extension above roofs: Vent pipe extensions through the roof shall terminate at least 6 inches above the high side of the penetration. Where a roof is to be used for any purpose other than weather protection, vent extensions shall run at least 7 feet above the roof.

P-2207.6.3 Vent extension through wall or overhang: 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 P-2207.6.1. Vent terminals shall not terminate under the overhang of the building.

P-2207.6.4 Vent pipe flashing and sealing: Vent extensions through roofs shall be made water-tight by use of approved flashings. Vent extensions in walls or soffits shall be made weather-tight by caulking or other suitable means.

P-2207.6.5 Frost closure: DELETED.

P-2207.6.6 Vent terminals in attic spaces: Vent terminals equipped with approved air admittance valves may be located in accessible attic spaces where the building drainage system connects to a vented sewer. Valves shall comply with ASSE 1051 as listed in Section S-26.2207, shall be installed above the attic insulation and shall be sized according to Section P-2207.12.

P-2207.7 Dry vent sizing: The vent sizing requirements set forth in Table No. P-2207.7 shall apply to all dry portions of any venting system in this document, including:

1. Individual and common vents extending from trap arms.
2. Stack vents.
3. Vent stacks, branch vents, relief vents or other dry vents.

Vents may be sized using the method presented in Appendix D when plans and specifications are prepared and sealed by a professional engineer. The professional engineer shall be required to certify the system has been installed according to the design plans.

Table No. P-2207.7
MINIMUM SIZE FOR DRY VENTS

VENTING APPLICATION	MINIMUM VENT SIZE (inches)
Dry vent extension from individual fixtures, fixture groups, or waste stacks	1 1/4*
Individual soil stack vents and water closet vents	1 1/2
Combined stack vent from two or more stacks	2

*Except water closets.

P-2207.8 Wet venting

P-2207.8.1 Single-bathroom groups: A single bathroom group may be installed with the drain from an individual vented lavatory or other waste fixture serving as a wet vent for a bathtub or shower and/or for the water closet (see Figure No. P-2207.8.1), provided that:

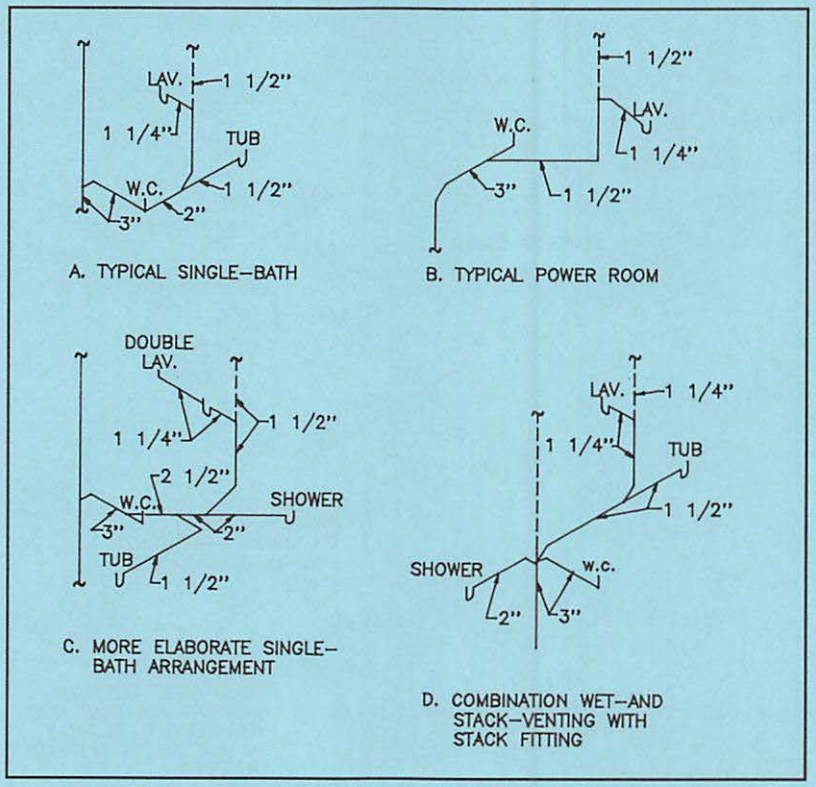
1. Not more than 1.0 d.f.u. drain into a 1 1/4-inch wet vent, not more than 2.0 d.f.u. drain into a 1 1/2-inch wet vent, not more than 4 d.f.u. drain into a 2-inch wet vent, not more than 6 d.f.u. drain into a 2 1/2-inch wet vent, or not more than 10 d.f.u. drain into a 3-inch wet vent, except as provided in Section P-2207.8.3 provided that no wet vent shall be smaller than the dry vent extension of a wet vent.
2. The horizontal branch shall connect to the water closet branch or bend, to the stack at the same center line as the water closet branch; or to the stack below the water closet branch.
3. The dry vent extension of a wet-vented circuit shall be sized in accordance with Table No. P-2207.7.
4. If a stack fitting consisting of a water closet opening and two side inlets with the same center line of the water closet opening is used, one side inlet may be used for an independent connection of a tub or shower without individual reventing, and the other may be used for an individually vented lavatory with or without an additional wet-vented tub or shower. This line serves as a wet vent for the water closet and nonindividually vented tub or shower (see Figure No. P-2207.8.1, item D).

P-2207.8.2 Double-bathroom groups: Two bathroom groups side-by side or back-to-back may be installed in a wet vent arrangement, with the water closets connecting independently to the stack at the same level, provided the requirements of Section P-2207.8.1 are met (see Figure No. P-2207.8.2).

P-2207.8.3 Location of water closet connection controlling dry vent size: The manner and location in which the water closet is connected to the stack shall control the method by which the dry vent extension of the wet vent is sized:

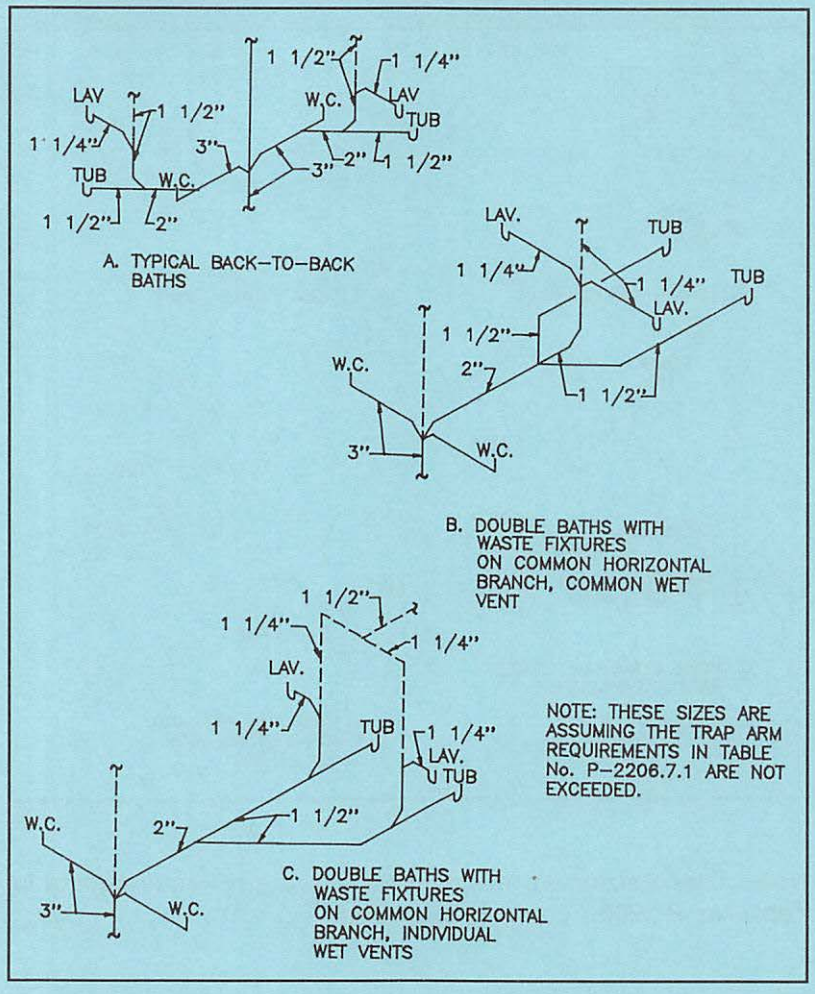
1. If the water closet is connected to a soil stack which terminates as a stack vent, the water closet itself shall be considered stack vented (see Section P-2207.9). The dry vent extension of the wet vent shall be sized according to the d.f.u. load of the waste fixtures served (see Figure Nos. P-2207.8.2, Items A, C and D and P-2207.8, Item A and B).
2. If the water closet horizontal branch is connected by an elbow on the top of a secondary stack, or is connected at lower branch intervals of a soil stack serving more than one story, the dry vent extension of the wet vent shall be sized according to the d.f.u. load of the entire horizontal branch (see Figure Nos. P-2207.8.2, item B and P-2207.8.2, Item C).

Figure No. P-2207.8.2
TYPICAL SINGLE-BATH WET-VENT ARRANGEMENTS



Note: These sizes are assuming the trap arm requirements in Table No. P-2206.7.1 are not exceeded.

Figure No. P-2207.8.3
TYPICAL DOUBLE-BATH WET-VENT ARRANGEMENTS



P-2207.8.4 Vertical Combination Waste And Wet Vent: Fixture branches discharging on all floors (other than water closets or urinals of all types) may be installed on a combined waste and vent as follows:

Diameter of Stack	Total Fixture Units in Stack	Maximum Length
2"	4	30 ft
3"	24	50 ft

Such branches may discharge into a waste stack or branch beginning at the house drain and extending through the roof undiminished in a size according to the following table, provided no kitchen sink or washing machine trap shall be placed on a 2-inch combined waste and vent.

P-2207.9 Stack venting

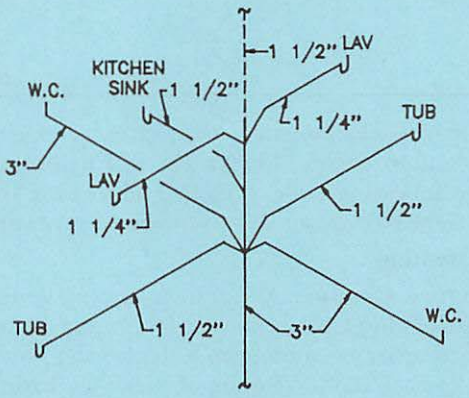
P-2207.9.1 Fixture Groups: A single bathroom group of fixtures, consisting of a water closet, basin, shower or tub, and a kitchen sink (with disposal and dishwasher) located back-to-back to the bathroom, or two bathrooms back-to-back each consisting of one toilet, basin, shower or tub may be installed without individual fixture vents in a one story building or on the top floor of a building provided each fixture drain connects independently to the stack and that the tub and/or shower, and water closet enter the stack at the same level and in accordance with the requirements in Table P-2206.7.1.

P-2207.9.2 Method of connection:

1. Waste fixtures shall enter the stack with either a wye and eighth bend or a sanitary tee above the water closet connection, or at the same center line as the water closet connection through multi-inlet fittings that have the smaller waste fixture inlets set 90 degrees apart from the water closet inlet (see Figure No. P-2207.9.2).
2. A side inlet or high-heel inlet connection into a water closet bend, or a connection into a water closet horizontal branch, shall be considered an independent connection to the stack , provided:
   a. Only waste fixtures shall be connected.
   b. Connection of a horizontal branch serving a water closet to a soil stack shall be made only with a sanitary tee.
   c. Not more than two such independent fixture connections shall be made into each water closet fitting or branch.
3. Water closet branches that receive no additional waste fixture loads shall enter a 3-inch stack with either a wye and eighth bend or a sanitary tee.
4. A 90-degree long sweep or combination of fittings creating the same effect shall be installed at the base of soil stacks.
5. Trap arms shall in all cases comply with Table No. P-2206.7.1.

P-2207.9.3 DELETED.

Figure No. P-2207.9.2
TYPICAL METHODS OF CONNECTING FIXTURE DRAINS TO STACK IN STACK-VENTED SYSTEMS



WASTE FIXTURE CONNECTED DIRECTLY TO STACK

Note: These signs are assuming the trap arm requirements in Table No. P-2206.7.1 are not exceeded.

P-2207.9.4 Load limit for stack-vented waste fixtures above highest water closet, bathtub or shower: Up to three waste fixtures without individual vents may be independently connected to a 3- or 4-inch soil or waste stack above the highest water closet, bathtub or shower connection within the same branch interval (see Figure No. P-2207.9.2).

P-2207.10 DELETED.

(Remove pages 235-236)

Figures No. P-2207.10a DELETED

Figures No. P-2207.10b DELETED

P-2207.11 Sump vent sizes and lengths: Drainage piping below sewer level shall be vented in a similar manner to that for a gravity system. Building and sump vents, where required, shall be sized in accordance with Table No. P-2207.11.

Table No. P-2207.11
SIZE AND LENGTH OF SUMP VENTS

DISCHARGE CAPACITY OF SUMP PUMP (gpm)	VENT PIPE SIZE (inches)		
	1 1/4	1 1/2	2
	LENGTH OF VENT (Feet)		
10	N.L.*	N.L.	N.L.
20	270	N.L.	N.L.
40	72	160	N.L.
60	31	75	270

* No Practical limit.

P-2207.12 Sizing: Air admittance valves shall be sized to accommodate the fixture unit load of the branch or fixture that it serves per Table P-2207.12. Devices designed to accommodate multiple pipe size connections shall be permitted.

Table No. P-2207.12
AIR ADMITTANCE VALVE MAXIMUM LOAD LIMITATIONS FOR HORIZONTAL FIXTURE BRANCHES

NOMINAL PIPE SIZE (INCHES)	D.F.U.[1] ANY HORIZONTAL FIXTURE BRANCH
1 1/4	1
1 1/2	3
2	6
3	20[2]
4	160

[1]Source: National model plumbing codes and Hunter Curve.

[2]Not more than 2 water closets or bathroom groups per interval.

SECTION P-2208–TESTING THE DRAINAGE, WASTE AND VENT SYSTEM

P-2208.1 DELETED.

P-2208.2 Methods of testing DWV systems

P-2208.2.1 Rough plumbing: DWV systems shall be tested upon completion of the rough piping installation by water or air with no evidence of leakage. Either test shall be applied to the drainage system in its entirety or in sections after rough piping has been installed, as follows:

1. Water Test – Each section shall be filled with water to a point no less than 10 feet above the highest fitting connection in that section, or to the highest point in the completed system. Water shall be held in the section under test for at least 15 minutes before inspection. The system shall prove leak free by visual inspection.
2. Air Test – The portion under test shall be maintained at a gauge pressure of 5 psi or 10 inches mercury column. This pressure shall be held without introduction of additional air for a period of at least 15 minutes.

P-2208.2.2 Finished plumbing: After the plumbing fixtures have been set and their traps filled with water, their connections shall be tested and proved gas-tight and/or water-tight as follows:

1. Water-tightness – Each fixture shall be filled and then drained. Traps and fixture connections shall be proven water-tight by visual inspection.
2. Gas-tightness – Where required by the local administrative authority, a final test for gas-tightness of the DWV system shall be made by the smoke or peppermint test as follows:
   a. Smoke Test – Introduce a pungent, thick smoke into the system. When the smoke appears at vent terminals, they shall be sealed and a pressure equivalent to a 1-inch water column shall be applied and maintained for the period of inspection.
   b. Peppermint Test – Introduce 2 ounces of oil of peppermint into the system. Add 10 quarts of hot water and seal all vent terminals. The odor of peppermint shall not be detected at any trap or other point in the system.

*

Chapter 23
PLUMBING FIXTURES AND RECEPTORS

SECTION P-2301 – FIXTURES, FITTINGS AND APPURTENANCES

Plumbing fixtures, fittings and appurtenances shall be constructed from approved materials, have smooth impervious surfaces, be free from defects and concealed fouling surfaces and, except as permitted elsewhere in this code, shall conform to the standards specified in Table No. P-2301 and shall be provided with an adequate supply of potable water to flush and keep the fixtures in a clean and sanitary condition without danger of backflow or cross-connection.

Table No. P-2301
PLUMBING FIXTURES
(As listed in Section S-26.2001)

MATERIAL	STANDARD NO.
Vitreous China Fixtures	ASME/ANSI A112.19.2M-90
Trim for Water Closet Bowls, Tanks and Urinals	ASME/ANSI A112.19.5-79
Floor Drains	ASME/ANSI A112.21.1M-80
Plastic Bathtub Units	ANSI Z124.1-87
Plastic Shower Receptors and Shower Stalls	ANSI Z124.2-87
Plastic Lavatories	ANSI Z124.3-86
Plastic Water Closet Bowls and Tanks	ANSI Z124.4-86
Enameled Cast Iron Plumbing Fixtures	ASME/ANSI A112.19.1M-87
Stainless Steel Plumbing Fixtures (Residential)	ASME/ANSI A112.19.3M-87
Porcelain Enameled Formed Steel Plumbing Fixtures	ASME/ANSI A112.19.4M-84
Water Closet Flush Tank Ball Cocks	ASSE/ANSI 1002-79 (1986)
Household Dishwashing Machines	ASSE/ANSI 1006-86
Home Laundry Equipment	ASSE/ANSI 1007-73 (1986)
Household Disposers	ASSE/ANSI 1008-73 (1986)
Water Hammer Arrestors	ASSE/ANSI 1010-82
Hose Connection Vacuum Breakers	ASSE/ANSI 1011-82
Handheld Showers	ASSE/ANSI 1014-79
Individual Shower Control Valves Anti-Scald	ASSE/ANSI 1016-79
Wall Hydrants, Freezeless, Automatic Draining Anti-Backflow Types	ASSE/ANSI 1019-78
Hotwater Dispensers, Household Storage Type, Electrical	ASSE/ANSI 1023-79
Diverters for Faucets with Hose Spray Anti-Syphon Type, Residential Application	ASSE/ANSI 1025-78
Pressurized Flushing Devices for Fixtures	ASSE/ANSI 1037-86
Thermoplastic Accessible and Replaceable Plastic Tube and Tubular Fittings	ASTM F409-88
Pipe Applied Vacuum Breakers	ASSE/ANSI 1001-88
Hydraulic Performance for Water Closets and Urinals	ASME/ANSI A112.19.6-90
Whirlpool Bathtub Appliances	ASME/ANSI A112.19.7M-87
Plastic Sinks	ANSI Z124.6-1990
Suction Fittings for Use in Swimming Pools, Wading Pools, Spas, Hot Tubs and Whirlpool Bathtub Appliances	ASME/ANSI A119.19.8M-87
Water Pressure Reducing Valves for Domestic Water Supply Systems	ASSE/ANSI 1003-1982

[1]Section P-2001.1 provides for use of other approved materials in accordance with Section R-108.

SECTION P-2302 – FIXTURE ACCESSORIES

P-2302.1 Plumbing fixtures, other than water closets, shall be provided with approved strainers.

P-2302.2 Fixture supply valves and faucets shall be brass or other approved materials.

P-2302.3 Accessible continuous wastes, waste and overflow fittings, and tail pieces may be seamless drawn brass of No. 20 gauge minimum thickness.

P-2302.4 Plastic tubular fittings shall conform to ASTM F409 listed in Table P-2301.

SECTION P-2303 – TAIL PIECES

Fixture tail pieces shall be not less than 1 1/2 inches O.D. for sinks, dishwashers, laundry tubs, bathtubs and similar fixtures, and not less than 1 1/4 inches for bidets lavatories and similar fixtures.

SECTION P-2304 – ACCESS TO CONNECTIONS

Fixtures having concealed tubular traps shall be provided with an access panel or unobstructed utility space 12 inches in least dimension. Joints that are soldered, screwed, fused or solvent-welded to form a solid connection or those designs which withstand 25 psi unrestrained need not be accessible.

SECTION P-2305 – INSTALLATION

The installation of fixtures shall conform to the following:

1. Floor-outlet or floor-mounted fixtures shall be secured to the drainage connection and to the floor, when so designed, by screws, bolts, washers, nuts and similar fasteners of copper, brass or other corrosion-resistant material.
2. Wall-hung fixtures shall be rigidly supported so that strain is not transmitted to the plumbing system.
3. Where fixtures come in contact with walls or floors, the joint shall be water-tight.
4. Plumbing fixtures shall be functionally accessible.
5. The center line of water closets or bidets shall be not less than 15 inches from adjacent walls or partitions or not less than 30 inches center to center from an adjacent water closet or bidet.
6. The location of piping, fixtures or equipment shall not interfere with the operation of windows or doors.

*

SECTION P-2306 – RECEPTORS

Plumbing fixtures or other receptors receiving the discharge of indirect waste pipes shall be shaped and have a capacity to prevent splashing or flooding and shall be readily accessible for inspection and cleaning.

SECTION P-2307 – PROHIBITED RECEPTORS

No plumbing fixture which is used for domestic or culinary purposes shall be used to receive the discharge of an indirect waste, except that in a residence, a kitchen sink trap is acceptable for use as a receptor for a dishwasher and, similarly, a laundry tray as a receptor for a clothes-washing machine.

SECTION P-2308 – DIRECTIONAL FITTINGS

Approved "wye" or other directional-type branch fittings shall be installed in fixture tail pieces connecting or receiving the discharge from food-waste disposal units, dishwashers, clothes washers, or other fixtures or appliances.

SECTION P-2309 – SHOWERS

P-2309.1 General: Hinged shower doors shall open outward. The wall area above built-in tubs having installed shower heads and in shower compartments shall be constructed as per Section R-502.6. Such walls shall form a water-tight joint with each other and with either the tub, receptor or shower floor.

P-2309.2 Water-supply riser: The water-supply riser from the shower valve to the shower head outlet shall be secured to the permanent structure.

P-2309.3 Shower heads: Shower heads shall be of the water-conserving type, See Section P-2413.

SECTION P-2310 – SHOWER RECEPTORS

P-2310.1 Construction: Shower receptors shall have a finished curb threshold not less than 1 inch below the sides and back of the receptor. The curb shall be not less than 2 inches or more than 9 inches in depth when measured from the top of the curb to the top of the drain. The finished floor shall slope uniformly toward the drain not less than 1/4 inch per foot nor more than 1/2 inch, and floor drains shall be flanged to provide a water-tight joint in the floor.

P-2310.2 Lining required: The adjoining walls and floor framing, enclosing on-site built-up shower receptors shall be lined with sheet lead or copper or other approved materials extending not less than 3 inches beyond or around the rough jambs and not less than 3 inches above finished thresholds. Plastic liner materials shall comply with ASTM D4068 listed in Section S-26.2310.

P-2310.3 Installation: Lining materials shall be 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 copper pans or liners shall be burned or silver brazed, respectively. Joints in plastic liner materials shall be jointed per manufacturer's recommendations.

P-2310.4 Receptor drains: An approved flanged drain shall be installed with shower subpans or linings. The flange shall be placed flush with the subbase and be equipped with a clamping ring or other device to make a water-tight connection between the lining and the drain. The flange shall have weep holes into the waste line.

SECTION P-2311 – SHOWER WALLS

Shower walls shall be finished in accordance with Section R-502.6.

SECTION P-2312 – LAVATORIES

P-2312.1 Lavatory waste outlets: Lavatories shall have waste outlets not less than 1 1/4 inch in diameter. A strainer, pop-up stopper, crossbar or other device shall be provided to restrict the clear opening of the waste outlet.

SECTION P-2313 – WATER CLOSETS

P-2313.1 Prohibited water closets: Water closets which have an invisible seal and unventilated space or walls which are not thoroughly washed at each discharge shall be prohibited. Water closets which could permit backflow of the contents of the bowl into the flush tank shall be prohibited.

P-2313.2 Flushing devices required: Water closets shall be provided with a flush tank or similar device designed and installed to supply water in sufficient quantity and flow to flush the contents of the fixture, to cleanse the fixture and refill the fixture trap.

P-2313.3 Water supply for flush tanks: An adequate quantity of water shall be provided to flush and clean the fixture served. The water supply to flush tanks equipped for manual flushing shall be controlled by a float valve or other automatic device designed to refill the tank after each discharge and to completely shut off the water flow to the tank when the tank is filled to operational capacity. Water closets having any portion of the tank below the flood-level rim of the closet bowl shall have a ball

cock installed within a sheath or in a separate and isolated compartment of the tank. Both the sheath or compartment shall have visible discharge onto the floor in case of failure. Provision shall be made to automatically supply water to the fixture so as to refill the trap after each flushing.

P-2313.4 Flush valves in flush tanks: Flush valve seats in tanks for flushing water closets shall be at least 1 inch above the flood-level rim of the bowl connected thereto, except an approved water closet and flush tank combination designed so that when the tank is flushed and the fixture is clogged or partially clogged, the flush valve will close tightly so that water will not spill continuously over the rim of the bowl or backflow from the bowl to the tank.

P-2313.5 Overflows in flush tanks: Flush tanks shall be provided with overflows discharging to the water closet connected thereto and of sufficient size to prevent flooding the tank at the maximum rate at which the tanks are supplied with water.

P-2313.6 Water closet seats: Water closets shall be equipped with seats of smooth, nonabsorbent material and shall be properly sized for the water closet bowl type.

SECTION P-2314 – DELETED

SECTION P-2315 – SINKS

P-2315.1 Sink waste outlets: Sinks shall be provided with waste outlets not less than 1 1/2 inches in diameter. A strainer, crossbar or other device shall be provided to restrict the clear opening of the waste outlet. Sinks on which a waste grinder is installed shall have a waste opening not less than 3 1/2 inches in diameter.

SECTION P-2316 – LAUNDRY TUBS

P-2316.1 Laundry tub waste outlet: Each compartment of a laundry tub shall be provided with a waste outlet not less than 1 1/2 inches in diameter and a strainer or crossbar to restrict the clear opening of the waste outlet.

SECTION P-2317 – FOOD-WASTE GRINDER

P-2317.1 Food-waste grinder waste outlets: Food-waste grinders shall be connected to a drain of not less than 1 1/2 inches in diameter.

P-2317.2 Water supply required: Food-waste grinders shall be provided with an adequate supply of water at a sufficient flow rate to ensure proper functioning of the unit.

SECTION P-2318 – DISHWASHING MACHINES

P2318.1 Protection of water supply: Each unit shall have integral backflow protection of the water supply to the appliance.

P-2318.2 Sink and dishwasher: A sink and dishwasher may discharge through a single 1 1/2-inch trap. The discharge from the dishwasher shall be increased to a minimum of 5/8-inch and be connected with a wye fitting between the sink outlet and the trap inlet.

P-2318.3 Sink, dishwasher and food grinder: The discharge from a sink, dishwasher, and waste grinder may discharge through a single 1 1/2-inch trap. The discharge from the dishwasher shall be increased to a minimum of 5/8 inch and connected with a wye fitting between the discharge of the food-waste grinder and the trap inlet or to the head of the food grinder.

SECTION P-2319 – CLOTHES WASHER

Each unit shall have integral backflow protection of the water supply to the appliance. The discharge from such a machine shall be through an air break.

SECTION P-2320 – FLOOR DRAINS

Floor drains shall have waste outlets not less than 2 inches in diameter and shall be provided with a removable strainer with an open area of at least two-thirds of the cross-sectional area of the drain line to which it connects.

SECTION P-2321 – WHIRLPOOL BATHTUBS

P-2321.1 Access panel: A door or panel of sufficient size shall be installed to provide access to the pump for repair and/or replacement.

P-2321.2 Piping drainage: The circulation pump shall be accessibly located above the crown weir of the trap. The pump drain line shall be properly graded to assure minimum water retention in the volute after fixture use.

P-2321.3 Leak testing: Leak testing and pump operation shall be performed in accordance with manufacturer's instructions.

P-2321.4 Manufacturer's instructions: The product shall be installed in accordance with installation instructions.

P-2321.5 Piping: Whirlpool bathtub circulation piping shall be installed to be self-draining.

SECTION P-2322 – BIDET INSTALLATIONS

P-2322.1 Water supply: The bidet shall be equipped with either an air-gap-type or vacuum-breaker-type fixture fitting.

SECTION P-2323 – FIXTURE-FITTING INSTALLATION

Faucets and diverters shall be installed so that the flow of hot water from the fittings corresponds to the left-hand side of the fitting.

Chapter 24
WATER SERVICE AND DISTRIBUTION

SECTION P-2401 – GENERAL

Every dwelling unit shall be provided with a supply of potable water in the amounts and pressures specified in this chapter. In a building where both a potable and nonpotable water-distribution system are installed, each system shall be identified by color marking, metal tag or other appropriate method. Any nonpotable outlet that could inadvertently be used for drinking or domestic purposes shall be posted.

SECTION P-2402 – PROTECTION OF POTABLE WATER SUPPLY

P-2402.1 Connections: Connections shall not be made to a potable water supply in a manner which could contaminate the water supply or provide a cross-connection between the supply and source of contamination unless an approved backflow-prevention device is provided. Cross-connections between a private water supply and a public supply shall be prohibited .

P-2402.2 Backflow-prevention devices

P-2402.2.1 Air gaps: Where specified, a 1-inch-minimum air gap, measured vertically, is required between the lowest end of a water-supply outlet and the flood rim of the fixture or receptor. An air gap is required at the discharge point of a relief valve or piping. Air-gap devices shall be incorporated in dishwasher and clothes washer equipment.

P-2402.2.2 Vacuum breakers: A vacuum-breaker device is required at any water-supply outlet with a hose connection or at outlets which could be submerged and are not protected by an air gap. Typical applications include plumbing fixtures, hose bibb outlets and certain solar/storage tank installations. The vacuum breaker shall be installed per the manufacturers recommendations.

P-2402.3 Heat exchangers

P-2402.3.1 Double wall: Where a heat-exchange process takes place between a toxic substance and potable water, an approved double-walled heat exchanger shall be used. Examples include solar collector fluids (other than water) used for preheating domestic water in a tank, and desuperheaters utilizing rejected heat from an air-conditioner refrigerant to preheat domestic water.

P-2402.3.2 Single wall: A single-walled heat exchanger shall be permitted where potable water would not be contaminated in a heat-exchange process. Examples include solar installations that heat potable water directly in a collector, solar systems utilizing potable water as the collector fluid, domestic hot-water coils in boilers, and water-to-air heating coils.

SECTION P-2403 – WATER SERVICE PIPING

P-2403.1 Materials: Materials for underground water-supply systems, water-service pipe and lawn sprinkler systems shall be as shown in Table P-2403.1. Any material subject to corrosion shall be protected when installed in corrosive soils. Approved fittings shall be used on the water-supply system or water-service piping.

Underground piping for water-service and lawn-sprinkling systems, when installed outside of the foundation walls of the building, may be of pressure-rated plastic conforming to the standards specified in Table P-2403.1.

Minimum working pressure rating for piping shall be 160 psi at 73 degrees F or 100 psi at 180 degrees F. Fittings shall be approved and compatible with the type of piping used.

Table No. P-2403.1
WATER SERVICE PIPING[1]
(As listed in Section S-26.2001)

MATERIAL	STANDARD NO.
Welded Copper Water Tube (WK, WL, WM)	ASTM B447-89
Cast Copper Alloy Solder-Joint Pressure Fittings	ASME B16.18-84
Steel Pipe, Black and Hot Dipped, Zinc Coated Welded and Seamless	ASTM A53-88a
Ductile Iron Pressure Pipe	ASTM A377-84
Steamless Red Brass Pipe, Standard Sizes	ASTM B43-88
Seamless Copper Tube	ASTM B75-86
Seamless Copper Watertube Type K, L, and M	ASTM B88-89a
Seamless Brass Type	ASTM B135-86a
ABS Plastic Pipe Sch. 40 and 80	ASTM D1527-89
PVC Plastic Pipe Sch. 40, 80 and 120	ASTM D1785-89
Polyethylene Plastic Pipe, Sch. 40	ASTM D2104-89el
Polyethylene Plastic Pipe (SDR-PR) Controlled ID	ASTM D2239-89el
PVC Pressure Rated Pipe (SDR Series)	ASTM D2241-89
ABS Plastic Pipe (SDR-PR)	ASTM D2282-89
PVC Plastic Pipe Fittings, Sch. 40	ASTM D2466-89
Socket Type PVC Plastic Pipe Fittings Sch. 80	ASTM D2467-89el
ABS Plastic Pipe Fittings, Sch. 40	ASTM D2468-89
Plastic Insert Fittings for P.E. Plastic Pipe	ASTM D2609-89
Polybutylene (PB) Plastic Pipe (SDR-PR)	ASTM D2662-89
Polybutylene (PB) Plastic Tubing	ASTM D2666-89
Polyethylene (PE) Plastic Tubing	ASTM D2737-89
CPVC Plastic Hot and Cold Water Distribution Systems	ASTM D2846-89el
Butt Heat Fusion P.E. Fittings for P.E. Plastic Pipe and Tubing	ASTM D3261-88a
P.B. Plastic Hot Water Distribution Systems	ASTM D3309-89a
Socket Type CPVC Plastic Pipe Fittings, Sch. 40	ASTM F438-89a
Socket Type CPVC Plastic Pipe Fittings, Sch. 80	ASTM F439-89el
CPVC Plastic Pipe Sch. 40 and 80	ASTM F441-89el
CPVC Plastic Pipe (SDR-PR)	ASTM F442-89el
Plastic Insert Fittings for P.B. Tubing	ASTM F845-88
Polyethylene (PE) Plastic Pipe Controlled OD	ASTM D2447-88
Polyethylene (PB) Plastic Pipe (SDR-PR) Controlled OD	ASTM D3000-89

[1]Section P-2001.1 provides for use of other approved materials in accordance with Section R-108.

P-2403.2 Pressure: Maximum average static pressure shall be 80 psi. * Where main pressure exceeds 80 psi, an approved pressure-reducing valve shall be installed in the water-service pipe near its entrance to the building.

P-2403.3 Thermal expansion: In addition to the required pressure relief valve, an approved device for thermal expansion control shall be installed whenever the building supply pressure is greater than the required relief valve pressure setting or when any device is installed that prevents pressure relief through the building supply.

P-2403.4 Size: The water-service pipe shall be of sufficient size to furnish water to the dwelling in required quantities and pressures, but in no case shall be less than 3/4-inch nominal diameter. Water-supply pipe sizes shall be determined from Table No. P-2409.3. Exact sizing to account for total demand and for pressure drop due to friction loss may be determined by standard engineering practice (see Appendix E).

P-2403.5 Installation

P-2403.5.1 Trench installation: Trenching, pipe installation and backfilling shall be in conformance with Section P-2204. Water-service pipes may be laid in the same trench with a building sewer constructed of materials listed in Section P-2202.3. If the building sewer is constructed of material not approved for use within the building as listed in Section P-2202.2, the water-service pipe shall be placed on a solid ledge at least 12 inches above and to one side of the highest point in the sewer line.

P-2403.5.2 Polyethylene plastic piping installation: Polyethylene pipe shall be cut square with the ends chamfered to remove sharp edges. Pipe that has been kinked shall not be installed. The installed radius of pipe curvature shall not be less than 30 pipe diameters or the coil radius when bending with the coil. Coiled pipe shall not be bent beyond straight. Bends shall not be permitted within ten pipe diameters of any fitting or valve. Compression type couplings and fittings shall be used when installing 1 1/2 inch and larger pipe. Stiffeners that extend beyond the clamp or nut shall not be used. Polyethylene pipe shall not be flared.

P-2403.6 Soil and groundwater: The installation of water-service piping, fittings, valves, appurtenances and gaskets shall be prohibited in soil and groundwater that is contaminated with solvents, fuels, organic compounds or other detrimental materials which will cause permeation, corrosion, degradation or structural failure of the water-service material.

Where detrimental conditions are suspected by or brought to the attention of the building official, a chemical analysis of the soil and groundwater conditions shall be required to ascertain the acceptability of the water-service material for the specific installation.

Where a detrimental condition exists, approved alternate materials or alternate routing shall be required.

SECTION P-2404 – JOINTS AND CONNECTIONS

P-2404.1 Tightness: Joints and connections in the plumbing system shall be gas-tight and water-tight for the intended use or required test pressure.

P-2404.2 Joint requirements

P-2404.2.1 Threaded pipe joints: Threaded joints shall conform to American National Taper Pipe Thread specifications. Pipe ends shall be deburred and all chips removed. Pipe joint compound shall be used only on male threads.

P-2404.2.2 Soldered joints: Soldered joints in tubing shall be made with fittings approved for water piping. Surfaces to be soldered shall be cleaned bright. The joints shall be properly fluxed and made with approved solder. Pipe and fittings used in the water-supply system shall have a maximum of 8 percent lead. Solders and fluxes used in potable water-supply systems shall have a maximum of 0.2 percent lead.

P-2404.2.3 Flared joints: Flared joints in water tubing shall be made with approved fittings. The tube shall be reamed and then expanded with a proper flaring tool.

P-2404.2.4 Plastic pipe joints: Joints in plastic piping shall be made with approved fittings by solvent cementing, heat fusion, corrosion-resistant metal clamps with insert fittings, compression connections, or other approved manufactured systems.

P-2404.2.5 Pressure lock fittings: Joints within the building between copper pipe, polybutylene tubing, CPVC tubing, or other approved material, in any combination with compatible outside diameters, may be made with the use of approved push-in mechanical fittings of a pressure-lock design.

P-2404.2.6 Joints between different materials: Joints between different materials in the plumbing system shall be as approved by the administrative authority.

P-2404.2.7 Joints between dissimilar metal pipe: Joints between ferrous (iron-based) piping and nonferrous metallic piping (typically copper) shall be made with a dielectric fitting or other nonmetallic connection to prevent deterioration of the joint by electrolysis.

SECTION P-2405—UNDER CONCRETE SLABS OR UNDERGROUND

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 degrees F.

SECTION P-2406 — CHANGES IN DIRECTION

Changes in direction in copper tube may be made with bends having a radius of not less than four diameters of the tube, providing such bends are made by use of forming equipment which does not deform or create loss in cross-sectional area of the tube.

SECTION P-2407 — UNDERGROUND JOINTS

Joints in polybutylene (PB) plastic pipe or tubing under a concrete floor slab shall be installed using heat fusion, in accordance with the manufacturers recommendations and Appendix X2.2.1.9 of ASTM D3309 listed in Section S-26.2407. Joints in 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 P-2408 – VALVES

P-2408.1 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.

P-2408.2 Water heater valve: A readily accessible fullway valve shall be installed in the cold-water supply pipe to each water heater at or near the water heater.

P-2408.3 Individual fixture, riser and branch valves: Valves or stops to individual fixtures, appliances, risers and branches may be installed. Where installed, such valves or stops shall be accessible.

P-2408.4 Hose bibb: DELETED

SECTION P-2408.5 SAFETY DEVICES

P-2408.5.1 Hot Water Heaters or Tanks of 120 Gallons or Less

P-2408.5.1.1 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.

P-2408.5.1.2 Replacement Components: All replacement components for an automatic hot water heater or tank (120 gallons or less) shall meet the provisions of P-2408.5.1.1.

P-2408.5.2 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.

P-2408.5.3 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.

P-2408.5.4 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.

P-2408.5.5 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.

P-2408.5.6 Safety Pans and Relief Valve Waste

P-2408.5.6.1 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.

P-2408.5.6.2 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.

P-2408.5.6.3 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.

P-2408.5.6.4 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.

P-2408.5.6.5 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.

P-2408.5.6.6 Relief valve discharge piping shall be of those materials listed in P-2409.1.

P-2408.5.7 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.

P-2408.5.8 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.

SECTION P-2409 – WATER-DISTRIBUTION SYSTEM

P-2409.1 Materials

P-2409.1.1 Above Ground: Material for water-distribution pipes and tubing shall be brass, copper water tube minimum type M, stainless steel water water tub minimum Grade H, cast iron pressure pipe, galvanized steel, chlorinated polyvinyl chloride(CPVC) or polbutylene(PB) 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.

P-2409.1.2 Under Ground: Inaccessible water distributuin piping under slabs shall be copper water tube type L, brass, cast iron pressure pipe, galvanized steel, chlorinated polyvinyl chloride(CPVC) or polbutylene(PB) 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.

P-2409.1.3 Minimum Pressure Rating: Minimum working pressure for plastics hot and cold piping material shall be 100 psi at 180^{o} degrees F.

P-2409.2 Sizing of Water Distribution System

P-2409.2.1 Minimum Size: The sizing of the water distribution system shall conform to Appendix E or to good engineering practice.

P-2409.2.2 Calculation of Size: When required by the Plumbing Official, the sizing of the water distribution system shall be calculated by a professional engineer or other acceptable authority.

P-2409.2.3 Size of Fixture Supply: The minimum size of fixture supply pipe shall be as listed in Table No. P-2409.3.

Table No. P-2409.3
SIZE OF FIXTURE SUPPLY
(Minimum Pipe Sizes

Type of Fixture or Device	Pipe Size (in)	Type of Fixture or Device	Pipe Size (in)
Bath Tubs	1/2	Shower (Single head)	1/2
Combination Sink		Sinks (Serv., Slop)	1/2
and tray	1/2	Sinks FLusing Rim	3/4
Drinking Fountain	3/8	Urinal (Flush Tank)	1/2
Dishwasher		Urinal (Direct	
(Domestic)	1/2	Flush Valve)	3/4
Kitchen Sink,		Water Closet	
Residential	1/2	(Tank Type)	3/8
Kitchen Sink,			
Commercial	3/4	Water Closet	
Lavatory	3/8	(Flush Valve Type)	1
Laundry Tray, 1,2 or		Water Closet	
3 Compartments	1/2	(Flushometer Tank)	3/8
Wall Hydrants	1/2	Hose Bibbs	1/2

P-2409.2.4 For fixtures not listed, the minimum supply branch may be made the same as for a comparable fixture.

P-2409.2.5 Minimum Pressure: Minimum fairly constant, service pressure at the point of outlet discharge shall not be less than 8 psi for all fixtures except for direct flush valves, for which it shall not be less than 15 psi, and except where special equipment is used requiring higher pressure. In determining the minimum pressure, allowance shall be made for the pressure drop due to friction loss in the piping system during maximum demand periods as well as head, meter, and other losses in the system.

P-2409.2.6 Auxiliary Pressure, Supplementary Tank: If the residual pressure in the system is below the minimum allowable at the highest water outlet when the flow in the system is at peak demand, an automatically controlled pressure tank or automatically controlled pump or gravity tank of sufficient capacity shall be installed. Its capacity shall be sufficient to supply sections of the building installation which are too high to be supplied directly from the public water main.

P-2409.2.7 Low Pressure Cutoff: When a booster pump is used on an auziliary pressure system, there shall be installed a low-pressure cutoff on the booster pump to prevent the creation of negative pressures on the suction side of the water system. Other arrangements may be used if found adequate and if approved by the Plumbing Official.

P-2409.2.8 Variable Street Pressures: When the street main has a wide fluctuation in pressure, the water distribution system shall be designed for minimum pressure available.

P-2409.3 Water Pressure Reducing Valve or Regulators

P-2409.3.1 Where water pressure within a building exceeds 80 psi, an approved water pressure regulator with strainer shall be installed to reduce the pressure in the building water distribution piping to 80 psi or less, whichever is consistent with good engineering practice. Exceptions to this requirement are service lines to sill cocks and outside hydrants, and main supply risers in tall buildings where pressure from the mains is reduced to 80 psi or less at the fixture branches or at individual fixtures.

P-2409.3.2 The delivery pressure variation shall not exceed 1 psi for every 10 psi pressure change in the inlet pressure. The reduced pressure fall-off from its no flow setting shall not exceed 17 psi and with a difference at this point of 50 psi between the initial and this reduced flow pressure of 50 psi, the capacity shall not be less than that shown in Table No. P-2409.3.2.

Table No. P-2409.3.2

Nom. Pipe Size	1/2"	3/4"	1"	1 1/4"	1 1/2"	2"
Avg. Vel/thru pipe in ft./sec.	10.5	10.00	9.5	9.0	8.5	7.5
Flow in GPM	9.95	16.65	25.0	42.0	54.8	77.5

P-2409.3.3 For service water systems up to and including 2 inches, provisions shall be made to permit water on the building side of the reducing valve to flow back into the main when the building pressure exceeds the main supply pressure due to thermal expansion. Reducing valves with built-in bypass check valves will be acceptable.

P-2409.3.4 An integral bypass check valve shall be capable of opening to permit a reverse flow of water through the reducing valve to prevent a buildup of system pressure by thermal expansion of the water with an increase of reduced pressure not exceeding 2 psi above the prevailing initial pressure.

P-2409.3.5 The valve shall be designed to remain open to permit uninterrupted water flow in case of valve failure.

P-2409.3.6 All regulators and strainers must be so constructed and installed as to permit repair or removal of parts without breaking a pipe line or removing the valve and strainer from the pipe line.

P-2409.3.7 Approved valves shall comply with ASSE 1003.

P-2409.4 – P-2409.6 DELETED

P-2409.7 Manifold parallel water distribution systems

P-2409.7.1 General: Hot and cold manifold parallel water distribution systems with individual distribution lines to each fixture or fixture fittings shall be sized and installed per Sections P-2409.2.

P-2409.7.2 Sizing of manifolds: Manifold shall be sized per Table No. P-2409.7.2 Total GPM is the demand of all outlets.

Table No. P-2409.7.2
MANIFOLD SIZING

PLASTIC		METALLIC	
Nominal Size ID (Inches)	*Maximum GPM	Nominal Size ID (Inches)	*Maximum GPM
3/4	17	3/4	11
1	29	1	20
1 1/4	46	1 1/4	31
1 1/2	66	1 1/2	44

*Based on velocity limitation: plastic – 12 fps; metal – 8 fps.
Note: Reference shall be made to Table P-2409.3 for WFSU.

P-2409.7.3 Minimum size: The minimum size of individual distribution lines shall be 3/8 inch.

Exceptions

1. Certain fixtures such as one-piece water closets and whirlpool bathtubs shall require a larger size when specified by the manufacturer.
2. If a water heater is fed from the end of a cold water manifold, the manifold shall be one size larger than the water heater feed.

P-2409.7.4 Maximum length: The maximum length of individual distribution lines shall be 60 feet nominal.

P-2409.7.5 Orientation: Manifolds shall be permitted to be installed in a horizontal or vertical position

P-2409.7.6 Support: Piping bundles shall be secured per manufacturer's instructions and supported every 4 feet. Bundles that change direction 45 degrees or greater shall be protected from chaffing at point of contact with framing members by sleeving or wrapping.

P-2409.7.7 Valving: Fixture valves, when installed, shall be located either at the fixture or at the manifold. If installed at the manifold, they shall be labeled indicating the fixture served.

P-2409.7.8 Hose bibb bleed: A readily accessible air bleed shall be installed in hose bibb supplies at the manifold or at the bibb exit point.

SECTION P-2410 – SUPPORT

Pipe and tubing support shall conform to Section P-2005.

SECTION P-2411 – WATER HEATER

P-2411.1 General: Every dwelling shall have an approved automatic water heater or other type domestic water-heating system sufficient to supply hot water to plumbing fixtures and appliances intended for bathing, washing or culinary purposes. Water heaters and storage tanks shall be so located and connected that they will be accessible for observation, maintenance, servicing and replacement. Storage tanks shall be constructed of noncorrosive metal or be lined with noncorrosive material. When installed in a crawl space, the provisions of Section M-1101.1.5 must be met.

P-2411.2 Tank sizing: Table No. P-2411.2 may be used as a guide in determining minimum water heater tank size.

P-2411.3 Prohibited locations: Water heaters, which depend on the combustion of fuel with the exception of those having direct vent 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.

SECTION P-2412 – TESTING WATER-DISTRIBUTION SYSTEMS

Upon completion of a section or of the entire water-distribution 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.

SECTION P-2413 WATER CONSERVATION

Plumbing fixtures and plumbing fixture fittings shall conform to the following requirements.

1. All faucets, showerheads and their packaging shall be marked by the manufacturer in accordance with the provisions of ANSI Standard A112.18.1M listed in Chapter 26. Water closets and urinals and their packaging shall be marked in accordance with the provisions of ANSI A112.19.2M listed in Chapter 26.
2. New or replacement water closets, urinals, faucets or showerheads shall not be installed with a flow rate or flush volume in excess of the maximum specified in Table No. P-2413.2, when tested in accordance with the provisions of the applicable ANSI Standard listed in Chapter 26.

Table No. P-2413.2
Maximum Allowable Water Usage For Plumbing Fixtures[1]

Water closets, flushometer tank or close-coupled 2-piece gravity-flush type	1.6 gal/flush[5]
Water closets, flushometer valve floor mount	3.5 gal/flush
Water closets, wall mount	3.5 gal/flush
Urinals	1.5 gal/flush
Residential sink and lavatory faucets	3.0 gal/minute
Public lavatory faucets, metering type[2]	0.25 gal/cycle
Public lavatory faucets, where metering type is not required	0.5 gal/minute
Showerheads[3,4]	3.0 gal/minute

1. Maximum allowable water usage for plumbing fixtures and fixture fittings not listed in this table shall coform to the applicable ANSI standard listed in Chapter 26.
2. Lavatory faucets shall be of the metering type when located in the following public restrooms.
   a. In all occupancies in restrooms which have six or more lavatories.
   b. In school occupancies in student-use restrooms.
   c. In assembly occupancies in all customer or public-use restrooms.
3. Showerheads flow rate as tested at 80 psi in accordance with ANSI standard A112.18.1M.
4. Special purpose safety showers are exempted from maximum flow rate limitations.
5. Average water consumption for low consumption water closets over a range of test pressures shall not exceed 1.6 gpf. The consumption shall not exceed 2.0 gpf at any one test pressure.

Table No. P-2411.2
GUIDELINES FOR WATER HEATER SIZING

Fuel		Gas	Elect	Oil	Gas	Elect	Oil	Gas	Elect	Oil	Gas	Elect	Oil
Number of Bedrooms		1			2			3			—		
1 to 1 1/2 Baths	Storage (gal)	20	20	30	30	30	30	30	40	30	—	—	—
	Input (Btuh or kw)	27K	2.5	70K	36K	3.5	70K	36K	4.5	70K	—	—	—
	Draw (gph)	43	30	89	60	44	89	60	58	89	—	—	—
	Recovery (gph)	23	10	59	30	14	59	30	18	59	—	—	—
Number of Bedrooms		2			3			4			5		
2 to 2 1/2 Baths	Storage (gal)	30	40	30	40	50	30	40	50	30	50	66	30
	Input (Btuh or kw)	36K	4.5	70K	36K	5.5	70K	38K	5.5	70K	47K	5.5	70K
	Draw (gph)	60	58	89	70	72	89	72	72	89	90	88	89
	Recovery (gph)	30	18	59	30	22	59	32	22	59	40	22	59
Number of Bedrooms		3			4			5			6		
3 to 3 1/2	Storage (gal)	40	50	30	50	66	30	50	66	30	50	80	40
	Input (Btuh or kw)	38K	5.5	70K	38K	5.5	70K	47K	5.5	70K	50K	5.5	70K
	Draw (gph)	72	72	89	82	88	89	90	88	89	92	102	99
	Recovery (gph)	32	22	59	32	22	59	40	22	59	42	22	59

Note: Storage capacity, input and the recovery requirements indicated in the table are typical and may vary with each individual manufacturer. Any combinations of these requirements to produce the 1 hour draw stated will be satisfactory. Recovery is based on 100°F water temperature rise.

Part VI– Electrical

The electrical requirements shall conform to the North Carolina State Building Code, Volume IV–Electrical as listed in Section S-26.6000.

CHAPTER 25
ENERGY REQUIREMENTS FOR DWELLINGS

E-2501 GENERAL REQUIREMENTS

E-2501.1 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).

E-2501.2 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.

E-2501.3 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.

E-2501.4 For unfaced blankets and rolls, the manufacturer shall furnish sufficient identifying markings to indicate the insulation R-Value.

E-2501.5 When loose fill insulation is proposed, the R-value of the material shall be determined in accordance with ASTM C-687.

E-2501.6 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.

E-2501.7 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.

E-2501.8 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.

E-2501.9 A prescriptive Compliance Worksheet (Appendix J) shall be furnished to the CEO for the inspection listed in R-111.2.6.

E-2502 MINIMUM R-VALUE FOR EXTERIOR WALLS

All walls within the heated or cooled space exposed to the exterior shall be insulated so that the entire assembly (through the cavity section) will have a total R-Value of not less than R-16.

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 E-2504.

E-2503 MINIMUM R-VALUE FOR CEILINGS

E-2503.1 All ceilings within the heated or cooled space exposed to the exterior shall be insulated so that the entire assembly (through the cavity section) will have a total R-Value of not less than R-31.

Exception: Cathedral ceiling may be insulated with a minimum total R-Value of R-23 (through the cavity section), when other components are increased in accordance with Section E-2501.7.

E-2503.2 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.)

E-2503.3 When soffitt 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.

E-2503.4 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-707.

E-2504 MINIMUM R-VALUE FOR FLOORS

E-2504.1 All floors exposed to a crawl space, unconditioned basements, unheated garages, or breezeways shall be insulated so that the entire assembly (through the cavity section) will have a total R-Value of not less than R-20.

E-2504.2 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 R-310.5. 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 N).

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.

E-2505 EXTERIOR DOORS AND WINDOWS

E-2505.1 All unglazed doors within the heated or cooled space exposed to the exterior shall have a minimum R-Value of R-1.66.

E-2505.2 All doors with glass units shall be in accordance with Table E-2505.

E-2505.3 All window units shall be in accordance with Table E-2505. A thermal break shall be provided on all metal windows.

Table E-2505
GLASS DOORS AND WINDOW UNITS[1,4]

% Openings[2]	Minimum Glazing	Typical R-Value[5]
≤ 23%	Single glazed & storm window, or double glazed	1.90
> 23% < 33%	Double glazed with Low-E[3] or triple glazed	2.70
≥ 33%	Double glazed with Low-E &Argon gas	3.5

1. Includes sky lights.
2. % openings equals the area of glazed openings (doors and windows) divided by the gross heated floor area of the building.
3. Low-E indicates Low-emissivity glass.
4. Single glazed window units may be up to 1% of gross heated floor area.
5. The typical R-Value is to be used for calculations required in E-2501.7 only. Higher R-Values may be used in the trade-off calculations when certified by an approved testing laboratory.

E-2505.4 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.

E-2506 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.

(Delete pages 269-270)

Part VIII – Standards

Chapter 26
STANDARDS

SECTION S-26.000 – GENERAL

The following is a listing of standards which are referenced in this code, the date of the standard and the promulgating agency of the standard. The specific subsection of the code in which each standard is referenced is also identified. The digits following the decimal in the section numbers of this chapter refer to that section of this code where the standards are put in alphabetical order referenced.

SECTION S-26.001 – ABBREVIATIONS

The abbreviations preceding these standards shall have the following meaning and are the organizations issuing the standards and publications listed.

AA — Aluminum Association
818 Connecticut Avenue, NW, Washington, D.C. 20006

AAMA — American Architectural Manufacturers Association
2700 River Road, Des Plaines, IL 60018

ACCA — Air Conditioning Contractors of America
1228 17th Street, NW, Washington, D.C. 20036

ACI — American Concrete Institute
P.O. Box 19150, Detroit, MI 48219

AHA — American Hardboard Association
887-B Wilmette Road, Palatine, IL 60067

AISC — American Institute of Steel Construction
400 N. Michigan Avenue, Chicago, IL 60611

AISI — American Iron and Steel Institute
1000 16th Street, NW, Washington, D.C. 20036

ALSC — American Lumber Standard Committee
P.O. Box 210, Germanton, Md. 20875-0210

ANSI — American National Standards Institute
1430 Broadway, New York, NY 10018

APA — American Plywood Association
P.O. Box 11700, Tacoma, WA 98411

ASCE — American Society of Civil Engineers
345 E. 47th Street, New York, NY 10017

ASHRAE — American Society of Heating, Refrigeration, and Air Conditioning Engineers
1791 Tullie Circle, N. E., Atlanta, Ga 30329

ASME — American Society of Mechanical Engineers
United Engineering Center, 345 E. 47th Street
New York, NY 10017

ASSE — American Society of Sanitary Engineering
P.O. Box 40362, Bay Village, OH 44140

ASTM — American Society for Testing and Materials
1916 Race Street, Philadelphia, PA 19103

AWPA — American Wood Preservers Association
P.O. Box 849, Stevensville, MD 21666

BIA — Brick Institute of America
11490 Commerce Park Drive, Suite 300, Reston, VA 22091

CABO — Council of American Building Officials
5203 Leesburg Pike, Suite 708, Falls Church, VA 22041

CISPI — Cast Iron Soil Pipe Institute
1499 Chain Bridge Road, McLean, VA 22101

CPSC — Consumer Products Safety Commission
Office of the Secretary, Washington, D.C. 20207

CSSB — Cedar Shake and Shingle Bureau
515 116th Avenue, NE, Suite 275, Bellevue, WA 98004

CWC — Canadian Wood Council
55 Metcalfe Street, Suite 1550, Ottawa, Ontario
Canada K1P6L5

DOC — U.S. Department of Commerce
National Bureau of Standards, Washington, D.C. 20234

FM — Factory Mutual Engineering Corporation
1151 Boston Providence Turnpike, Norwood, MA 02062

FS — Federal Specification
Department of Commerce, Washington, D.C. 20230

GA — Gypsum Association
1603 Orrington Avenue, Suite 1210, Evanston, IL 60201

HPMA — Hardwood Plywood Manufacturers Association
P.O. Box 2789, Reston, VA 22090

NAHB — National Association of Home Builders
15th and M Streets, NW, Washington, D.C. 20005

NCMA — National Concrete Masonry Association
2302 Horse Pen Road, P.O. Box 781, Herndon, VA 22070

NFiPA — National Fire Protection Association
Batterymarch Park, Quincy, MA 02269

NFoPA — National Forest Products Association
1250 Connecticut Avenue, NW, Washington, D.C. 20036

NWWDA — National Wood Window and Door Association
1400 E. Touhy Avenue, Suite G-54, Des Plaines, IL 60018

PTI — Post-Tensioning Institute
1717 W. Northern Ave., Suite 218, Phoenix, AZ 85021-5469

SFPA — Southern Forest Products Association
P.O. Box 52468, New Orleans, LA 70152

SMACNA — Sheet Metal and Air Conditioning Contractors
National Association, Inc.
4201 Lafayette Center Drive, Chantilly, VA 22021

SPI — Society of the Plastics Industry
355 Lexington Avenue, New York, NY 10017

SPIB — Southern Pine Inspection Bureau
4701 Scenic Highway
Pensacola, Fl 32504-9094

TPI — Truss Plate Institute
583 D'Onofrio Drive, Suite 200, Madison, WI 53719

UL — Underwriters Laboratories Inc.
333 Pfingsten Road, Northbrook, IL 60062

WRI — Wire Reinforcement Institute
8361A Greensboro Drive, McLean, VA 22102

SECTION S-26.118 – DEFINITIONS

ASTM

C55—1985 Concrete Building Brick ..... Def. of "Solid Masonry"

C62—1989 Building Brick (Solid Masonry Units Made From Clay or Shale) ..... "Def. of Solid Masonry"

C73—1985 Sand-Lime Building Brick ..... "Def. of Solid Masonry"

C90—1985 Hollow Load-Bearing Concrete Masonry ..... Def. of "Hollow Masonry"

C129—1985 NonLoad-bearing Concrete Masonry Units ..... Def of "Hollow Masonry"

C145—1985 Solid Load-Bearing Concrete Masonry Units ..... "Def. of Solid Masonry"

C216—1989 Facing Brick (Solid Masonry Units Made From Clay or Shale) ..... "Def. of Solid Masonry"

C652—1985 Hollow Brick (Hollow Masonry Units Made From Clay or Shale) ..... Def of "Hollow Masonry"

F547—1977(Reapproved 1990) Standard Terminology of Nails for Use with Wood and Wood-Base Materials ..... Def of "Nails"

SECTION S-26.201 – DESIGN CRITERIA

ASCE

7—1993 Minimum Design Loads for Buildings and Other Structures ..... Tables R-201.2

ASTM

C34—1984 Structural Clay Load-Bearing Wall Tile ..... Table R-201.2

C55—1985 Concrete Building Brick ..... Table R-201.2

C62—1992C Building Brick (Solid Masonry Units Made From Clay or Shale) ..... Table R-201.2

C73—1985 Sand-Lime Building Brick ..... Table R-201.2

C90—1985	Hollow Load-Bearing Concrete Masonry Units	Table R-201.2
C129—1985	NonLoad-bearing Concrete Masonry Units	Table R-201.2
C145—1985	Solid Load-Bearing Concrete Masonry Units	Table R-201.2
C216—1994	Facing Brick (Solid Masonry Units Made From Clay or Shale)	Table R-201.2
C652—1994	Hollow Brick (Hollow Masonry Units Made From Clay or Shale)	Table R-201.2
SBCCI		
SSTD10—1993	Standard for Hurricane Resistant Residential Construction	Tables R-201.2

SECTION S-26.208 – GLAZING

ASCE		
7—1993	Minimum Design Loads for Buildings and Other Structures	Tables R-208.5b
ANSI		
Z97.1—1984	Safety Glazing Materials Used in Buildings, Performance Specifications and Methods of Test for	R-208.3
CPSC		
16 CFR, Part 1201—1977	Architectural Glazing Standards and Related Materials	R-208.3

SECTION S-26.216 – FOAM PLASTIC

ASTM		
E84—1987	Surface Burning Characteristics of Building Materials, Test Method for	R-216.1, R-216.2.6, R-216.3
E119—1988	Fire Test of Building Construction and Materials, Methods of	R-216.1
E152—1981a	Fire Test of Door Assemblies	R-216.3
FM		
4450—1989	Class I Insulated Steel Deck Roofs, Approval Standard for	R-216.2.2
4880—1972	Factory Mutual Building Corner Fire Test	R-216.1, R-216.3
NFiPA		
259—1993	Potential Heat of Building Materials, Standard Method of Test for	R-216.2.5

UL

1040—1971 (1980)	Outline of Investigation for Insulated Wall Construction	R-216.1, R-216.3
1256—1985	Fire Test of Roof Deck Construction	R-216.2.2
1715—1989	Outline of Investigation of Classifications of Interior Finish Material Assemblies Using a Room Fire Test	R-216.1, R-216.3

SECTION S-26.217 – INTERIOR FINISHES

ASTM

E84—1987	Surface Burning Characteristics of Building Materials, Test Method for	R-217.4

SECTION S-26.218 – DWELLING UNIT SEPARATION

ASTM

E119—1988	Fire Test of Building Construction and Materials, Methods of	R-218
E90—1990	Standard test method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions	R-218.3
E492—1990	Standard Test Method for Laboratory Measurement of Impact Sound Transmission Through Floor-Ceiling Using the Trapping Machine	R-218.3

SECTION S-26.220 — MOISTURE VAPOR RETARDERS

ASTM

E96—1990	Standard Test for Water Vapor Transmission of Materials	R-220

SECTION S-26.302 – FOUNDATION MATERIALS

AWPB

C22—1990	Lumber and Plywood for Permanent Wood Foundations—Preservative Treatment by Pressure Process	R-302.1

NFoPA

Technical Report No. 7—1987	The Permanent Wood Foundation System, Basic Requirements R-302.1

SECTION S-26.303 – FOOTINGS

NFoPA

Technical Report No. 7—1987	The Permanent Wood Foundation System, Basic Requirements R-303

PTI

PTI—1980	Post-Tensioned Slabs-on-Ground R-303

WRI

WRI—1981	Design of Slabs-on-Ground Foundations R-303

SECTION S-26.304 – FOUNDATION WALLS

ACI

318—1989	Building Code Requirements for Reinforced Concrete R-304.1
318.1—1989	Building Code Requirements for Structural Plain Concrete R-304.1

ACI/ASCE

530—1988	Building Code Requirements for Masonry Structures R-304.1

AWPA

C22—1990	Lumber and Plywood for Permanent Wood Foundations —Preservative Treatment by Pressure Process R-304.5

BIA

BIA—1969	Building Code Requirements for Engineered Brick Masonry R-304.1

DOC

PS1—1983	Construction and Industrial Plywood ..... Table R-304.5
PS 2-1992	Performance Standard for Wood Structural Panels ..... Table R-304.5

NCMA

TR68-A—1975	Design and Construction of Plain and Reinforced Concrete Masonry Basement and Foundation Walls	R-304.1

NFoPA

Technical Report No. 7—1987	The Permanent Wood Foundation System, Basic Requirements	R-304.5, Table R-304.5

SECTION S-26.305 – FOUNDATION DRAINAGE

NFoPA

Technical Report No. 7—1987	The Permanent Wood Foundation System, Basic Requirements	R-305.2

SECTION S-26.306 – FOUNDATION DAMPPROOFING

NFoPA

Technical Report No. 7—1987	The Permanent Wood Foundation System, Basic Requirements	R-306.2

SECTION S-26.309 – PROTECTION AGAINST DECAY AND TERMITES

AWPA

C1—1988	Pressure Treatment (General Requirements), All Timber Products	R-308.1
C2—1989	Pressure Treatment, Lumber, Timber, Bridge Ties and Mine Ties	R-308.1
C3—1989	Pressure Treatment, Piles	R-308.1
C4—1989	Pressure Treatment, Poles	R-308.1
C9—1985	Pressure Treatment, Plywood	R-308.1
C15—1989	Wood for Commercial-Residential Construction, Preservative Treatment by Pressure Process	R-308.1
C18—1989	Standard for Pressure-Treated Material in Marine Construction	R-308.1

C20-1988	Structural Lumber–Fire-Retardant Treatment by Pressure Processes	R-308.1
C22-1990	Lumber and Plywood for Permanent Wood Foundations –Preservative Treatment by Pressure Process	R-308.1
C23-1984	Round Poles and Posts Used in Building Construction, Preservative Treatment by Pressure Process	R-308.1
C24-1986	Sawn Timber Piles Used for Residential and Commercial Building	R-308.1
C27-1988	Plywood–Fire-Retardant Treatment by Pressure Processes	R-308.1
C28-1989	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	R-308.1
P1-1989	Standard for Coal Tar Creosote for Land and Fresh Water and Marine (Coastal Water Use)	R-308.1
P2-1989	Standard for Cresote and Cresote Solutions	R-308.1
P3-1989	Standard for Cresote–Petroleum Oil Solution	R-308.1
NFoPA		
Technical Report No. 7-1987	The Permanent Wood Foundation System, Basic Requirements	R-308.3

SECTION S-26.310–PROTECTION AGAINST TERMITES

AWPA		
M4-1988	Care of Preservative Treated Wood	R-310.3
USDAForest Service		
Home and Garden Bulletin No. 64 -1989	Subterranean Termites, Their Prevention and Control in Buildings	R-310.2

SECTION S-26.402–DIMENSION LUMBER

AHA		
194.1-1985	Cellulosic Fiber Board	Table R-402.3a
ASTM		
C79-1987	Test Method for Gypsum Sheathing Board	Table R-402.3a

C208-1972 Specification for Insulating Board (Cellulosic Fiber) Structural and Decorative (Reapproved 1982).....Table R-402.3a

D2277-1987 Specification for Fiberboard Nail Base Sheathing (Reapproved 1987).....Table R-402.3a

DOC

PSI-1983 Construction and Industrial Plywood.....R-402.6

PS 2-1992 Performance Standard for Wood Structural Panels ..R-402.6

NAHB

NAHB-1983 Plywood Headers for Residential Construction, Table F; Construction Guide, Design Tables and Technical Report, NAHB Research Report 5.....R-402.6

NFoPA

NDS-1991 National Design Specification for Wood

NDS(supp)-1991Construction (with Supplement of Design Values for Wood Construction) R-402.3

SBCCI

SSTD10—1993 Standard for Hurricane Resistant Residential Construction R-402.3

SECTION S-26.403–METAL

AA

SAS30-1986 Specifications for Aluminum Structures.....R-403

AISC

AISC-1978 Specification for the Design, Fabrication and Erection of Structural Steel for Buildings.....R-403

AISI

AISI-1986 Specification for the Design of Cold-Formed Steel Structural Members.....R-403

SECTION S-26.404–MASONRY–GENERAL

ACI/ASCE

530-1988 Building Code Requirements for Masonry Structures.....R-404.3.1, R-404.3.2

AISC

AISC-1978 Specification for the Design, Fabrication and Erection of Structural Steel Buildings.....R-404.8

ASTM

A36-1988	Specification for Structural Steel.....R-404.13
A82-1988	Specifications for Steel Wire, Plain, Concrete Reinforcement.....R-404.13
A153-1982	Specifications for Zinc-Coated (Hot-Dip) on Iron and Steel Hardware.....Table No. R-404.13.1
A167-1988	Specifications for Stainless and Heat-Resisting Chronium-Nickel Steel Plate, Sheet and Strip.....R-404.13 .....Table No. R-404.13.1
A510-1982	Specifications for Wire Rods and Coarse Round Wire, Carbon Steel.....R-404.13
A525-1987	Specification for Steel sheet, Zinc-Coated (Galvanized) by Hot-Dip Process.....Table No. R-404.13.1
A641-1982	Specification for Zinc-Coated (Galvanized) Steel Wire.....Table No. R-404.13.1
B227-1980	Specification for Hard-Drawn Copper-Clad Steel Wire.....R-404.13

BIA

BIA-1969	Building Code Requirements for Engineered.....R-404.3.1 Brick Masonry.....R-404.3.2
TN17H-1986	Reinforced Brick and Tile Lintels, July, 1986.....R-404.8
TN31A-1986	Structural Design of Brick Masonry Arches, July, 1980.....R-404.8
TN31B-1987	Structural Steel Lintels, May, 1987.....R-404.8

NCMA

TEK25A-1985	Concrete Masonry Lintels.....R-404.8
TEK81-1976	Lintels for Concrete Masonry Walls.....R-404.8
TR91-1977	Design Tables for Reinforced Concrete Masonry Lintels for Concrete Masonry Structures.....R-404.8

SECTION S-26.408–MORTAR AND GROUT – MASONRY WYTHES

ASTM

C270-1989	Specification for Mortar for Unit Masonry.....R-408.2
C476-1983	Specification for Grout for Masonry.....R-408.2

SECTION S-26.410–MORTAR AND GROUT – HOLLOW MASONRY

ASTM

C270-1989 Specification for Mortar for Unit Masonry.....R-410.2

C476-1983 Specification for Grout Masonry R-410.21

SECTION S-26.411 – WINDOWS AND DOORS

AAMA

101-1988 Voluntary Specification for Aluminum Prime Windows and Sliding Glass Doors R-411

ASTM

D4099-1989 Standard Specification for Poly (Vinyl Chloride) (PVC) Prime Windows R-411

E283-1984 Test Method for Rate of Air Leakage Through Exterior Windows, Curtain Walls and Doors R-411

NWWDA

1.S.2-1987 Industry Standard for Wood Window Units R-411

SECTION S-26.412 – DOORS

AAMA

101-1988 Voluntary Specification for Aluminum Prime Windows and Sliding Glass Doors R-412

ASTM

E283-1984 Test Method for Rate of Air Leakage Through Exterior Windows, Curtain Walls and Doors.....R-412

NWWDA

1.S.3-1988 Industry Standard forWood Sliding Patio Doors.....R-412

SECTION S-26.413 – WOOD STRUCTURAL PANELS

APA

E30-1993 Design and Construction Guide: Residential and Commercial.....R-413.1

PRP-108-1988 Performance Standards and Policies for Structural Use Panels.....R-413.1

Y510-1986 Plywood Design Specifications.....R-413.1

DOC

PSI-1983 Construction and Industrial Plywood.....R-413.1

PS 2-1992 Performance Standard for Wood Structural Panels.....413.1

HPMA

HP-1983 Hardwood and Decorative Plywood.....R-413.1

HP-SG-1986 Structural Design Guide for Hardwood Plywood.....R-413.1

SECTION S-26.414 – PARTICLEBOARD

ANSI

A208.1-1989 Wood Particleboard.....R-414.1

SECTION S-26.502 – WALL COVERINGS – INTERIOR

ANSI

A108.1-1985 Installation of Ceramic Tile with Portland Cement Mortar.....R-502.6

A108.4-1985 Ceramic Tile Installed With Water-Resistant Organic Adhesives.....R-502.6

A108.5-1985 Installation of Ceramic Tile with Dry-Set Portland Cement Mortar or Latex-Portland Cement Mortar.....R-502.6

A108.6-1985 Installation of Ceramic Tile with Chemical-Resistant, Water Cleanable Tile – Setting and Grouting Epoxy.....R-502.6

A118.1-1985 Dry-Set Portland Cement Mortar (for Ceramic Tile).....R-502.6

A118.3-1985 Standard Specifications for Chemical-Resistant, Water Cleanable Tile – Setting and Grouting Epoxy.....R-502.6

A136.1-1985 Standard for Organic Adhesives for Installation of Ceramic Tile, Types I and II.....R-502.6

A137.1-1988 Ceramic Tile.....R-502.6

ASTM

C5-1979	Specification for Quicklime for Structural Purposes (Reapproved 1984)	R-502.4
C28-1986	Specification for Gypsum Plasters	R-502.4
C35-1989	Specification for Inorganic Aggregates for Use in Gypsum Plaster	R-502.4
C36-1985	Specification for Gypsum Wallboard	R-502.5
C37-1987	Specification for Gypsum Lath	R-502.4
C59-1983	Specification for Gypsum Casting and Molding Plaster	R-502.4
C61-1987	Specification for Gypsum Keene's Cement (Reapproved 1981)	R-502.4
C474-1987	Test Method for Joint Treatment Materials for Gypsum Board Construction	R-502.5
C475-1989	Specification for Joint Treatment Materials for Gypsum Wallboard Construction	R-502.5
C557-1973	Specification for Adhesives for Fastening Gypsum Wallboard to Wood Framing (Reapproved 1985)	R-502.5
C587-1983	Specification for Gypsum Veneer Plaster	R-502.4
C588-1984a	Specification for Gypsum Base for Veneer Plasters	R-502.4
C631-1988	Standard Specification for Bonding Compounds for Interior Plastering	R-502.4
C841-1987	Specification for Installation of Interior Lathin and Furring	R-502.4
C842-1985	Specification for Application of Interior Gypsum Plaster	R-502.4
C-847-1988	Specification for Metal Lath	R-502.4
C926-1986	Application of Portland Cement-Based Plaster	R-502.4
C933-1980	Standard Specification for Welded Wire Lath (Reapproved 1985)	R-502.4
C1002-1988	Specification for Drill-Screws for the Application of Gypsum Board	Table R-502.5

CSSB

CSSB-1989	Cedar Shake and Shingle Bureau Design and Application Manual for Exterior and Interior Walls	R-502.7

CSSB-1985	Grading and Packing Rules for Certi-Split Red Cedar Shakes (Revised October 1, 1985)	R-502.7
CSSB-1984	Grading and Packing Rules for Certigrade Red Cedar Shingles (Revised February 1, 1984)	R-502.7
CSSB-1990	Grading Rules for Certi-Sawn Red Cedar Shakes (Revised May 30, 1990)	R-502.7
GA		
216-1989	Recommended Specification for Application and Finishing of Gypsum Board	R-502.5
HPMA		
HP-1983	Hardwood and Decorative Plywood	R-502.7

SECTION S-26.503 – WALL COVERINGS – EXTERIOR

ASTM		
C926-1986	Application of Portland Cement-Based Plaster	R-503.3
AHA		
A135.6	1989 Hardboard Siding	Table R-503.6
AAMA		
1402-1989	Standard Specifications for Aluminum Siding, Soffit and Fascia	Table R-503.6
CSSB		
CSSB-1992	Grading Rules for Wood Shakes and Shingles	R-503.5
CSSB-1989	Cedar Shake and Single Bureau Design and Application Manual for Exterior and Interior Walls	R-503.10
NFoPA		
Technical Report No. 7-1987	The Permanent Wood Foundation System, Basic Requirements	R-503.4

SECTION S-26.601–FLOORS–DESIGN AND CONSTRUCTION

CWC

CWC-1987	Canadian Dimension Lumber Data Book	R-601.2

HPMA

LHF-1987	Laminated Hardwood Flooring	R-601.2

NFoPA

NFoPA-1986 (1987) NDS (supp) 1988	National Design Specification for Wood Construction (with Supplement of Design Values for Wood Construction)	R-601.2

SFPA

SFPA-1989	Southern Pine Maximum Spans for Joists and Rafters	R-601.2

SECTION S-26.602–FLOOR JOISTS AND TRUSSES

NAHB

NAHB-1982	NAHB Research Report; Design Tables-Fabrication Guide, Off-Center Spliced Floor Joists	R-602.2.1

TPI

BWT-1976	Backing Wood Trusses: Commentary and Recommendations	R-602.9
PCT-1980	Design Specification for Metal Plate Connected Parallel Chord Wood Trusses	R-602.9
QST-1989	Quality Standard for Metal Plate Connected Wood Trusses	R-602.9
TPI-1985	Design Specification for Metal Plate Connected Wood Trusses	R-602.9

SECTION S-26.604 – FLOORS – TREATED WOOD

AWPA

C22-1988	Lumber and Plywood for Permanent Wood Foundations–Preservative Treatment by Pressure Process	R-604.3

NFoPA

Technical Report No. 7-1987	The Permanent Wood Foundation System, Basic Requirements.....R-604.3

SECTION S-26.605 – FLOORS – METAL

AA

SAS30-1986	Specifications for Aluminum Structures.....R-605

AISC

AISC-1978	Specification for the Design, Fabrication and Erection of Structural Steel for Buildings.....R-605

SECTION S-26.606 – FLOORS – WOOD STRUCTURAL PANELS

APA

E30-1993	Design and Construction Guide: Residential and Commercial R-606.1
PRP-108-1988	Performance Standards and Policies for Structural Use Panels.....R-606.1
Y510-1986	Plywood Design Specifications.....R-606.1

DOC

PS1-1983	Construction and Industrial Plywood.....R-606.1
PS 2-1992	Performance Standard for Wood Structural Panels ..R-606.1

HPMA

HP-1983	Hardwood and Decorative Plywood R-606.1
HP-SG-1986	Structural Design Guide for Hardwood Plywood.....R-606.1

SECTION S-26.607 – FLOORS – PARTICLEBOARD

ANSI

A208.1-1989	Wood Particleboard.....R-607.1

SECTION S-26.701–ROOF-CEILINGS–DESIGN AND CONSTRUCTION

CWC

CWC-1987	Canadian Dimension Lumber Data Book R-701.2

NFoPA

NFoPA-1991 NDS (Supp)-1991	National Design Specification for Wood Construction (with Supplement of Design Values for Wood Construction).....R-701.2

SFPA

SFPA-1989 Southern Pine Maximum Spans for Joists and Rafters R-701.2

SECTION S-26.702–ROOF TRUSSES

SBCCI

SSTD10-93 Standard for Hurricane Resistant Residential Construction ..... Table R-702.10

TPI

BWT-1976 Bracing Wood Trusses: Commentary and Recommendations R-702.9

PCT-1980 Design Specification for Metal Plate Connected Parallel Chord Wood Trusses R-702.9

QST-1989 Quality Standard for Metal Plate Connected Wood Trusses R-702.9

TPI-1985 Design Specifications for Metal Plate Connected Wood Trusses R-702.9

SECTION S-26.703–ROOFS–WOOD STRUCTURAL PANELS

APA

E30-1993 Design and Construction Guide: Residential and Commercial R-703.3

PRP-108-1988 Performance Standards and Policies for Structural Use Panels R-703.1

DOC

PS1-1983 Construction and Industrial Plywood R-703.1

PS 2-1992 Performance Standard for Wood Structural Panels ..R-703.1

SECTION S-26.704–ROOFS–PARTICLEBOARD

ANSI

A208.1-1989 Wood Particleboard R-704.1

SECTION S-26.705–ROOFS–METAL

AA

SAS30-1986 Specifications for Aluminum Structures R-705.2

AISC

AISC-1978	Specification for the Design, Fabrication and Erection of Structural Steel for Buildings	R-705.1

SECTION S-26.801–ROOF COVERING MATERIALS

AA

ASM35-1980	Specifications for Aluminum Sheet Metal Work in Building Construction	R-801.3

ASTM

A239-1973	Test Method for Locating the Thinnest Spot in a Zinc (Galvanized) Coating on Iron or Steel Articles by the Preece Test (Copper Sulfate Dip) (Reapproved 1983)	R-801.3
A361-1985	Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process for Roofing and Siding	R-801.3
B134-1988	Specification for Brass Wire	R-801.3
B209-1989	Specification for Aluminum and Aluminum-Alloy Sheet and Plate	R-801.3
B211-1988	Specification for Aluminum and Aluminum-Alloy Bars, Rods and Wire	R-801.3
B250-1987	Specification for General Requirements for Wrought Copper-Alloy Wire	R-801.3
C406-1984	Specification for Roofing Slate	R-801.3
D312-1984	Specification for Asphalt Used in Roofing	R-801.3

CSSB

CSSB-1992	Grading Rules for Wood Shakes and Shingles	R-801.3

UL

55A-1983	Materials for Built-Up Roof Coverings (Revised 1985)	R-801.3
790-1983	Test for Fire Resistance of Roof Covering Materials	R-801.3

SECTION S-26.807–ROOF COVERINGS – INSULATION

ASTM

D312-1984 Specification for Asphalt Used in Roofing R-807.3

SECTION S-26.808 – WOOD SHINGLES

CSSB

CSSB-1992 Grading Rules for Wood Shakes and Shingles R-808.2

CSSB-1989 Cedar Shake and Shingle Bureau Design and Application Manual for New Roof Construction R-808.2

SECTION S-26.809 – WOOD SHAKES

CSSB

CSSB-1992 Grading Rules for Wood Shakes and Shingles R-809.2

CSSB-1990 Wood Shakes (Preservative Treated) Based on Grading and Packing Rules for Treated Southern Pine Taper-Sawn Shakes of the Cedar Shake and Shingle Bureau R-809.2

CSSB-1989 Cedar Shake and Shingle Bureau Design and Application Manual for New Roof Construction R-809.2

SECTION S-26.1003 – TYPE OF FUEL

ANSI

Z21.17-1984 Domestic Gas Conversion Bureau M-1003

Z21.8-1984 Installation of Domestic Gas Conversion Burners M-1003

SECTION S-26.1010 – DEFINITIONS

AGA		
7-90	AGA Requirements for Gas Convenience Outlets	Def. of "Convenience Outlet, Gas"
ASTM		
E84-1987	Test Method for Surface Burning Characteristics of Building Materials	Def. of "Flame-Spread Rating" and "Smoke-Developed Rating"
E136-1982	Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°F	Def. of "Noncombustible Material"
UL		
103	Chimneys, Factory-Built, Residential Type and Building Heating Appliances	Def. of "H.T. Chimney"
441	Gas Vents	Def. "Type B and Type BW Vents"
641	Low-Temperature Venting Systems, Type L	Def. of "Type L Vents"

SECTION S-26.1101 – HEATING AND COOLING EQUIPMENT

ACCA		
Manual J-1986	Load Calculation for Residential Winter and Summer Air Conditioning, 7th edition	M-1101.1.2
ANSI		
Z21.47-1983	Gas-Fired Central Furnaces (Except Direct Vent and Separated Combustion System Central Furnaces), with Addenda Z21.47a-1985 and Z21.47b-1986	M-1101.2.1
Z21.64-1985	Direct Vent Central Furnaces, with Addenda Z21.64a-1986	M-1101.2.1
ANSI/ASHRAE		
15-89	Safety Code for Mechanical Refrigeration	M-1101.4.1

SECTION S-26.1102 – DUCT SYSTEMS

ACCA		
Manual D-1984	Duct Design and Residential Winder and Summer Air Conditioning and Equipment Selection	M-1102.2.1

ASTM

A525-1991 — Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process.....M-1102.1

C411-1982 — Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation (Reapproved 1987).....M-1102.1.2

D1784-1990 — Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Viny Chloride) (CPVC) Compounds M-1102.1

D2412-1987 — Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading.....M-1102.1

SMACNA

SMACNA-1988 — Installation Standards for Residential Heating and Air-Conditioning Systems.....M-1102.2.1

UL

181-1990 — Factory Made Air Ducts and Connectors.....M-1102.1.1

SECTION S-26.1304 – HYDRONIC PIPING MATERIALS

ASTM

A53-1990 — Specification for Pipe, Steel, Black, and Hot-Dipped, Zinc-Coated Welded and Seamless .....Table M-1304.1

A106-1990 — Specification for Seamless Carbon Steel Pipe for High Temperature Service.....Table M-1304.1

A254-1991 — Specification for Copper-Brazed Steel Tubing .....Table M-1304.1

B42-1989 — Specification for Seamless Copper Pipe, Standard Sizes .....Table M-1304.1

B43-1991 — Specification for Seamless Red Brass Pipe, Standard Sizes .....Table M-1304.1

B75-1986 — Specification for Seamless Copper Tube.....Table M-1304.1

B88-1989 — Specification for Seamless Copper Water Tube.....Table M-1304.1

B251-1988 — Specifications for General Requirements for Wrought Seamless Copper and Copper-Alloy Tube.....Table M-1304.1

B135-1991 — Specification for Seamless Brass Tube.....Table M-1304.1

B302-1988 — Specification for Threadless Copper Pipe.....Table M-1304.1

D3309-1989 — Specification for Polybutylene (PB) Plastic Hot- and Cold-Water Distribution Systems .....Table M-1304.1

F876-1990 — Specification for Crosslinked Polyethylene (PEX) Tubing .....Table M-1304.1

F877-1989 Specification for Crosslinked Polyethylene (PEX) Tubing Plastic Hot- and Cold-Water Distribution Systems ..... Table M-1304.1

SECTION S-26.1401–VENTED ROOM HEATERS

ANSI

Z21.48-1986 Gas-Fired Gravity and Fan Type Floor Furnaces M-1401.1

SECTION S-26.1402–VENTED WALL FURNACES

ANSI

Z21.44-1985 Gas-Fired Gravity and Fan Type Direct Vent Wall Furnaces, with Addenda Z21.44a-1985 ..... M-1402.1

Z21.49-1986 Gas-Fired Gravity and Fan Type Vented Wall Furnaces M-1402.1

SECTION S-26.1403–VENTED ROOM HEATERS

ANSI

Z21.11.1-1983 Vented Room Heaters, Volume I, with Addenda Z21.11.2a-1984 ..... M-1403.1

Z21.11.2-1992 Gas Fired Room Heaters, Volume II Unvented Room Heaters M-1403.1

SECTION S-26.1602–VENT COMPONENTS

ANSI

Z21.66-1985 Electrically Operated Automatic Vent Damper Devices for Use with Gas-Fired Appliances M-1602.2.2

Z21.67-1985 Mechanically Actuated Automatic Vent Damper Devices for Use with Gas-Fired Appliances M-1602.2.2

Z21.68-1985 Thermally Activated Automatic Vent Damper Devices for Use with Gas Fired Appliances M-1602.2.2

SECTION S-26.1604–VENTS

NFiPA

54/ANSI Z223.1-1988 National Fuel Gas Code M-1604.3.1, M-1604.3.2

UL

441 Gas Vents M-1604.2.3

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SECTION S-26.1605–MASONRY AND FACTORY-BUILT CHIMNEYS

NFiPA 54/ANSI Z223.1-1988	National Fuel Gas Code M-1605.4

SECTION S-26.1704–GAS PIPING MATERIALS

ANSI/AGA LCI-91	AGA Requirements for Interior Natural Gas Piping Systems Using Corrugated Stainless Steel Conduit.....Table M-1704.1
ASTM A53-1990	Specification for Pipe, Steel, Black, and Hot-Dipped, Zinc-Coated Welded and Seamless.....Table M-1704.1
A106-1990	Specification for Seamless Carbon Steel Pipe for High Temperature Service .....Table M-1704.1
B42-1989	Specification for Seamless Copper Pipe, Standard Sizes .....Table M-1704.1
B43-1991	Specificaton for Seamless Red Brass Pipe, Standard Sizes .....Table M-1704.1
B68-1986	Specification for Seamless Copper Tube, Bright Annealed .....Table M-1704.1
B75-1986	Specification for Seamless Copper Tube.....Table M-1704.1
B88-1989	Specification for Seamless Copper Water Tube.....Table M-1704.1
B280-1988	Specification for Seamless Copper Tube for Air Conditioning and Refrigertion Field Service.....Table M-1704.1
B302-1988	Specification for Threadless Copper Pipe.....Table M-1704.1
D2513-1990	Specifications for Thermoplastic Gas Pressure Pipe, Tubing and Fittings .....Table M-1704.1

SECTION S-26.1705–GAS VALVES

AGA 7–9	Requirements for Gas Convenience Outlets M-1705.5
ANSI Z21.15-1979	Manually Operated Gas Valves with Addenda Z21.15a-1981 and Z21.15b-1984.....M-1705.1

SECTION S-26.1708–GAS PIPE SIZING

N.C. State Building Code, Volume IV-Gas M-1708.2

SECTION S-26.1710–LIQUIFIED PETROLEUM GAS SYSTEMS

UL

144-1985 Pressure-Regulating Valves for LP Gas.....M-1710.1

SECTION S-26.1802–OIL PIPING, FITTINGS, AND CONNECTIONS

ASTM

A539-1990 Specification for Electric-Resistance-Welded Coiled Steel Tubing for Gas and Fuel Oil Lines.....M-1802.1

SECTION S-26.1901–RANGES AND OVENS

ANSI

Z21.1-1987 Household Cooking Gas Appliances, with Addenda Z21.1a-1982 and Z21.1b-1984.....M-1901.2

SECTION S-26.1902–OPEN TOP BROILER UNITS

ANSI

Z21.1-1987 Household Cooking Gas Appliances, with Addenda Z21.1a-1982 and Z21.1b-1984.....M-1902.1

SECTION S-26.1903–OUTDOOR COOKING APPLIANCES

ANSI

Z21.54-1987 Gas Hose Connectors for Portable Outdoor Gas-Fired Appliances, with Addenda Z21.54a-1983 and Z21.54b-1985 .....M-1903

Z21.58-1987	Outdoor Cooking Gas Appliances, with Addenda Z-21.58a-1982 and Z21.58b-1985 .....M-1903

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ANSI

Z21.5.1-1982	Gas Clothes Dryers, Volume I, Type 1 .....M-1904.1

SECTION S-26.1906 – VENTED DECORATIVE APPLIANCES

ANSI

Z21.50-1986	Vented Decorative Gas Appliances.....M-1906.1

SECTION S-26.1911 – COMPRESSED NATURAL GAS RESIDENTIAL FUELING FACILITIES

NFiPA

52-1988	Standard for Compressed Natural Gas (CNG) Vehicular Fuel Systems.....M-1911

SECTION S-26.2001– PLUMGING STANDARDS–GENERAL

(As Listed in Table P-2001.1)

ANSI

A112.1.2-1942	Air Gaps in Plumbing Systems
B16.12-1983	Cast Iron Threaded Drainage Fittings
B16.22-1989	Wrought Copper and Copper-Alloy Solder Joint Pressure Fittings
B16.26-1988	Cast Copper-Alloy Fittings for Flared Copper Tubes
Z21.10.1-1987	Storage Water Heaters with Input Ratings of 75,000 Btu per Hour or Less, Gas Water Heaters, Volume I with Addenda Z21.10.1a–1988
Z21.10.3-1987	Gas Water Heaters, Volume III, Circulating and Storage, with Input Ratings above 75,000 Btu per Hour, with Addenda Z21.10.3a–1988 Table P
Z21.12-1981	Draft Hood, with Addenda Z21.12a–1983
Z21.13-1987	Gas–Fired Low-Pressure Steam and Hot Water Boilers
Z21.22-1986	Relief Valves and Automatic Gas Shutoff Devices for Hot Water Supply Systems
Z21.24-1987	Metal Connectors for Gas Appliances
Z21.41-1989	Quick-Disconnect Devices for Use with Gas Fuel
Z21.45-1985	Flexible Connectors of Other Than All-Metal Construction for Gas Appliances with Addenda Z21.45a-1987
Z124.1-1987	Plastic Bathtub Units

Z124.2-1987	Plastic Shower Receptors and Shower Stalls
Z124.3-1986	Plastic Lavatories
Z124.4-1986	Plastic Water Closet Bowls and Tanks
Z124.6-1990	Plastic Sinks
ANSI/NSF	
14-1990	Plastic Piping Components and Related Materials
ASME	
A112.18.1M -1989	Plumbing Fixture Fittings
B16.18-1984	Cast Copper Alloy Solder Joist Pressure Fittings
B16.23-1984	Cast Copper Alloy Solder-Joint Drainage Fittings
ASME/ANSI	
A112.19.1M -1987	Enameled Cast Iron Plumbing Fixtures
A112.19.2M -1990	Vitreous China Plumbing Fixtures
A112.19.3M -1987	Stainless Steel Plumbing Fixtures (Designed for Residential Use)
A112.19.4M -1984	Porcelain Enameled Formed Steel Plumbing Fixtures
A112.19.5 -1979	Trim for Water Closet Bowls, Tanks and Urinals
A112.19.6	Hydraulic Performance for Water Closets and Urinals
A112.19.7M -1987	Whirlpool Bathtub Appliances
A112.19.8M -1987	Suction Fittings for Use in Swimming Pools, Wading Pools, Spas, Hot Tubs and Whirlpool Bathtub Appliances
A112.21.1M 1980	Floor Drains
B16.3-1985	Malleable Iron Threaded Fittings, Classes 150 and 300
B16.4-1985	Cast Iron Threaded Fittings, Classes 125 and 250
B16.15-1985	Cast Bronze Threaded Fittings, Classes 125 and 250
B16.29-1986	Wrought Copper and Wrought Copper-Alloy Solder Joint Drainage Fittings, DWV
ASSE/ANSI	
1001-1988	Pipe Applied Vacuum Breakers
1002-1979(1986)	Water Closet Flush Tank Ball Cocks
1003-1981	Water Pressure Reducing Valves for Domestic Water Supply Systems
1006-1986	Household Dishwashing Machines

1007-1973(1986)	Home Laundry Equipment
1008-1973(1986)	Household Disposers
1010-1982	Water Hammer Arrestors
1011-1982	Hose Connection Vacuum Breakers
1014-1979	Handheld Showers
1016-1979	Individual Shower Control Valves, Anti-Scald
1019-1978	Wall Hydrants, Freezeless, Automatic Drainage, Anti-Backflow Types
1023-1979	Plumbing Requirements for Hot Water Dispensers, Household Storage Type, Electrical
1025-1978	Diverters for Plumbing Faucets with Hose Spray, Anti-Siphon Type, Residential Application
1037-1986	Pressurized Flushing Devices for Plumbing Fixtures

ASTM

A53-1988a	Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
A74-1987	Specification for Cast Iron Soil Pipe and Fittings
A126-1984	Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings
A197-1987	Specification for Cupola Malleable Iron
A377-1984	Specification for Ductile Iron Pressure Pipe
A525-1987	Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process
B32-1989	Specification for Solder Metal
B42-1989	Specification for Seamless Copper Pipe, Standard Size
B43-1988	Specification for Seamless Red Brass Pipe, Standard Sizes
B75-1986	Specification for Seamless Copper Tube
B88-1988a	Specification for Seamless Copper Water Tube
B135-1986a	Specification for Seamless Brass Tube
B152-1988	Specification for Copper Sheet, Strip, Plate and Rolled Bar
B306-1988	Specification for Copper Drainage Tube
B447-1989	Welded Copper Water Tube (WK, WL, WM)
C14-1988	Specification for Concrete Sewer, Storm Drain, and Culvert Pipe
C425-1988	Specification for Compression Joints for Vitrified Clay Pipe and Fittings

C564-1988	Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings (Reapproved 1982)
C700-1988	Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength and Perforated
D1527-1989	Specification for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe, Schedule 40 and 80 (Reapproved 1982)
D1785-1989	Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80 and 120
D1861-1988	Specification for Homogeneous Bituminized Fiber Drain and Sewer Pipe (Reapproved 1981)
D2104-1989	Specification for Polyethylene (PE) Plastic Pipe, Schedule 40
D2235-1988	Specification for Solvent Cement Acrylanitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings
D2239-1989	Specification for Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter
D2241-1989	Specification for Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR-Series)
D2282-1989	Specification for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe (SDR-PR)
D2321-1983a	Recommended Practice for Underground Installation of Flexible Thermoplastic Sewer Pipe
D2447-1988	Specification for Polyethylene (PE) Plastic Pipe, Schedules 40 and 80 Based on Outside Diameter
D2466-1989	Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
D2467-1989	Specification for Socket-Type Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
D2468-1989	Specification for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe Fittings, Schedule 40
D2564-1988	Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings
D2609-1989	Specification for Plastic Insert Fittings for Polyethylene (PE) Plastic Pipe
D2661-1987a	Specification for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Drain, Waste, and Vent Pipe and Fittings
D2662-1989	Specification for Polybutylene (PB) Plastic Pipe (SDR-PR)
D2665-1989a	Specification for Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings

D2666-1989	Specification for Polybutylene (PB) Plastic Tubing
D2672-1989	Specification for Bell-End Poly (Vinyl Chloride) (PVC) Pipe
D2737-1989	Specification for Polyethylene (PE) Plastic Tubing
D2751-1983a	Specifications for Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings
D2846-1989	Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Hot- and Cold-Water Distribution Systems
D3000-1989	Standard Specification for Polybutylene (PB) Plastic Pipe (SDR-PR) Based on Outside Diameter
D3034-1989	Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings
D3122-1980	Specification for Solvent Cement for Systems Rubber (SR) Plastic Pipe and Fittings (Reapproved 1985)
D3212-1989	Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
D3261-1988a	Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
D3309-1989a	Specification for Polybutylene (PB) Plastic Hot-Water Distribution Systems
F402-1988	Standard Practice for Safe Handling of Solvent Cements, Primers and Cleaners Used for Joining Thermoplastic Pipe and Fittings
F409-1988	Specification for Thermoplastic Accessible and Replaceable Plastic Tube and Tubular Fittings
F438-1989a	Specification for Socket-Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40
F439-1989	Specification for Socket-Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Fittings, Schedule 80
F441-1989	Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80

F442-1989	Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe (SDR-PR)
F493-1988	Standard Specification for Solvent Cements for Chlorinated Poly (Vinyl) (CPVC) Plastic Pipe and Fittings
F628-1988	Specification for Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe With a Cellular Core
F442-1989	Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe (SDR-PR)
F493-1988	Standard Specification for Solvent Cements for Chlorinated Poly (Vinyl) (CPVC) Plastic Pipe and Fittings
F628-1988	Specification for Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe With a Cellular Core
F656-1988	Standard Specification for Primers for Use inSolvent Cement Joints of Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings
F845-1988	Specification for Plastic Insert Fittings for Polybutylene (PB) Tubing
F891-1988a	Specification for Coextruded Poly (Vinyl Chloride) (PVC) Plastic Pipe with a Cellular Core
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
HSN-1985	Specification for Neoprene Rubber Gaskets for Hub and Spigot Cast Iron Soil Pipe and Fittings
301-1985	Specifications for Cast Iron Soil Pipe and Fittings for Hubless Cast Iron Sanitary System
CSA	
B602M-1990	Mechanical Couplings for Drain, Waste and Vent Pipe and Sewer Pipe
FS	
QQ-L-201f-2 -1965 (1970)	Sheet Lead
UL	
174-1983	Household Electric Storage Tank Water Heaters (Revised, March 1988)

441-1986	Gas Vents
726-1975	Oil-Fired Boiler Assemblies (Revised, March 1989)
732-1988	Oil-Fired Storage Tank Water Heaters

SECTION S-26.2207–VENT SYSTEMS

ASSE

1051-1990 Air Admittance Valves For Plumbing DWV Systems–Fixture and Branch Devices P-2207.6, P-2207.6.6

SECTION S-26.2309–SHOWER CONTROL VALVES

ASSE

1016-1979 Individual Shower Control Valves, Anti-Scald P-2309.4

SECTION S-26.2310–SHOWER RECEPTOR LINER MATERIALS

ASTM

D4068-1986a Specification for Chlorinated Polyethylene (CPE) Sheeting for Concealed Water Containment Membrane P-2310.2

SECTION S-26.2314–BATHTUBS

ASSE

1016-1979 Individual Shower Control Valves, Anti-scald P-2314.2

SECTION S-26.2407–UNDERGROUND JOINTS

ASTM

D3309-1988a Specification for Polyethylene (PB) Plastic Hot-Water Distribution Systems P-2407

PART VI–ELECTRICAL CODE

NFiPA

70-1993 North Carolina State Building Code, Volume IV-Electrical ..... Part VI

SECTION S-26.2501-GENERAL REQUIREMENTS

ACCA

Maneul J — Load Calculation for Residential Winter and Summer Air Conditioning E-2501.7

ASHRAE

Handbook-1993 — Fundamentals E-2501.7

CHAPTER 27
COASTAL AND FLOOD PLAIN CONSTRUCTION STANDARDS

C-2701–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. R-201.2 and Appendix A.

C-2702–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)

C-2703.0–PILING STANDARDS

C-2703.1 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.

C-2703.2 Concrete Piles: Concrete piles may be used if made and installed in accordance with North Carolina State Building Code, Volume I–General Construction, Chapter 13.

C-2703.3 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.

C-2703.4 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.

C-2703.5 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.

C-2703.6 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 C-2706.3a). 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 C-2703.6b). 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.

FIGURE C-2703.6a

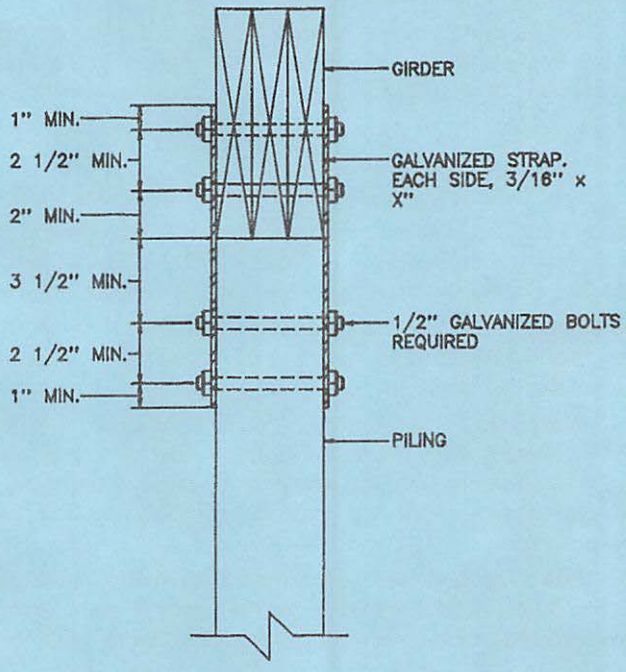
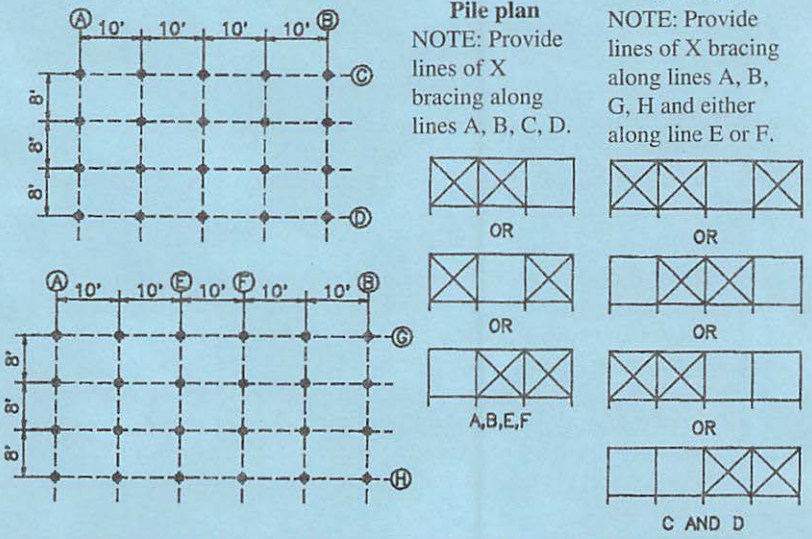


FIGURE C-2703.6b



ELEVATIONS (SHOWING POSSIBLE ARRANEMENT OF X BRACING IN LINE) (G AND H SIMILAR).

C-2703.7 The minimum net retention of preservatives shall be in accordance with Section R-308.

C-2703.8 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.

C-2704 ELEVATION STANDARDS

C-2704.1 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.

C-2704.2 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.

C-2704.3 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.

C-2705 CONSTRUCTION MATERIALS AND METHODS STANDARDS

C-2705.1 The requirements of Section C-2705.2 through C-2705.9 are applicable in the Coastal High Hazard Area, the Ocean Hazard Area, and all areas defined as 110 MPH wind zone.

C-2705.2 Every rafter or roof truss shall be anchored to the bearing wall plate as required by Section R-702.10. At the ridges, rafters shall have a minimum 1x6 or 2x4 collar or wind beam. Every third rafter not to exceed 4 feet on centers shall be anchored vertically with minimum 1x6 or 2x4 from its midpoint to ceiling joists below.

C-2705.3 Wood Frame Wall Construction: Maximum stud spacing shall be 16 inches o.c. for 2x4's and 24 inches for 2x6's. See Section R-402 for wall construction requirements. Vertical tie of wall may be in accordance with Section R-402 or this Section. If this Section is used, the plywood sheeting connection to the top plate and the sill, girder or beam shall be capable of resisting the forces in Table R-702.10. Continuous 15/32 inch plywood or structural use panel sheathing shall fully overlap the top wall plate and continue down so that it overlaps the sill, beam, or girder at least 6 inches.

Exception: For a wall stud spacing of 16 inches oc or less, 7/16 inch nonveneer structural-use panel sheathing is permissible in lieu of 15/32 inch plywood.

On buildings with gabled end construction, plywood shall extend to the top chord of roof trusses or top of rafter at roof line. Note especially the nailing requirements found in Table No. R-503.6. The minimum height of the top and bottom panel shall be 4 feet. The long side of plywood or structural use panels shall be installed in the vertical direction only. This requirement applies to full and partial panels.

Exception: If the vertical tie of a wall is done in accordance with Section R-402 or 3/8 inch steel rods as described below, the long side of the plywood or structural-use panels may be oriented vertically or horizontally.

In lieu of the plywood or structural-use panel system, 3/8 inch hot dip galvanized steel rods which provide a continuous tie from top wall plate down through the sill, beam, or girder may be installed in all exterior walls–one no more than 2 feet from each corner and no more than 8 feet on center. Washer with a minimum dimension of 3 inches shall be used at each end of these 3/8 inch round rods.

C-2705.4 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.

C-2705.5 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. Metal connectors of approved equivalent corrosion resistant material may be accepted. See Table C-2705.5.

C-2705.6

1. For masonry buildings, the roof structure, including rafters and joists shall be securely anchored to the footing by 3/8 inch steel rod not more than 3'-6" apart, one of which shall be no more than 2 feet from each corner. All mortar used for masonry walls shall be type M or S.

2. For masonry or wood frame buildings, all sills, beams or girders into which smaller joists are framed, which bear on masonry foundation walls or piers shall be anchored to the footing with 5/8 inch steel roods embedded at least 6 inches therein. Rods shall have a 10 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 C-2705.5[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.

C-2705.7 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.

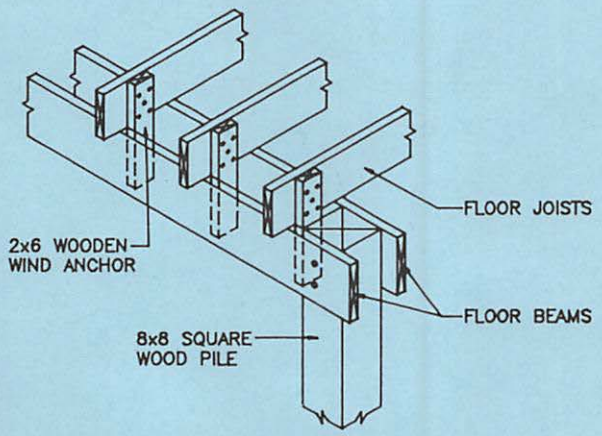
3. Where two or more layers of roll or built-up roofing are applied, the deck shall be thoroughly mopped before the anchor sheet is nailed to the sheathing with sheet metal caps and nails not over 12 inches on center in each direction and 6 inches along edges and laps. Each additional sheet above the 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.

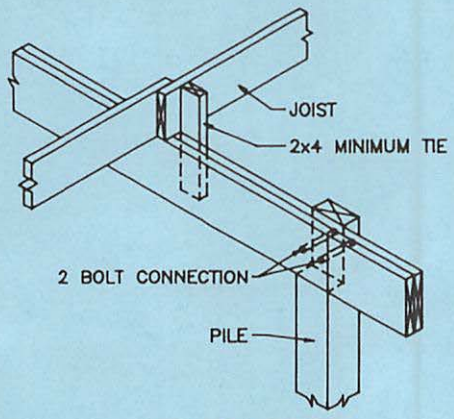
C-2705.8 Insulation: Insulation installed in floors in buildings elevated on pilings shall be held in place with plywood with exterior glue or other material approved by the building inspector.

C-2705.9 Detached accessory structures and out buildings shall be bolted to their foundation or otherwise constructed so as to prevent overturning during high winds.

DELETE PAGES 304.5 & 304.6

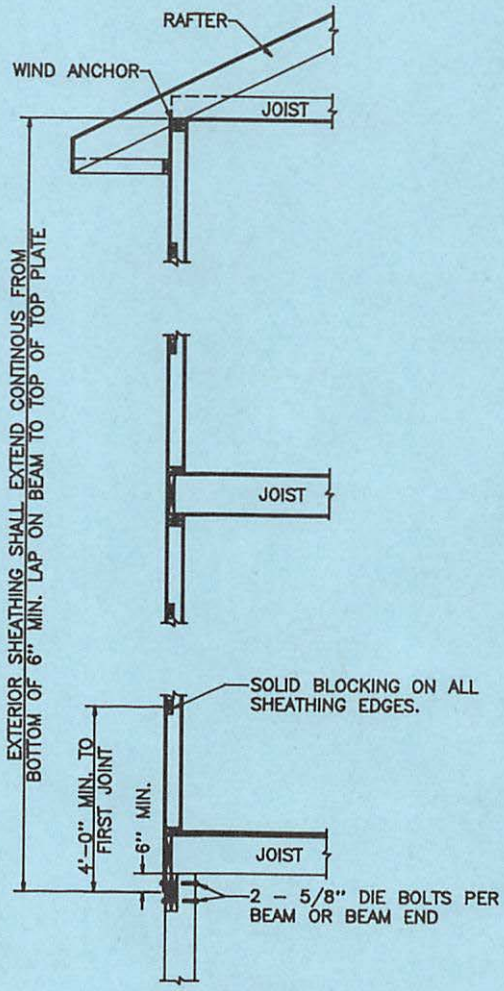


SPACED BEAM TIE DETAILS



SOLID BEAM TIE DETAIL

TYPICAL CONNECTIONS ON INTERIOR COLUMN LINES



TYPICAL 2 STORY WALL SECTION

CHAPTER 28
PIERS, BULKHEADS AND WATERWAY STRUCTURES

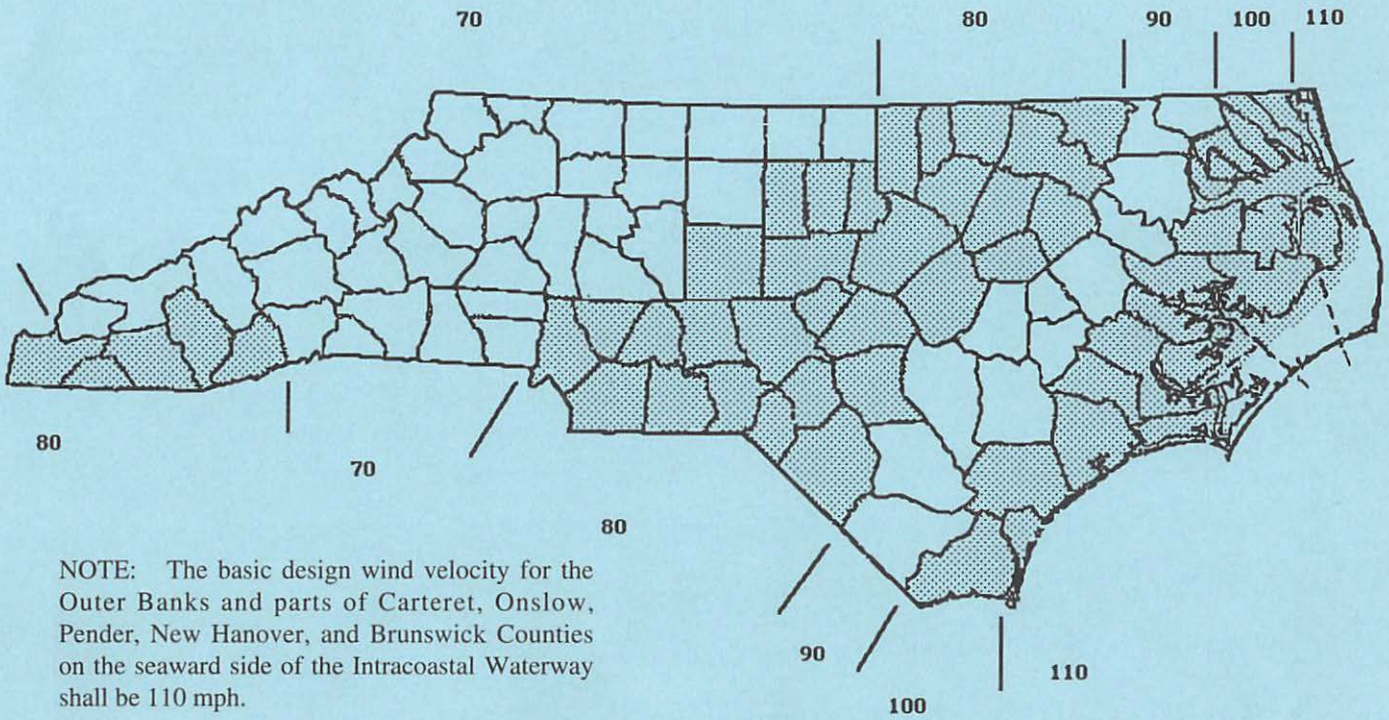
B-2801 GENERAL

The provisions of this Chapter are printed as Chapter 33 in the North Carolina State Building Code, Volume I-General Construction .

Appendix A

This appendix contains maps showing wind data, weathering probability, termite infestation, weathering decay, and winter temperature isolines.

NORTH CAROLINA



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.

BASIC DESIGN WIND VELOCITIES IN MPH

BASIC DESIGN WIND VELOCITIES[1]

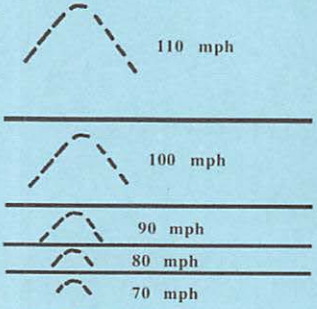
Counties not listed	70	Jones	100
Alamance	80	Lee	80
Anson	80	Lenior	90
Beaufort	100	Macon	80
Bertie	90	Martin	90
Bladen	90	Mecklenburg	80
Brunswick	100	Montgomery	80
Cabarrus	80	Moore	80
Camden	100	Nash	80
Carteret	100	New Hanover	100
Chatham	80	Northampton	80
Cherokee	80	Onslow	100
Chowan	100	Orange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

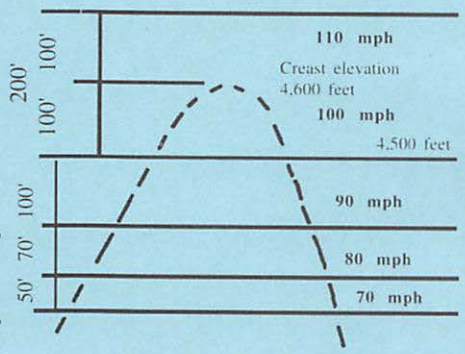
BASIC DESIGN WIND VELOCITIES FOR MOUNTAIN REGIONS

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 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 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



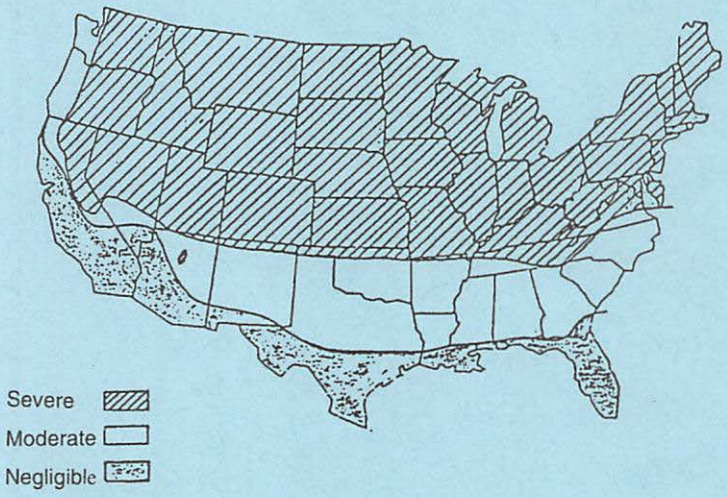
Example
Note # 2 Modification
Note 3, 4, and 5 Similar

DEAD LOAD ASSUMPTIONS

Finished floor	2.5 lbs. per sq. ft.
Rough floor	2.5 lbs. per sq. ft.
Roof sheathing	2.5 lbs. per sq. ft.
Plaster and Lath	10.0 lbs. per sq. ft.
1/2" Gypsum Dry Wall	2.0 lbs. per sq. ft.
Shingles	2.5 lbs. per sq. ft.
Timber Trusses (24" o.c.)	3.0 lbs. per sq. ft.
8" Insulation	4.0 lbs. per sq. ft.
1" Rigid Insulation	1.0 lbs. per sq. ft.
Exterior Stud Walls	
2x4 @ 16", 1/2" gypsum	
insulated, 3/8" siding	11.0 lbs. per sq. ft.
2x4 @ 16", 1/2" gypsum,	
insulated, with brick	
veneer	48.0 lbs. per sq. ft.
Wood studs @ 16" o.c., 1/2"	
gypsum on each side	8.0 lbs. per sq. ft.

NOTE: When actual weights are not known, the assumptions listed shall be considered as minimum.

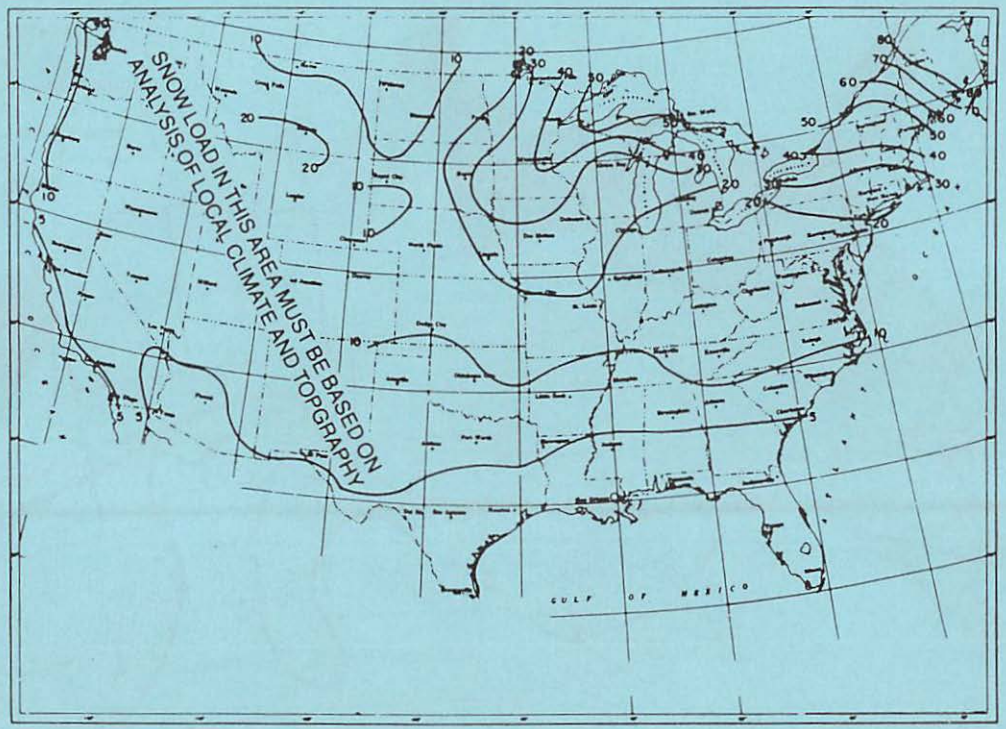
WEATHERING PROBABILITY MAP FOR CONCRETE



Notes:

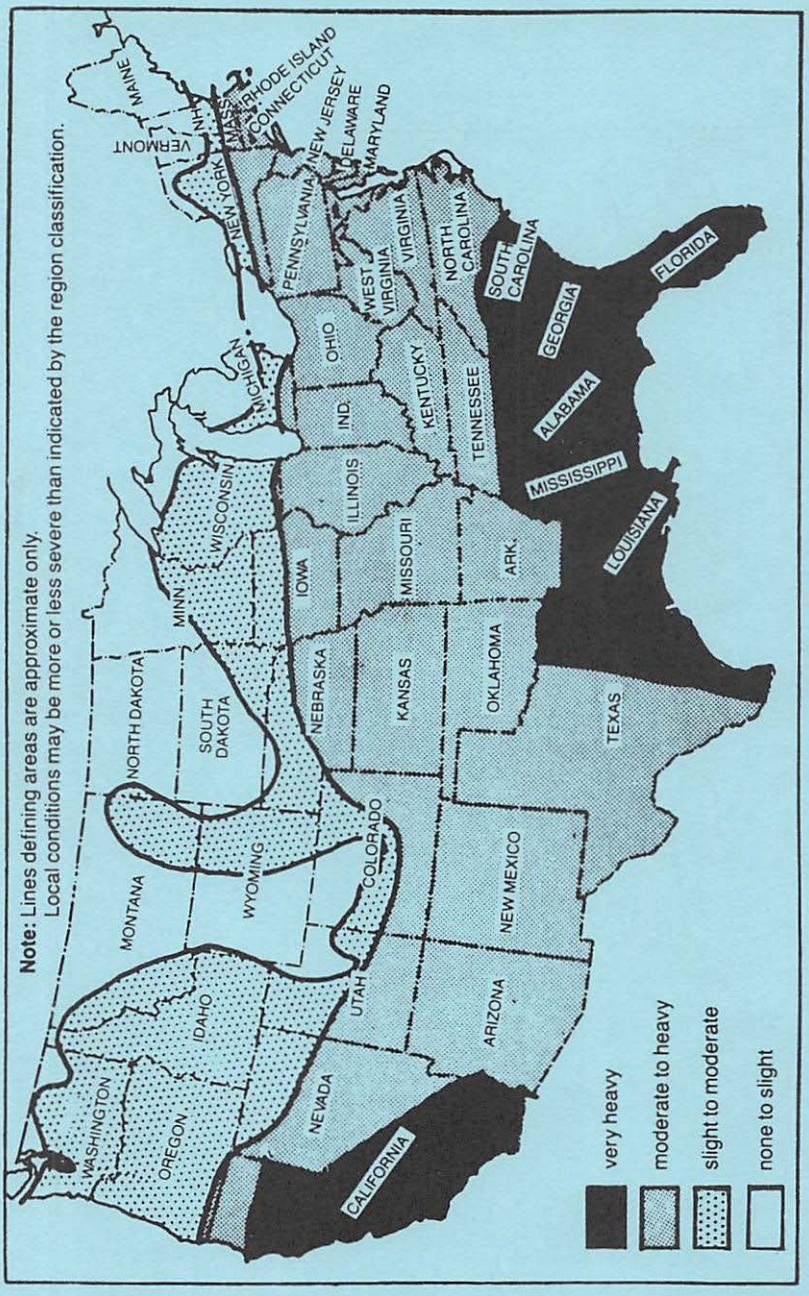
1. Alaska and Hawaii are classified as severe and negligible respectively.
2. Lines defining areas are approximate only. Local conditions may be more or less severe than indicated by the region classification is where weather conditions result in significant snowfall combined with extended periods during which there is little or no natural thawing causing deicing salts to be used extensively.
3. Map is for informational purposes only. The moderate classification in Table R-201.2 applies to the entire state of North Carolina.

SNOW LOAD MAP

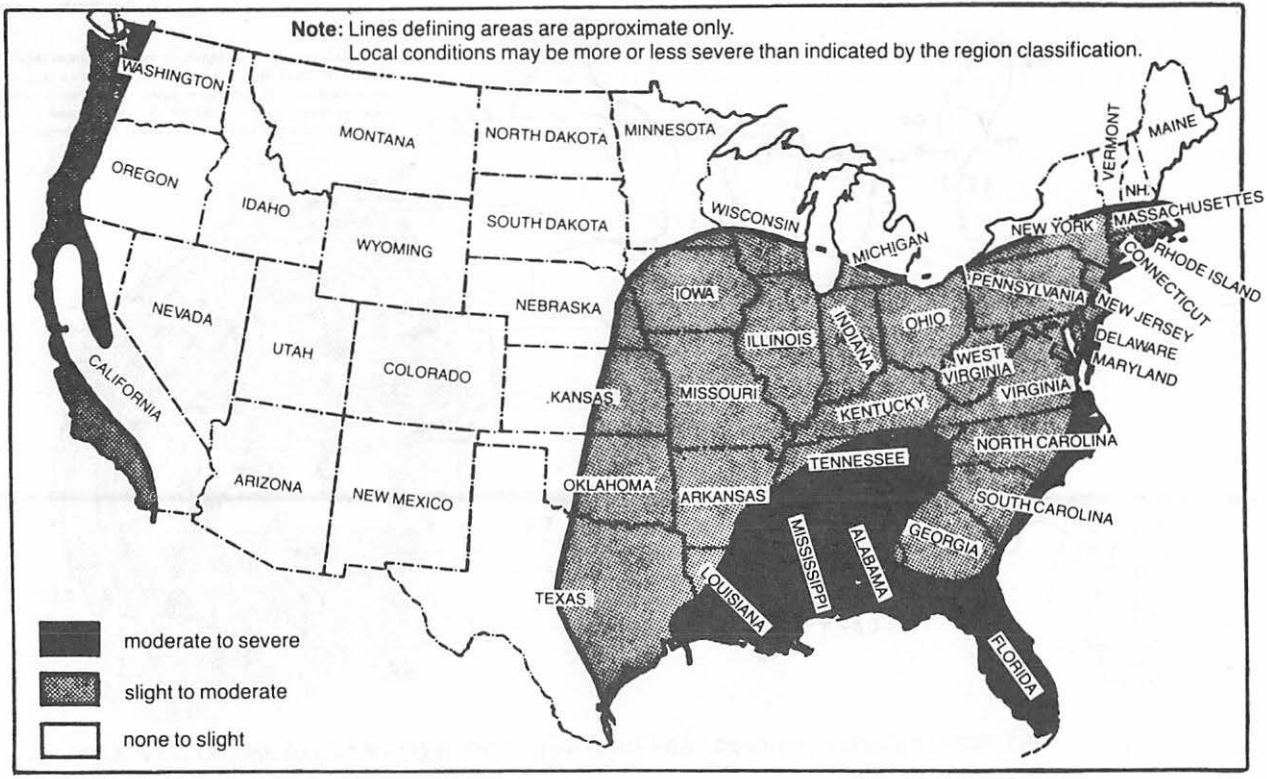


Estimated Ground Snow Load in Lbs./Sq. Ft.
50-year Mean Recurrence Interval

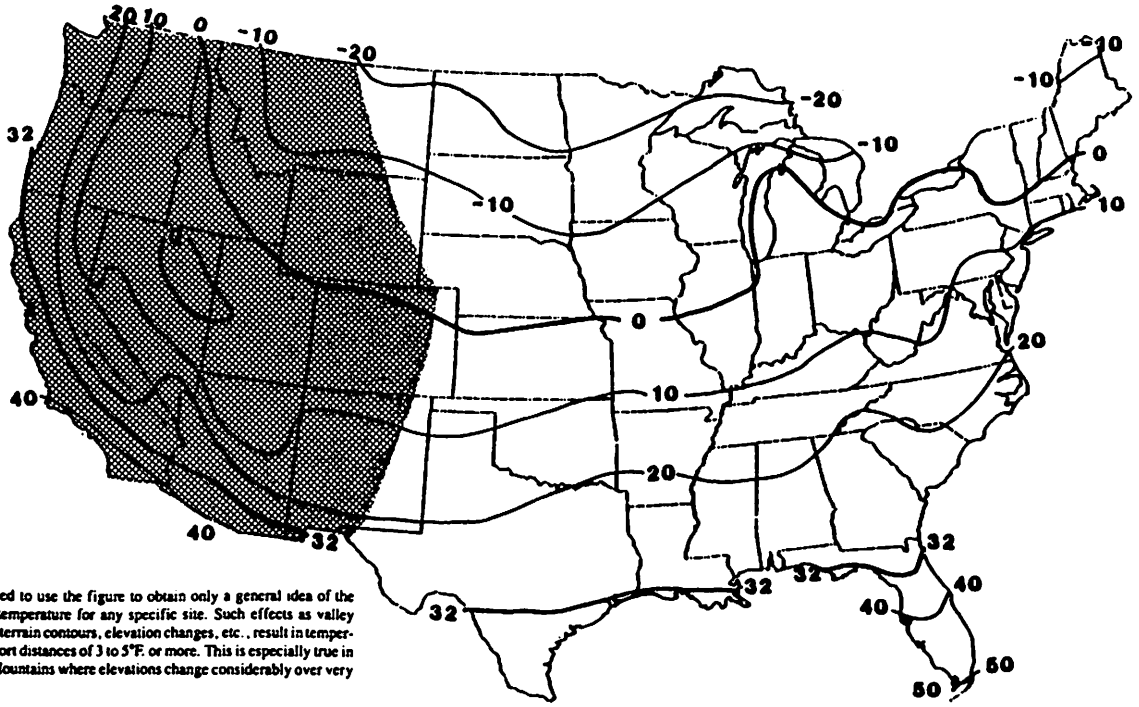
TERMITE INFESTATION PROBABILITY MAP



DECAY PROBABILITY MAP



ISOLINES OF THE 97½% WINTER (DEC., JAN. AND FEB.) DESIGN TEMPERATURES (°F.)



One should be cautioned to use the figure to obtain only a general idea of the 97½% winter design temperature for any specific site. Such effects as valley drainage, wind breaks, terrain contours, elevation changes, etc., result in temperature variations over short distances of 3 to 5°F. or more. This is especially true in the area of the Rocky Mountains where elevations change considerably over very short distances.

ASHRAE Handbook of Fundamentals, 1985
Air Force Manual 88-29, Engineering Weather Data, July 1, 1978

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

Appendix B

This appendix contains in the order listed below span tables for joists and rafters as well as tables containing design values for joists and rafters.

SPANS FOR JOISTS AND RAFTERS

DESIGN VALUES FOR JOIST AND RAFTERS

Table No. 6-A
ALLOWABLE SPANS FOR FLOOR JOISTS

40 Lbs. Per Sq. Ft. Live Load
(All rooms except those used for sleeping areas and attic floors.)
Strength – Live Load of 40 lbs. per sq. ft. plus dead load of 10 lbs. per sq. ft. determines the fiber stress value shown.

DESIGN CRITERIA:
Deflection – For 40 lbs. per sq. ft. live load.
Limited to span in inches divided by 360.

JOIST SIZE (IN)	SPACING (IN)	Modulus of Elasticity, "E", in 1,000,000 psi									
		0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3
2x6	12.0	6-9 450	7-3 520	7-9 590	8-2 660	8-6 720	8-10 780	9-2 830	9-6 890	9-9 940	10-0 990
	13.7	6-6 470	7-0 550	7-5 620	7-9 690	8-2 750	8-6 810	8-9 870	9-1 930	9-4 980	9-7 1040
	16.0	6-2 500	6-7 580	7-0 650	7-5 720	7-9 790	8-0 860	8-4 920	8-7 980	8-10 1040	9-1 1090
	19.2	5-9 530	6-3 610	6-7 690	7-0 770	7-3 840	7-7 910	7-10 970	8-1 1040	8-4 1100	8-7 1160
	24.0	5-4 570	5-9 660	6-2 750	6-6 830	6-9 900	7-0 980	7-3 1050	7-6 1120	7-9 1190	7-11 1250
	32.0					6-2 1010	6-5 1090	6-7 1150	6-10 1230	7-0 1300	7-3 1390
2x8	12.0	8-11 450	9-7 520	10-2 590	10-9 660	11-3 720	11-8 780	12-1 830	12-6 890	12-10 940	13-2 990
	13.7	8-6 470	9-2 550	9-9 620	10-3 690	10-9 750	11-2 810	11-7 870	11-11 930	12-3 980	12-7 1040
	16.0	8-1 500	8-9 580	9-3 650	9-9 720	10-2 790	10-7 850	11-0 920	11-4 980	11-8 1040	12-0 1090
	19.2	7-7 530	8-2 610	8-9 690	9-2 770	9-7 840	10-0 910	10-4 970	10-8 1040	11-0 1100	11-3 1160
	24.0	7-1 570	7-7 660	8-1 750	8-6 830	8-11 900	9-3 980	9-7 1050	9-11 1120	10-2 1190	10-6 1250
	32.0					8-1 990	8-5 1080	8-9 1170	9-0 1230	9-3 1300	9-6 1370
2x10	12.0	11-4 450	12-3 520	13-0 590	13-8 660	14-4 720	14-11 780	15-5 830	15-11 890	16-5 940	16-10 990
	13.7	10-10 470	11-8 550	12-5 620	13-1 690	13-8 750	14-3 810	14-9 870	15-3 930	15-8 980	16-1 1040
	16.0	10-4 500	11-1 580	11-10 650	12-5 720	13-0 790	13-6 850	14-0 920	14-6 980	14-11 1040	15-3 1090
	19.2	9-9 530	10-6 610	11-1 690	11-8 770	12-3 840	12-9 910	13-2 970	13-7 1040	14-0 1100	14-5 1160
	24.0	9-0 570	9-9 660	10-4 750	10-10 830	11-4 900	11-10 980	12-3 1050	12-8 1120	13-0 1190	13-4 1250
	32.0					10-4 1000	10-9 1080	11-1 1150	11-6 1240	11-10 1310	12-2 1380
2x12	12.0	13-10 450	14-11 520	15-10 590	16-8 660	17-5 720	18-1 780	18-9 830	19-4 890	19-11 940	20-6 990
	13.7	13-3 470	14-3 550	15-2 620	15-11 690	16-8 750	17-4 810	17-11 870	18-6 930	19-1 980	19-7 1040
	16.0	12-7 500	13-6 580	14-4 650	15-2 720	15-10 790	16-5 860	17-0 920	17-7 980	18-1 1040	18-7 1090
	19.2	11-10 530	12-9 610	13-6 690	14-3 770	14-11 840	15-6 910	16-0 970	16-7 1040	17-0 1100	17-6 1160
	24.0	11-0 570	11-10 660	12-7 750	13-3 830	13-10 900	14-4 980	14-11 1050	15-4 1120	15-10 1190	16-3 1250
	32.0					12-7 1000	13-1 1080	13-6 1150	13-11 1220	14-4 1300	14-9 1380

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

Table No. 6-A (cont.)

HOW TO USE TABLES: Enter Table with span of joists (upper figure in each square). Determine size and spacing (first column) based on stress grade (lower figure in each square) and modulus of elasticity (top row) of lumber to be used.

JOIST SIZE (IN)	SPACING (IN)	Modulus of Elasticity, "E", in 1,000,000 psi								
		1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.2	2.4
2x6	12.0	10 3 1040	10 6 1090	10 9 1140	10 11 1190	11 2 1230	11 4 1280	11 7 1320	11 11 1410	12 3 1490
	13.7	9 10 1090	10 0 1140	10 3 1190	10 6 1240	10 8 1290	10 10 1340	11 1 1380	11 5 1470	11 9 1560
	16.0	9 4 1150	9 6 1200	9 9 1250	9 11 1310	10 2 1360	10 4 1410	10 6 1460	10 10 1550	11 2 1640
	19.2	8 9 1220	9 0 1280	9 2 1330	9 4 1390	9 6 1440	9 8 1500	9 10 1550	10 2 1650	10 6 1750
	24.0	8 2 1310	8 4 1380	8 6 1440	8 8 1500	8 10 1550	9 0 1610	9 2 1670	9 6 1780	9 9 1880
	32.0	7 5 1450	7 7 1520	7 9 1590	7 11 1660	8 0 1690	8 2 1760	8 4 1840	8 7 1950	8 10 2060
2x8	12.0	13 6 1040	13 10 1090	14 2 1140	14 5 1190	14 8 1230	15 0 1280	15 3 1320	15 9 1410	16 2 1490
	13.7	12 11 1090	13 3 1140	13 6 1190	13 10 1240	14 1 1290	14 4 1340	14 7 1380	15 0 1470	15 6 1560
	16.0	12 3 1150	12 7 1200	12 10 1250	13 1 1310	13 4 1360	13 7 1410	13 10 1460	14 3 1550	14 8 1640
	19.2	11 7 1220	11 10 1280	12 1 1330	12 4 1390	12 7 1440	12 10 1500	13 0 1550	13 5 1650	13 10 1750
	24.0	10 9 1310	11 0 1380	11 3 1440	11 5 1500	11 8 1550	11 11 1610	12 1 1670	12 6 1780	12 10 1880
	32.0	9 9 1450	10 0 1520	10 2 1570	10 5 1650	10 7 1700	10 10 1790	11 0 1840	11 4 1950	11 8 2070
2x10	12.0	17 3 1040	17 8 1090	18 0 1140	18 5 1190	18 9 1230	19 1 1280	19 5 1320	20 1 1410	20 8 1490
	13.7	16 6 1090	16 11 1140	17 3 1190	17 7 1240	17 11 1290	18 3 1340	18 7 1380	19 2 1470	19 9 1560
	16.0	15 8 1150	16 0 1200	16 5 1250	16 9 1310	17 0 1360	17 4 1410	17 8 1460	18 3 1550	18 9 1640
	19.2	14 9 1220	15 1 1280	15 5 1330	15 9 1390	16 0 1440	16 4 1500	16 7 1550	17 2 1650	17 8 1750
	24.0	13 8 1310	14 0 1380	14 4 1440	14 7 1500	14 11 1550	15 2 1610	15 5 1670	15 11 1780	16 5 1880
	32.0	12 5 1440	12 9 1520	13 0 1580	13 3 1640	13 6 1700	13 9 1770	14 0 1830	14 6 1970	14 11 2080
2x12	12.0	21 0 1040	21 6 1090	21 11 1140	22 5 1190	22 10 1230	23 3 1280	23 7 1320	24 5 1410	25 1 1490
	13.7	20 1 1090	20 6 1140	21 0 1190	21 5 1240	21 10 1290	22 3 1340	22 7 1380	23 4 1470	24 0 1560
	16.0	19 1 1150	19 6 1200	19 11 1250	20 4 1310	20 9 1360	21 1 1410	21 6 1460	22 2 1550	22 10 1640
	19.2	17 11 1220	18 4 1280	18 9 1330	19 2 1390	19 6 1440	19 10 1500	20 2 1550	20 10 1650	21 6 1750
	24.0	16 8 1310	17 0 1380	17 5 1440	17 9 1500	18 1 1550	18 5 1610	18 9 1670	19 4 1780	19 11 1880
	32.0	15 2 1450	15 6 1520	15 10 1580	16 2 1650	16 5 1700	16 9 1770	17 0 1830	17 7 1950	18 1 2070

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

Table No. 6-B
ALLOWABLE SPANS FOR FLOOR JOISTS

30 Lbs. Per Sq. Ft. Live Load
(All rooms used for sleeping areas and attic floors.)
Strength – Live load of 30 lbs. per sq. ft. plus dead load of 10 lbs. per sq. ft. determines the fiber stress value shown.

DESIGN CRITERIA:
Deflection – For 30 lbs. per sq. ft. live load.
Limited to span in inches divided by 360.

JOIST SIZE	JOIST SPACING (IN)	Modulus of Elasticity, "E", in 1,000,000 psi									
		0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3
2x6	12.0	7-5 440	8-0 510	8-6 570	8-11 640	9-4 700	9-9 750	10-1 810	10-5 860	10-9 910	11-0 960
	13.7	7-1 460	7-8 530	8-2 600	8-7 670	8-11 730	9-4 790	9-8 840	10-0 900	10-3 950	10-6 1010
	16.0	6-9 480	7-3 560	7-9 630	8-2 700	8-6 770	8-10 830	9-2 890	9-6 950	9-9 1000	10-0 1060
	19.2	6-4 510	6-10 600	7-3 670	7-8 740	8-0 810	8-4 880	8-8 940	8-11 1010	9-2 1070	9-5 1130
	24.0	5-11 550	6-4 640	6-9 720	7-1 800	7-5 880	7-9 950	8-0 1020	8-3 1080	8-6 1150	8-9 1210
	32.0					6-9 960	7-0 1040	7-3 1110	7-6 1190	7-9 1270	7-11 1330
2x8	12.0	9-10 440	10-7 510	11-3 570	11-10 640	12-4 700	12-10 750	13-4 810	13-9 860	14-2 910	14-6 960
	13.7	9-4 460	10-1 530	10-9 600	11-4 670	11-10 730	12-3 790	12-9 840	13-2 900	13-6 950	13-11 1010
	16.0	8-11 480	9-7 560	10-2 630	10-9 700	11-3 770	11-8 830	12-1 890	12-6 950	12-10 1000	13-2 1060
	19.2	8-5 510	9-0 600	9-7 670	10-1 740	10-7 810	11-0 880	11-4 940	11-9 1010	12-1 1070	12-5 1130
	24.0	7-9 550	8-5 640	8-11 720	9-4 800	9-10 880	10-2 950	10-7 1020	10-11 1080	11-3 1150	11-6 1210
	32.0					8-11 970	9-3 1040	9-7 1120	9-11 1200	10-2 1260	10-6 1340
2x10	12.0	12-6 440	13-6 510	14-4 570	15-1 640	15-9 700	16-5 750	17-0 810	17-6 860	18-0 910	18-6 960
	13.7	11-11 460	12-11 530	13-8 600	14-5 670	15-1 730	15-8 790	16-3 840	16-9 900	17-3 950	17-9 1010
	16.0	11-4 480	12-3 560	13-0 630	13-8 700	14-4 770	14-11 830	15-5 890	15-11 950	16-5 1000	16-10 1060
	19.2	10-8 510	11-6 600	12-3 670	12-11 740	13-6 810	14-0 880	14-6 940	15-0 1010	15-5 1070	15-10 1130
	24.0	9-11 550	10-8 640	11-4 720	11-11 800	12-6 880	13-0 950	13-6 1020	13-11 1080	14-4 1150	14-8 1210
	32.0					11-4 960	11-10 1050	12-3 1120	12-8 1200	13-0 1260	13-4 1330
2x12	12.0	15-2 440	16-5 510	17-5 570	18-4 640	19-2 700	19-11 750	20-8 810	21-4 860	21-11 910	22-6 960
	13.7	14-7 460	15-8 530	16-8 600	17-6 670	18-4 730	19-1 790	19-9 840	20-5 900	21-0 950	21-7 1010
	16.0	13-10 480	14-11 560	15-10 630	16-8 700	17-5 770	18-1 830	18-9 890	19-4 950	19-11 1000	20-6 1060
	19.2	13-0 510	14-0 600	14-11 670	15-8 740	16-5 810	17-0 880	17-8 940	18-3 1010	18-9 1070	19-3 1130
	24.0	12-1 550	13-0 640	13-10 720	14-7 800	15-2 880	15-10 950	16-5 1020	16-11 1080	17-5 1150	17-11 1210
	32.0					13-10 970	14-4 1040	14-11 1130	15-4 1190	15-10 1270	16-3 1340

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

Table No. 6-B (cont).

HOW TO USE TABLES: Enter Table with span of joists (upper figure in each square). Determine size and spacing (first column) based on stress grade (lower figure in each square) and modulus of elasticity (top row) of lumber to be used.

JOIST SIZE	SPACING (IN)	Modulus of Elasticity, "E", in 1,000,000 psi								
		1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.2	2.4
2x6	12.0	11-3 1010	11-7 1060	11-10 1100	12-0 1150	12-3 1200	12-6 1240	12-9 1280	13-1 1370	13-6 1450
	13.7	10-10 1060	11-1 1110	11-3 1160	11-6 1200	11-9 1250	11-11 1300	12-2 1340	12-7 1430	12-11 1510
	16.0	10-3 1110	10-6 1160	10-9 1220	10-11 1270	11-2 1320	11-4 1360	11-7 1410	11-11 1500	12-3 1590
	19.2	9-8 1180	9-10 1240	10-1 1290	10-4 1350	10-6 1400	10-8 1450	10-10 1500	11-3 1600	11-7 1690
	24.0	8-11 1270	9-2 1330	9-4 1390	9-7 1450	9-9 1510	9-11 1560	10-1 1620	10-5 1720	10-9 1820
	32.0	8-2 1410	8-4 1470	8-6 1530	8-8 1590	8-10 1650	9-0 1710	9-2 1780	9-6 1910	9-9 2010
2x8	12.0	14-11 1010	15-3 1060	15-7 1100	15-10 1150	16-2 1200	16-6 1240	16-9 1280	17-4 1370	17-10 1450
	13.7	14-3 1060	14-7 1110	14-11 1160	15-2 1200	15-6 1250	15-9 1300	16-0 1340	16-7 1430	17-0 1510
	16.0	13-6 1110	13-10 1160	14-2 1220	14-5 1270	14-8 1320	15-0 1360	15-3 1410	15-9 1500	16-2 1590
	19.2	12-9 1180	13-0 1240	13-4 1290	13-7 1350	13-10 1400	14-1 1450	14-4 1500	14-9 1600	15-3 1690
	24.0	11-10 1270	12-1 1330	12-4 1390	12-7 1450	12-10 1510	13-1 1560	13-4 1620	13-9 1720	14-2 1820
	32.0	10-9 1410	11-0 1470	11-3 1540	11-5 1590	11-8 1660	11-11 1730	12-1 1780	12-6 1900	12-10 2010
2x10	12.0	19-0 1010	19-5 1060	19-10 1100	20-3 1150	20-8 1200	21-0 1240	21-5 1280	22-1 1370	22-9 1450
	13.7	18-2 1060	18-7 1110	19-0 1160	19-4 1200	19-9 1250	20-1 1300	20-5 1340	21-1 1430	21-9 1510
	16.0	17-3 1110	17-8 1160	18-0 1220	18-5 1270	18-9 1320	19-1 1360	19-5 1410	20-1 1500	20-8 1590
	19.2	16-3 1180	16-7 1240	17-0 1290	17-4 1350	17-8 1400	18-0 1450	18-3 1500	18-10 1600	19-5 1690
	24.0	15-1 1270	15-5 1330	15-9 1390	16-1 1450	16-5 1510	16-8 1560	17-0 1620	17-6 1720	18-0 1820
	32.0	13-8 1400	14-0 1470	14-4 1540	14-7 1590	14-11 1660	15-2 1720	15-5 1780	15-11 1890	16-5 2020
2x12	12.0	23-1 1010	23-7 1060	24-2 1100	24-8 1150	25-1 1200	25-7 1240	26-0 1280	26-10 1370	27-8 1450
	13.7	22-1 1060	22-7 1110	23-1 1160	23-7 1200	24-0 1250	24-5 1300	24-10 1340	25-8 1430	26-5 1510
	16.0	21-0 1110	21-6 1160	21-11 1220	22-5 1270	22-10 1320	23-3 1360	23-7 1410	24-5 1500	25-1 1590
	19.2	19-9 1180	20-2 1240	20-8 1290	21-1 1350	21-6 1400	21-10 1450	22-3 1500	22-11 1600	23-7 1690
	24.0	18-4 1270	18-9 1330	19-2 1390	19-7 1450	19-11 1510	20-3 1560	20-8 1620	21-4 1720	21-11 1820
	32.0	16-8 1400	17-0 1460	17-5 1530	17-9 1590	18-1 1650	18-5 1720	18-9 1780	19-4 1890	19-11 2010

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

Table No. 7-A
ALLOWABLE SPANS FOR CEILING JOISTS

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

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

JOIST SIZE	SPACING (IN)	Modulus of Elasticity, "E", in 1,000,000 psi									
		0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3
2x4	12 0	5 5 430	5 10 500	6 2 560	6 6 630	6 10 680	7 1 740	7 4 790	7 7 850	7 10 900	8 0 950
	13 7	5 2 450	5 7 520	5 11 590	6 3 650	6 6 720	6 9 770	7 0 830	7 3 880	7 6 940	7 8 990
	16 0	4 11 470	5 4 550	5 8 620	5 11 690	6 2 750	6 5 810	6 8 870	6 11 930	7 1 990	7 3 1040
	19 2	4 8 500	5 0 580	5 4 660	5 7 730	5 10 800	6 1 870	6 3 930	6 6 990	6 8 1050	6 10 1110
	24 0	4 4 540	4 8 630	4 11 710	5 2 790	5 5 860	5 8 930	5 10 1000	6 0 1070	6 2 1130	6 4 1190
2x6	12 0	8 6 430	9 2 500	9 9 560	10 3 630	10 9 680	11 2 740	11 7 790	11 11 850	12 3 900	12 7 950
	13 7	8 2 450	8 9 520	9 4 590	9 10 650	10 3 720	10 8 770	11 1 830	11 5 880	11 9 940	12 1 990
	16 0	7 9 470	8 4 550	8 10 620	9 4 690	9 9 750	10 2 810	10 6 870	10 10 930	11 2 990	11 5 1040
	19 2	7 3 500	7 10 580	8 4 660	8 9 730	9 2 800	9 6 870	9 10 930	10 2 990	10 6 1050	10 9 1110
	24 0	6 9 540	7 3 630	7 9 710	8 2 790	8 6 860	8 10 930	9 2 1000	9 6 1070	9 9 1130	10 0 1190
2x8	12 0	11 3 430	12 1 500	12 10 560	13 6 630	14 2 680	14 8 740	15 3 790	15 9 850	16 2 900	16 7 950
	13 7	10 9 450	11 7 520	12 3 590	12 11 650	13 6 720	14 1 770	14 7 830	15 0 880	15 6 940	15 11 990
	16 0	10 2 470	11 0 550	11 8 620	12 3 690	12 10 750	13 4 810	13 10 870	14 3 930	14 8 990	15 1 1040
	19 2	9 7 500	10 4 580	11 0 660	11 7 730	12 1 800	12 7 870	13 0 930	13 5 990	13 10 1050	14 2 1110
	24 0	8 11 540	9 7 630	10 2 710	10 9 790	11 3 860	11 8 930	12 1 1000	12 6 1070	12 10 1130	13 2 1190
2x10	12 0	14 4 430	15 5 500	16 5 560	17 3 630	18 0 680	18 9 740	19 5 790	20 1 850	20 8 900	21 2 950
	13 7	13 8 450	14 9 520	15 8 590	16 6 650	17 3 720	17 11 770	18 7 830	19 2 880	19 9 940	20 3 990
	16 0	13 0 470	14 0 550	14 11 620	15 8 690	16 5 750	17 0 810	17 8 870	18 3 930	18 9 990	19 3 1040
	19 2	12 3 500	13 2 580	14 0 660	14 9 730	15 5 800	16 0 870	16 7 930	17 2 990	17 8 1050	18 1 1110
	24 0	11 4 540	12 3 630	13 0 710	13 8 790	14 4 860	14 11 930	15 5 1000	15 11 1070	16 5 1130	16 10 1190

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

Table No. 7-A (cont.)

HOW TO USE TABLES: Enter Table with span of joists (upper figure in each square). Determine size and spacing (first column) based on stress grade (lower figure in each square) and modulus of elasticity (top row) of lumber to be used.

JOIST SIZE (IN)	SPACING (IN)	Modulus of Elasticity, "E", in 1,000,000 psi								
		1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.2	2.4
2x4	12.0	8-3 990	8-5 1040	8-7 1090	8-9 1130	8-11 1170	9-1 1220	9-3 1260	9-7 1340	9-10 1420
	13.7	7-10 1040	8-1 1090	8-3 1140	8-5 1180	8-7 1230	8-8 1270	8-10 1320	9-2 1400	9-5 1490
	16.0	7-6 1090	7-8 1140	7-10 1200	8-0 1240	8-1 1290	8-3 1340	8-5 1390	8-8 1480	8-11 1570
	19.2	7-0 1160	7-2 1220	7-4 1270	7-6 1320	7-8 1370	7-9 1420	7-11 1470	8-2 1570	8-5 1660
	24.0	6-6 1250	6-8 1310	6-10 1370	7-0 1420	7-1 1480	7-3 1530	7-4 1590	7-7 1690	7-10 1790
2x6	12.0	12-11 990	13-3 1040	13-6 1090	13-9 1130	14-1 1170	14-4 1220	14-7 1260	15-0 1340	15-6 1420
	13.7	12-4 1040	12-8 1090	12-11 1140	13-2 1180	13-5 1230	13-8 1270	13-11 1320	14-4 1400	14-9 1490
	16.0	11-9 1090	12-0 1140	12-3 1200	12-6 1240	12-9 1290	13-0 1340	13-3 1390	13-8 1480	14-1 1570
	19.2	11-1 1160	11-4 1220	11-7 1270	11-9 1320	12-0 1370	12-3 1420	12-5 1470	12-10 1570	13-3 1660
	24.0	10-3 1250	10-6 1310	10-9 1370	10-11 1420	11-2 1480	11-4 1530	11-7 1590	11-11 1690	12-3 1790
2x8	12.0	17-0 990	17-5 1040	17-10 1090	18-2 1130	18-6 1170	18-10 1220	19-2 1260	19-10 1340	20-5 1420
	13.7	16-3 1040	16-8 1090	17-0 1140	17-5 1180	17-9 1230	18-0 1270	18-4 1320	18-11 1400	19-6 1490
	16.0	15-6 1090	15-10 1140	16-2 1200	16-6 1240	16-10 1290	17-2 1340	17-5 1390	18-0 1480	18-6 1570
	19.2	14-7 1160	14-11 1220	15-3 1270	15-6 1320	15-10 1370	16-1 1420	16-5 1470	16-11 1570	17-5 1660
	24.0	13-6 1250	13-10 1310	14-2 1370	14-5 1420	14-8 1480	15-0 1530	15-3 1590	15-9 1690	16-2 1790
2x10	12.0	21-9 990	22-3 1040	22-9 1090	23-2 1130	23-8 1170	24-1 1220	24-6 1260	25-3 1340	26-0 1420
	13.7	20-9 1040	21-3 1090	21-9 1140	22-2 1180	22-7 1230	23-0 1270	23-5 1320	24-2 1400	24-10 1490
	16.0	19-9 1090	20-2 1140	20-8 1200	21-1 1240	21-6 1290	21-10 1340	22-3 1390	22-11 1480	23-8 1570
	19.2	18-7 1160	19-0 1220	19-5 1270	19-10 1320	20-2 1370	20-7 1420	20-11 1470	21-7 1570	22-3 1660
	24.0	17-3 1250	17-8 1310	18-0 1370	18-5 1420	18-9 1480	19-1 1530	19-5 1590	20-1 1690	20-8 1790

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

Table No. 7-B
ALLOWABLE SPAN FOR CEILING JOISTS

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

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

JOIST SIZE	SPACING (IN)	Modulus of Elasticity, "E", in 1,000,000 psi									
		0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3
2x4	12.0	6-2 560	6-8 660	7-1 740	7-6 820	7-10 900	8-1 970	8-5 1040	8-8 1110	8-11 1170	9-2 1240
	13.7	5-11 590	6-5 690	6-9 770	7-2 860	7-6 940	7-9 1010	8-1 1090	8-4 1160	8-7 1230	8-9 1300
	16.0	5-8 620	6-1 720	6-5 810	6-9 900	7-1 990	7-5 1070	7-8 1140	7-11 1220	8-1 1290	8-4 1360
	19.2	5-4 660	5-9 770	6-1 870	6-5 960	6-8 1050	6-11 1130	7-2 1220	7-5 1300	7-8 1370	7-10 1450
	24.0	4-11 710	5-4 830	5-8 930	5-11 1030	6-2 1130	6-5 1220	6-8 1310	6-11 1400	7-1 1480	7-3 1560
2x6	12.0	9-9 560	10-6 660	11-2 740	11-9 820	12-3 900	12-9 970	13-3 1040	13-8 1110	14-1 1170	14-5 1240
	13.7	9-4 590	10-0 690	10-8 770	11-3 860	11-9 940	12-3 1010	12-8 1090	13-1 1160	13-5 1230	13-10 1300
	16.0	8-10 620	9-6 720	10-2 810	10-8 900	11-2 990	11-7 1070	12-0 1140	12-5 1220	12-9 1290	13-1 1360
	19.2	8-4 660	9-0 770	9-6 870	10-0 960	10-6 1050	10-11 1130	11-4 1220	11-8 1300	12-0 1370	12-4 1450
	24.0	7-9 710	8-4 830	8-10 930	9-4 1030	9-9 1130	10-2 1220	10-6 1310	10-10 1400	11-2 1480	11-5 1560
2x8	12.0	12-10 560	13-10 660	14-8 740	15-6 820	16-2 900	16-10 970	17-5 1040	18-0 1110	18-6 1170	19-0 1240
	13.7	12-3 590	13-3 690	14-1 770	14-10 860	15-6 940	16-1 1010	16-8 1090	17-2 1160	17-9 1230	18-2 1300
	16.0	11-8 620	12-7 720	13-4 810	14-1 900	14-8 990	15-3 1070	15-10 1140	16-4 1220	16-10 1290	17-3 1360
	19.2	11-0 660	11-10 770	12-7 870	13-3 960	13-10 1050	14-5 1130	14-11 1220	15-5 1300	15-10 1370	16-3 1450
	24.0	10-2 710	11-0 830	11-8 930	12-3 1030	12-10 1130	13-4 1220	13-10 1310	14-3 1400	14-8 1480	15-1 1560
2x10	12.0	16-5 560	17-8 660	18-9 740	19-9 820	20-8 900	21-6 970	22-3 1040	22-11 1110	23-8 1170	24-3 1240
	13.7	15-8 590	16-11 690	17-11 770	18-11 860	19-9 940	20-6 1010	21-3 1090	21-11 1160	22-7 1230	23-3 1300
	16.0	14-11 620	16-0 720	17-0 810	17-11 900	18-9 990	19-6 1070	20-2 1140	20-10 1220	21-6 1290	22-1 1360
	19.2	14-0 660	15-1 770	16-0 870	16-11 960	17-8 1050	18-4 1130	19-0 1220	19-7 1300	20-2 1370	20-9 1450
	24.0	13-0 710	14-0 830	14-11 930	15-8 1030	16-5 1130	17-0 1220	17-8 1310	18-3 1400	18-9 1480	19-3 1560

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

Table No. 7-B (cont.)

HOW TO USE TABLES: Enter Table with span of joists (upper figure in each square). Determine size and spacing (first column) based on stress grade (lower figure in each square) and modulus of elasticity (top row) of lumber to be used.

JOIST SIZE	SPACING (IN)	Modulus of Elasticity, "E", in 1,000,000 psi								
		1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.2	2.4
2x4	12.0	9-5 1300	9-8 1360	9-10 1420	10-0 1480	10-3 1540	10-5 1600	10-7 1650	10-11 1760	11-3 1860
	13.7	9-0 1360	9-3 1420	9-5 1490	9-7 1550	9-9 1610	10-0 1670	10-2 1730	10-6 1840	10-9 1950
	16.0	8-7 1430	8-9 1500	8-11 1570	9-1 1630	9-4 1690	9-6 1760	9-8 1820	9-11 1940	10-3 2050
	19.2	8-1 1520	8-3 1590	8-5 1660	8-7 1730	8-9 1800	8-11 1870	9-1 1930	9-4 2060	9-8 2180
	24.0	7-6 1640	7-8 1720	7-10 1790	8-0 1870	8-1 1940	8-3 2010	8-5 2080	8-8 2220	8-11 2350
2x6	12.0	14-9 1300	15-2 1360	15-6 1420	15-9 1480	16-1 1540	16-4 1600	16-8 1650	17-2 1760	17-8 1860
	13.7	14-2 1360	14-6 1420	14-9 1490	15-1 1550	15-5 1610	15-8 1670	15-11 1730	16-5 1840	16-11 1950
	16.0	13-5 1430	13-9 1500	14-1 1570	14-4 1630	14-7 1690	14-11 1760	15-2 1820	15-7 1940	16-1 2050
	19.2	12-8 1520	12-11 1590	13-3 1660	13-6 1730	13-9 1800	14-0 1870	14-3 1930	14-8 2060	15-2 2180
	24.0	11-9 1640	12-0 1720	12-3 1790	12-6 1870	12-9 1940	13-0 2010	13-3 2080	13-8 2220	14-1 2350
2x8	12.0	19-6 1300	19-11 1360	20-5 1420	20-10 1480	21-2 1540	21-7 1600	21-11 1650	22-8 1760	23-4 1860
	13.7	18-8 1360	19-1 1420	19-6 1490	19-11 1550	20-3 1610	20-8 1670	21-0 1730	21-8 1840	22-4 1950
	16.0	17-9 1430	18-2 1500	18-6 1570	18-11 1630	19-3 1690	19-7 1760	19-11 1820	20-7 1940	21-2 2050
	19.2	16-8 1520	17-1 1590	17-5 1660	17-9 1730	18-2 1800	18-5 1870	18-9 1930	19-5 2060	19-11 2180
	24.0	15-6 1640	15-10 1720	16-2 1790	16-6 1870	16-10 1940	17-2 2010	17-5 2080	18-0 2220	18-6 2350
2x10	12.0	24-10 1300	25-5 1360	26-0 1420	26-6 1480	27-1 1540	27-6 1600	28-0 1650	28-11 1760	29-9 1860
	13.7	23-9 1360	24-4 1420	24-10 1490	25-5 1550	25-10 1610	26-4 1670	26-10 1730	27-8 1840	28-6 1950
	16.0	22-7 1430	23-2 1500	23-8 1570	24-1 1630	24-7 1690	25-0 1760	25-5 1820	26-3 1940	27-1 2050
	19.2	21-3 1520	21-9 1590	22-3 1660	22-8 1730	23-2 1800	23-7 1870	23-11 1930	24-9 2060	25-5 2180
	24.0	19-9 1640	20-2 1720	20-8 1790	21-1 1870	21-6 1940	21-10 2010	22-3 2080	22-11 2220	23-8 2350

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

Table No. 7-C
ALLOWABLE SPAN FOR CEILING JOISTS

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

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

JOIST SIZE	SPACING (IN)	Modulus of Elasticity, "E", in 1,000,000 psi									
		0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3
2x4	12.0	6 10 340	7 4 400	7 10 450	8 3 500	8 7 540	8 11 590	9 3 630	9 7 670	9 10 710	10 1 750
	13.7	6 6 360	7 0 410	7 6 470	7 10 520	8 3 570	8 7 610	8 10 660	9 2 700	9 5 740	9 8 780
	16.0	6 2 380	6 8 440	7 1 490	7 6 550	7 10 600	8 1 650	8 5 690	8 8 740	8 11 780	9 2 830
	19.2	5 10 400	6 3 460	6 8 520	7 0 580	7 4 630	7 8 690	7 11 740	8 2 790	8 5 830	8 8 880
	24.0	5 5 430	5 10 500	6 2 560	6 6 630	6 10 680	7 1 740	7 4 790	7 7 850	7 10 900	8 0 950
2x6	12.0	10 9 340	11 7 400	12 3 450	12 11 500	13 6 540	14 1 590	14 7 630	15 0 670	15 6 710	15 11 750
	13.7	10 3 360	11 1 410	11 9 470	12 4 520	12 11 570	13 5 610	13 11 660	14 4 700	14 9 740	15 2 780
	16.0	9 9 380	10 6 440	11 2 490	11 9 550	12 3 600	12 9 650	13 3 690	13 8 740	14 1 780	14 5 830
	19.2	9 2 400	9 10 460	10 6 520	11 1 580	11 7 630	12 0 690	12 5 740	12 10 790	13 3 830	13 7 880
	24.0	8 6 430	9 2 500	9 9 560	10 3 630	10 9 680	11 2 740	11 7 790	11 11 850	12 3 900	12 7 950
2x8	12.0	14 2 340	15 3 400	16 2 450	17 0 500	17 10 540	18 6 590	19 2 630	19 10 670	20 5 710	20 11 750
	13.7	13 6 360	14 7 410	15 6 470	16 3 520	17 0 570	17 9 610	18 4 660	18 11 700	19 6 740	20 0 780
	16.0	12 10 380	13 10 440	14 8 490	15 6 550	16 2 600	16 10 650	17 5 690	18 0 740	18 6 780	19 0 830
	19.2	12 1 400	13 0 460	13 10 520	14 7 580	15 3 630	15 10 690	16 5 740	16 11 790	17 5 830	17 11 880
	24.0	11 3 430	12 1 500	12 10 560	13 6 630	14 2 680	14 8 740	15 3 790	15 9 850	16 2 900	16 7 950
2x10	12.0	18.0 340	19.5 400	20.8 450	21.9 500	22.9 540	23.8 590	24.6 630	25.3 670	26.0 710	26.9 750
	13.7	17.3 360	18.7 410	19.9 470	20.9 520	21.9 570	22.7 610	23.5 660	24.2 700	24.10 740	25.7 780
	16.0	16.5 380	17.8 440	18.9 490	19.9 550	20.8 600	21.6 650	22.3 690	22.11 740	23.8 780	24.3 830
	19.2	15.5 400	16.7 460	17.8 520	18.7 580	19.5 630	20.2 690	20.11 740	21.7 790	22.3 830	22.10 880
	24.0	14.4 430	15.5 500	16.5 560	17.3 630	18.0 680	18.9 740	19.5 790	20.1 850	20.8 900	21.2 950

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

Table No. 7-C (cont.)

HOW TO USE TABLES: Enter Table with span of joists (upper figure in each square). Determine size and spacing (first column) based on stress grade (lower figure in each square) and modulus of elasticity (top row) of lumber to be used.

JOIST SIZE	SPACING (IN)	Modulus of Elasticity, "E", in 1,000,000 psi								
(IN)		1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.2	2.4
2x4	12.0	10-4 790	10-7 830	10-10 860	11-1 900	11-3 930	11-6 970	11-8 1000	12-1 1070	12-5 1130
	13.7	9-11 820	10-2 860	10-4 900	10-7 940	10-9 970	11-0 1010	11-2 1050	11-6 1110	11-10 1180
	16.0	9-5 870	9-8 910	9-10 950	10-0 990	10-3 1030	10-5 1060	10-7 1100	10-11 1170	11-3 1240
	19.2	8-10 920	9-1 970	9-3 1010	9-5 1050	9-8 1090	9-10 1130	10-0 1170	10-4 1250	10-7 1320
	24.0	8-3 990	8-5 1040	8-7 1090	8-9 1130	8-11 1170	9-1 1220	9-3 1260	9-7 1340	9-10 1420
2x6	12.0	16-3 790	16-8 830	17-0 860	17-4 900	17-8 930	18-0 970	18-4 1000	18-11 1070	19-6 1130
	13.7	15-7 820	15-11 860	16-3 900	16-7 940	16-11 970	17-3 1010	17-6 1050	18-1 1110	18-8 1180
	16.0	14-9 870	15-2 910	15-6 950	15-9 990	16-1 1030	16-4 1060	16-8 1100	17-2 1170	17-8 1240
	19.2	13-11 920	14-3 970	14-7 1010	14-10 1050	15-2 1090	15-5 1130	15-8 1170	16-2 1250	16-8 1320
	24.0	12-11 990	13-3 1040	13-6 1090	13-9 1130	14-1 1170	14-4 1220	14-7 1260	15-0 1340	15-6 1420
2x8	12.0	21-5 790	21-11 830	22-5 860	22-11 900	23-4 930	23-9 970	24-2 1000	24-11 1070	25-8 1130
	13.7	20-6 820	21-0 860	21-5 900	21-11 940	22-4 970	22-9 1010	23-1 1050	23-10 1110	24-7 1180
	16.0	19-6 870	19-11 910	20-5 950	20-10 990	21-2 1030	21-7 1060	21-11 1100	22-8 1170	23-4 1240
	19.2	18-4 920	18-9 970	19-2 1010	19-7 1050	19-11 1090	20-4 1130	20-8 1170	21-4 1250	21-11 1320
	24.0	17-0 990	17-5 1040	17-10 1090	18-2 1130	18-6 1170	18-10 1220	19-2 1260	19-10 1340	20-5 1420
2x10	12.0	27-5 790	28-0 830	28-7 860	29-2 900	29-9 930	30-4 970	30-10 1000	31-10 1070	32-9 1130
	13.7	26-2 820	26-10 860	27-5 900	27-11 940	28-6 970	29-0 1010	29-6 1050	30-5 1110	31-4 1180
	16.0	24-10 870	25-5 910	26-0 950	26-6 990	27-1 1030	27-6 1060	28-0 1100	28-11 1170	29-9 1240
	19.2	23-5 920	23-11 970	24-6 1010	25-0 1050	25-5 1090	25-11 1130	26-4 1170	27-3 1250	28-0 1320
	24.0	21-9 990	22-3 1040	22-9 1090	23-2 1130	23-8 1170	24-1 1220	24-6 1260	25-3 1340	26-0 1420

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

Table No. 7-D
ALLOWABLE SPAN FOR CEILING JOISTS

10 Lbs. Per Sq. Ft. Live Load
(No attic storage and roof slope not steeper than 3 in 12)

(Gypsum Ceiling)

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

JOIST SIZE	SPACING (IN)	Modulus of Elasticity, "E", in 1,000,000 psi									
		0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3
2x4	12.0	7-10 450	8-5 520	8-11 590	9-5 650	9-10 710	10-3 770	10-7 830	10 11 880	11 3 930	11 7 980
	13.7	7-6 470	8-1 540	8-7 610	9-0 680	9 5 740	9 9 800	10-2 860	10 6 920	10 9 970	11 1 1030
	16.0	7-1 490	7-8 570	8-1 650	8 7 720	8-11 780	9 4 850	9 8 910	9 11 970	10 3 1030	10 6 1080
	19.2	6-8 520	7-2 610	7-8 690	8 1 760	8 5 830	8-9 900	9 1 970	9 4 1030	9 8 1090	9 11 1150
	24.0	6-2 560	6-8 660	7 1 740	7 6 820	7-10 900	8 1 970	8-5 1040	8 8 1110	8 11 1170	9 2 1240
2x6	12.0	12-3 450	13-3 520	14-1 590	14-9 650	15-6 710	16 1 770	16 8 830	17 2 880	17 8 930	18 2 980
	13.7	11-9 470	12-8 540	13-5 610	14 2 680	14-9 740	15 5 800	15 11 860	16 5 920	16 11 970	17 5 1030
	16.0	11-2 490	12-0 570	12-9 650	13 5 720	14-1 780	14 7 850	15 2 910	15 7 970	16 1 1030	16 6 1080
	19.2	10-6 520	11-4 610	12 0 690	12 8 760	13 3 830	13 9 900	14 3 970	14 8 1030	15 2 1090	15 7 1150
	24.0	9-9 560	10-6 660	11-2 740	11 9 820	12 3 900	12 9 970	13 3 1040	13 8 1110	14 1 1170	14 5 1240
2x8	12.0	16-2 450	17-5 520	18-6 590	19-6 650	20-5 710	21 2 770	21 11 830	22 8 880	23 4 930	24 0 980
	13.7	15-6 470	16-8 540	17-9 610	18-8 680	19-6 740	20 3 800	21 0 860	21 8 920	22 4 970	22 11 1030
	16.0	14-8 490	15-10 570	16-10 650	17-9 720	18-6 780	19 3 850	19 11 910	20 7 970	21 2 1030	21 9 1080
	19.2	13-10 520	14-11 610	15-10 690	16-8 760	17 5 830	18 2 900	18 9 970	19 5 1030	19 11 1090	20 6 1150
	24.0	12-10 560	13-10 660	14-8 740	15-6 820	16 2 900	16 10 970	17 5 1040	18 0 1110	18 6 1170	19 0 1240
2x10	12.0	20-8 450	22-3 520	23-8 590	24 10 650	26 0 710	27 1 770	28 0 830	28 11 880	29 9 930	30 7 980
	13.7	19-9 470	21-3 540	22-7 610	23 9 680	24 10 740	25 10 800	26-10 860	27 8 920	28 6 970	29 3 1030
	16.0	18-9 490	20-2 570	21-6 650	22 7 720	23 8 780	24-7 850	25 5 910	26 3 970	27 1 1030	27 9 1080
	19.2	17-8 520	19-0 610	20-2 690	21 3 760	22 3 830	23 2 900	23 11 970	24 9 1030	25 5 1090	26 2 1150
	24.0	16-5 560	17 8 660	18-9 740	19-9 820	20 8 900	21 6 970	22 3 1040	22 11 1110	23 8 1170	24 3 1240

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

Table No. 7-D (cont.)

HOW TO USE TABLES: Enter Table with span of joists (upper figure in each square). Determine size and spacing (first column) based on stress grade (lower figure in each square) and modulus of elasticity (top row) of lumber to be used.

JOIST SIZE	SPACING (IN)	Modulus of Elasticity, "E", in 1,000,000 psi								
		1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.2	2.4
2x4	12.0	11-10 1030	12-2 1080	12-5 1130	12-8 1180	12-11 1220	13-2 1270	13-4 1310	13-9 1400	14-2 1480
	13.7	11-4 1080	11-7 1130	11-10 1180	12-1 1230	12-4 1280	12-7 1320	12-9 1370	13-2 1460	13-7 1550
	16.0	10-9 1140	11-0 1190	11-3 1240	11-6 1290	11-9 1340	11-11 1390	12-2 1440	12-6 1540	12-11 1630
	19.2	10-2 1210	10-4 1270	10-7 1320	10-10 1380	11-0 1430	11-3 1480	11-5 1530	11-9 1630	12-2 1730
	24.0	9-5 1300	9-8 1360	9-10 1420	10-0 1480	10-3 1540	10-5 1600	10-7 1650	10-11 1760	11-3 1860
2x6	12.0	18-8 1030	19-1 1080	19-6 1130	19-11 1180	20-3 1220	20-8 1270	21-0 1310	21-8 1400	22-4 1480
	13.7	17-10 1080	18-3 1130	18-8 1180	19-0 1230	19-5 1280	19-9 1320	20-1 1370	20-9 1460	21-4 1550
	16.0	16-11 1140	17-4 1190	17-8 1240	18-1 1290	18-5 1340	18-9 1390	19-1 1440	19-8 1540	20-3 1630
	19.2	15-11 1210	16-4 1270	16-8 1320	17-0 1380	17-4 1430	17-8 1480	17-11 1530	18-6 1630	19-1 1730
	24.0	14-9 1300	15-2 1360	15-6 1420	15-9 1480	16-1 1540	16-4 1600	16-8 1650	17-2 1760	17-8 1860
2x8	12.0	24-7 1030	25-2 1080	25-8 1130	26-2 1180	26-9 1220	27-2 1270	27-8 1310	28-7 1400	29-5 1480
	13.7	23-6 1080	24-0 1130	24-7 1180	25-1 1230	25-7 1280	26-0 1320	26-6 1370	27-4 1460	28-1 1550
	16.0	22-4 1140	22-10 1190	23-4 1240	23-10 1290	24-3 1340	24-8 1390	25-2 1440	25-11 1540	26-9 1630
	19.2	21-0 1210	21-6 1270	21-11 1320	22-5 1380	22-10 1430	23-3 1480	23-8 1530	24-5 1630	25-2 1730
	24.0	19-6 1300	19-11 1360	20-5 1420	20-10 1480	21-2 1540	21-7 1600	21-11 1650	22-8 1760	23-4 1860
2x10	12.0	31-4 1030	32-1 1080	32-9 1130	33-5 1180	34-1 1220	34-8 1270	35-4 1310	36-5 1400	37-6 1480
	13.7	30-0 1080	30-8 1130	31-4 1180	32-0 1230	32-7 1280	33-2 1320	33-9 1370	34-10 1460	35-10 1550
	16.0	28-6 1140	29-2 1190	29-9 1240	30-5 1290	31-0 1340	31-6 1390	32-1 1440	33-1 1540	34-1 1630
	19.2	26-10 1210	27-5 1270	28-0 1320	28-7 1380	29-2 1430	29-8 1480	30-2 1530	31-2 1630	32-1 1730
	24.0	24-10 1300	25-5 1360	26-0 1420	26-6 1480	27-1 1540	27-6 1600	28-0 1650	28-11 1760	29-9 1860

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

Table No. 7-E
ALLOWABLE SPAN FOR LOW OR HIGH SLOPE RAFTERS

20 Lbs. Per Sq. Ft Live Load
(Supporting Gypsum Ceiling)

DESIGN CRITERIA:
Strength – 15 lbs. per sq ft dead load plus 20 lbs. per sq. ft live load determines fiber stress.
Deflection – For 20 lbs. per sq. ft. live load. Limited to span in inches divided by 240.

HOW TO USE TABLES: Enter table with span of rafters (upper figure in each square) Determine size and spacing (first column) based on stress grade (top row) and modulus of elasticity (lower figure in each square) of lumber to be used.

RAFTER SIZE	SPACING (IN)	Allowable Extreme Fiber Stress in Bending, "F_b" (psi)										
		300	400	500	600	700	800	900	1000	1100	1200	1300
2×6	12.0	6 7 0 12	7 7 0 19	8 6 0 26	9 4 0 35	10 0 0 44	10 9 0 54	11 5 0 64	12 0 0 75	12 7 0 86	13 2 0 98	13 8 1 11
	13.7	6 2 0 12	7 1 0 18	7 11 0 25	8 8 0 33	9 5 0 41	10 0 0 50	10 8 0 60	11 3 0 70	11 9 0 81	12 4 0 92	12 10 1 04
	16.0	5 8 0 11	6 7 0 16	7 4 0 23	8 1 0 30	8 8 0 38	9 4 0 46	9 10 0 55	10 5 0 65	10 11 0 75	11 5 0 85	11 10 0 96
	19.2	5 2 0 10	6 0 0 15	6 9 0 21	7 4 0 27	7 11 0 35	8 6 0 42	9 0 0 51	9 6 0 59	9 11 0 68	10 5 0 78	10 10 0 88
	24.0	4 8 0 09	5 4 0 13	6 0 0 19	6 7 0 25	7 1 0 31	7 7 0 38	8 1 0 45	8 6 0 53	8 11 0 61	9 4 0 70	9 8 0 78
2×8	12.0	8 8 0 12	10 0 0 19	11 2 0 26	12 3 0 35	13 3 0 44	14 2 0 54	15 0 0 64	15 10 0 75	16 7 0 86	17 4 0 98	18 0 1 11
	13.7	8 1 0 12	9 4 0 18	10 6 0 25	11 6 0 33	12 5 0 41	13 3 0 50	14 0 0 60	14 10 0 70	15 6 0 81	16 3 0 92	16 10 1 04
	16.0	7 6 0 11	8 8 0 16	9 8 0 23	10 7 0 30	11 6 0 38	12 3 0 46	13 0 0 55	13 8 0 65	14 4 0 75	15 0 0 85	15 7 0 96
	19.2	6 10 0 10	7 11 0 15	8 10 0 21	9 8 0 27	10 6 0 35	11 2 0 42	11 10 0 51	12 6 0 59	13 1 0 68	13 8 0 78	14 3 0 88
	24.0	6 2 0 09	7 1 0 13	7 11 0 19	8 8 0 25	9 4 0 31	10 0 0 38	10 7 0 45	11 2 0 53	11 9 0 61	12 3 0 70	12 9 0 78
2×10	12.0	11 1 0 12	12 9 0 19	14 3 0 26	15 8 0 35	16 11 0 44	18 1 0 54	19 2 0 64	20 2 0 75	21 2 0 86	22 1 0 98	23 0 1 11
	13.7	10 4 0 12	11 11 0 18	13 4 0 25	14 8 0 33	15 10 0 41	16 11 0 50	17 11 0 60	18 11 0 70	19 10 0 81	20 8 0 92	21 6 1 04
	16.0	9 7 0 11	11 1 0 16	12 4 0 23	13 6 0 30	14 8 0 38	15 8 0 46	16 7 0 55	17 6 0 65	18 4 0 75	19 2 0 85	19 11 0 96
	19.2	8 9 0 10	10 1 0 15	11 3 0 21	12 4 0 27	13 4 0 35	14 3 0 42	15 2 0 51	15 11 0 59	16 9 0 68	17 6 0 78	18 2 0 88
	24.0	7 10 0 09	9 0 0 13	10 1 0 19	11 1 0 25	11 11 0 31	12 9 0 38	13 6 0 45	14 3 0 53	15 0 0 61	15 8 0 70	16 3 0 78
2×12	12.0	13 5 0 12	15 6 0 19	17 4 0 26	19 0 0 35	20 6 0 44	21 11 0 54	23 3 0 64	24 7 0 75	25 9 0 86	26 11 0 98	28 0 1 11
	13.7	12 7 0 12	14 6 0 18	16 3 0 25	17 9 0 33	19 3 0 41	20 6 0 50	21 9 0 60	23 0 0 70	24 1 0 81	25 2 0 92	26 2 1 04
	16.0	11 8 0 11	13 5 0 16	15 0 0 23	16 6 0 30	17 9 0 38	19 0 0 46	20 2 0 55	21 3 0 65	22 4 0 75	23 3 0 85	24 3 0 96
	19.2	10 8 0 10	12 3 0 15	13 9 0 21	15 0 0 27	16 3 0 35	17 4 0 42	18 5 0 51	19 5 0 59	20 4 0 68	21 3 0 78	22 2 0 88
	24.0	9 6 0 09	11 0 0 13	12 3 0 19	13 5 0 25	14 6 0 31	15 6 0 38	16 6 0 45	17 4 0 53	18 2 0 61	19 0 0 70	19 10 0 78

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

Table No. 7-E (cont.)

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

HOW TO USE TABLES: Enter table with span of rafters (upper figure in each square). Determine size and spacing (last column) based on stress grade (top row) and modulus of elasticity (lower figure in each square) of lumber to be used.

Allowable Extreme Fiber Stress in Bending, "F_b" (psi)											RAFTER SPACING (IN)	SIZE (IN)
1400	1500	1600	1700	1800	1900	2000	2100	2200	2400	2700		
14-2 1.24	14-8 1.37	15-2 1.51	15-8 1.66	16-1 1.81	16-7 1.96	17-0 2.12	17-5 2.28	17-10 2.44			12-0	
13-3 1.16	13-9 1.29	14-2 1.42	14-8 1.55	15-1 1.69	15-6 1.83	15-11 1.98	16-3 2.13	16-8 2.28	17-5 2.60		13-7	
12-4 1.07	12-9 1.19	13-2 1.31	13-7 1.44	13-11 1.56	14-4 1.70	14-8 1.83	15-1 1.97	15-5 2.11	16-1 2.41		16-0	2×6
11-3 0.98	11-7 1.09	12-0 1.20	12-4 1.31	12-9 1.43	13-1 1.55	13-5 1.67	13-9 1.80	14-1 1.93	14-8 2.20		19-2	
10-0 0.88	10-5 0.97	10-9 1.07	11-1 1.17	11-5 1.28	11-8 1.39	12-0 1.50	12-4 1.61	12-7 1.73	13-2 1.97	13-11 2.35	24-0	
18-9 1.24	19-5 1.37	20-0 1.51	20-8 1.66	21-3 1.81	21-10 1.96	22-4 2.12	22-11 2.28	23-6 2.44			12-0	
17-6 1.16	18-2 1.29	18-9 1.42	19-4 1.55	19-10 1.69	20-5 1.83	20-11 1.98	21-5 2.13	21-11 2.28	22-11 2.60		13-7	
16-3 1.07	16-9 1.19	17-4 1.31	17-10 1.44	18-5 1.56	18-11 1.70	19-5 1.83	19-10 1.97	20-4 2.11	21-3 2.41		16-0	2×8
14-10 0.98	15-4 1.09	15-10 1.20	16-4 1.31	16-9 1.43	17-3 1.55	17-8 1.67	18-2 1.80	18-7 1.93	19-5 2.20		19-2	
13-3 0.88	13-8 0.97	14-2 1.07	14-7 1.17	15-0 1.28	15-5 1.39	15-10 1.50	16-3 1.61	16-7 1.73	17-4 1.97	18-5 2.35	24-0	
23-11 1.24	24-9 1.37	25-6 1.51	26-4 1.66	27-1 1.81	27-10 1.96	28-7 2.12	29-3 2.28	29-11 2.44			12-0	
22-4 1.16	23-2 1.29	23-11 1.42	24-7 1.55	25-4 1.69	26-0 1.83	26-8 1.98	27-4 2.13	28-0 2.28	29-3 2.60		13-7	
20-8 1.07	21-5 1.19	22-1 1.31	22-10 1.44	23-5 1.56	24-1 1.70	24-9 1.83	25-4 1.97	25-11 2.11	27-1 2.41		16-0	2×10
18-11 0.98	19-7 1.09	20-2 1.20	20-10 1.31	21-5 1.43	22-0 1.55	22-7 1.67	23-2 1.80	23-8 1.93	24-9 2.20		19-2	
16-11 0.88	17-6 0.97	18-1 1.07	18-7 1.17	19-2 1.28	19-8 1.39	20-2 1.50	20-8 1.61	21-2 1.73	22-1 1.97	23-5 2.35	24-0	
29-1 1.24	30-1 1.37	31-1 1.51	32-0 1.66	32-11 1.81	33-10 1.96	34-9 2.12	35-7 2.28	36-5 2.44			12-0	
27-2 1.16	28-2 1.29	29-1 1.42	29-11 1.55	30-10 1.69	31-8 1.83	32-6 1.98	33-3 2.13	34-1 2.28	35-7 2.60		13-7	
25-2 1.07	26-0 1.19	26-11 1.31	27-9 1.44	28-6 1.56	29-4 1.70	30-1 1.83	30-10 1.97	31-6 2.11	32-11 2.41		16-0	2×12
23-0 0.98	23-9 1.09	24-7 1.20	25-4 1.31	26-0 1.43	26-9 1.55	27-5 1.67	28-2 1.80	28-9 1.93	30-1 2.20		19-2	
20-6 0.88	21-3 0.97	21-11 1.07	22-8 1.17	23-3 1.28	23-11 1.39	24-7 1.50	25-2 1.61	25-9 1.73	26-11 1.97	28-6 2.35	24-0	

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

Table No. 7-F
ALLOWABLE SPAN FOR LOW OR HIGH SLOPE RAFTERS

30 Lbs. Per Sq. Ft. Live Load
(Supporting Gypsum Ceiling)

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

HOW TO USE TABLES: Enter table with span of rafters (upper figure in each square). Determine size and spacing (first column) based on stress grade (top row) and modulus of elasticity (lower figure in each square) of lumber to be used.

RAFTER SIZE	SPACING (IN)	Allowable Extreme Fiber Stress in Bending, "F_b" (psi). 300	400	500	600	700	800	900	1000	1100	1200	1300
2x6	12.0	5-10 0.13	6-8 0.19	7-6 0.27	8-2 0.36	8-10 0.45	9-6 0.55	10-0 0.66	10-7 0.77	11-1 0.89	11-7 1.01	12-1 1.14
	13.7	5-5 0.12	6-3 0.18	7-0 0.25	7-8 0.33	8-3 0.42	8-10 0.52	9-5 0.61	9-11 0.72	10-5 0.83	10-10 0.95	11-3 1.07
	16.0	5-0 0.11	5-10 0.17	6-6 0.24	7-1 0.31	7-8 0.39	8-2 0.48	8-8 0.57	9-2 0.67	9-7 0.77	10-0 0.88	10-5 0.99
	19.2	4-7 0.10	5-4 0.15	5-11 0.22	6-6 0.28	7-0 0.36	7-6 0.44	7-11 0.52	8-4 0.61	8-9 0.70	9-2 0.80	9-6 0.90
	24.0	4-1 0.09	4-9 0.14	5-4 0.19	5-10 0.25	6-3 0.32	6-8 0.39	7-1 0.46	7-6 0.54	7-10 0.63	8-2 0.72	8-6 0.81
2x8	12.0	7-8 0.13	8-10 0.19	9-10 0.27	10-10 0.36	11-8 0.45	12-6 0.55	13-3 0.66	13-11 0.77	14-8 0.89	15-3 1.01	15-11 1.14
	13.7	7-2 0.12	8-3 0.18	9-3 0.25	10-1 0.33	10-11 0.42	11-8 0.52	12-5 0.61	13-1 0.72	13-8 0.83	14-4 0.95	14-11 1.07
	16.0	6-7 0.11	7-8 0.17	8-7 0.24	9-4 0.31	10-1 0.39	10-10 0.48	11-6 0.57	12-1 0.67	12-8 0.77	13-3 0.88	13-9 0.99
	19.2	6-1 0.10	7-0 0.15	7-10 0.22	8-7 0.28	9-3 0.36	9-10 0.44	10-6 0.52	11-0 0.61	11-7 0.70	12-1 0.80	12-7 0.90
	24.0	5-5 0.09	6-3 0.14	7-0 0.19	7-8 0.25	8-3 0.32	8-10 0.39	9-4 0.46	9-10 0.54	10-4 0.63	10-10 0.72	11-3 0.81
2x10	12.0	9-9 0.13	11-3 0.19	12-7 0.27	13-9 0.36	14-11 0.45	15-11 0.55	16-11 0.66	17-10 0.77	18-8 0.89	19-6 1.01	20-4 1.14
	13.7	9-1 0.12	10-6 0.18	11-9 0.25	12-11 0.33	13-11 0.42	14-11 0.52	15-10 0.61	16-8 0.72	17-6 0.83	18-3 0.95	19-0 1.07
	16.0	8-5 0.11	9-9 0.17	10-11 0.24	11-11 0.31	12-11 0.39	13-9 0.48	14-8 0.57	15-5 0.67	16-2 0.77	16-11 0.88	17-7 0.99
	19.2	7-8 0.10	8-11 0.15	9-11 0.22	10-11 0.28	11-9 0.36	12-7 0.44	13-4 0.52	14-1 0.61	14-9 0.70	15-5 0.80	16-1 0.90
	24.0	6-11 0.09	8-0 0.14	8-11 0.19	9-9 0.25	10-6 0.32	11-3 0.39	11-11 0.46	12-7 0.54	13-2 0.63	13-9 0.72	14-4 0.81
2x12	12.0	11-10 0.13	13-8 0.19	15-4 0.27	16-9 0.36	18-1 0.45	19-4 0.55	20-6 0.66	21-8 0.77	22-8 0.89	23-9 1.01	24-8 1.14
	13.7	11-1 0.12	12-10 0.18	14-4 0.25	15-8 0.33	16-11 0.42	18-1 0.52	19-3 0.61	20-3 0.72	21-3 0.83	22-2 0.95	23-1 1.07
	16.0	10-3 0.11	11-10 0.17	13-3 0.24	14-6 0.31	15-8 0.39	16-9 0.48	17-9 0.57	18-9 0.67	19-8 0.77	20-6 0.88	21-5 0.99
	19.2	9-5 0.10	10-10 0.15	12-1 0.22	13-3 0.28	14-4 0.36	15-4 0.44	16-3 0.52	17-1 0.61	17-11 0.70	18-9 0.80	19-6 0.90
	24.0	8-5 0.09	9-8 0.14	10-10 0.19	11-10 0.25	12-10 0.32	13-8 0.39	14-6 0.46	15-4 0.54	16-1 0.63	16-9 0.72	17-5 0.81

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

Table No. 7-F (cont.)

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

HOW TO USE TABLES: Enter table with span of rafters (upper figure in each square). Determine size and spacing (last column) based on stress grade (top row) and modulus of elasticity (lower figure in each square) of lumber to be used.

Allowable Extreme Fiber Stress in Bending, "F_b" (psi).											RAFTER SPACING (IN)	SIZE (IN)
1400	1500	1600	1700	1800	1900	2000	2100	2200	2400	2700		
12-6 1 28	13-0 1 41	13-5 1 56	13-10 1 71	14 2 1 86	14-7 2.02	15-0 2 18	15 4 2 34	15-8 2.51			12.0	
11 9 1 19	12-2 1 32	12-6 1 46	12 11 1 60	13-3 1 74	13-8 1 89	14-0 2.04	14-4 2 19	14-8 2.35			13.7	
10-10 1 10	11 3 1 22	11 7 1 35	11 11 1 48	12-4 1 61	12 8 1 75	13-0 1 89	13-3 2.03	13-7 2 18	14-2 2.48		16.0	2x6
9-11 1 01	10 3 1 12	10-7 1 23	10-11 1 35	11 3 1 47	11-6 1 59	11-10 1 72	12-2 1 85	12-5 1 99	13-0 2.26		19.2	
8-10 0 90	9-2 1 00	9 6 1 10	9 9 1 21	10-0 1 31	10-4 1 43	10-7 1 54	10-10 1 66	11-1 1 78	11-7 2.02	12-4 2.41	24.0	
16-6 1 28	17 1 1 41	17-8 1 56	18-2 1 71	18-9 1 86	19-3 2 02	19-9 2 18	20-3 2 34	20-8 2 51			12.0	
15-5 1 19	16 0 1 32	16-6 1 46	17 0 1 60	17-6 1 74	18-0 1 89	18-5 2 04	18-11 2 19	19-4 2 35			13 7	
14 4 1 10	14 10 1 22	15-3 1 35	15 9 1 48	16 3 1 61	16-8 1 75	17 1 1 89	17-6 2 03	17-11 2 18	18-9 2.48		16.0	2x8
13 1 1 01	13-6 1 12	13-11 1 23	14-5 1 35	14-10 1 47	15-2 1 59	15-7 1 72	16 0 1 85	16-4 1 99	17-1 2 26		19.2	
11-8 0 90	12 1 1 00	12-6 1 10	12 10 1 21	13-3 1 31	13-7 1 43	13-11 1 54	14-4 1 66	14-8 1 78	15-3 2 02	16-3 2 41	24 0	
21 1 1 28	21 10 1 41	22 6 1 56	23 3 1 71	23 11 1 86	24 6 2 02	25-2 2 18	25-10 2 34	26 5 2 51			12 C	
19-8 1 19	20-5 1 32	21 1 1 46	21-9 1 60	22 4 1 74	22 11 1 89	23-7 2 04	24-2 2 19	24-8 2.35			13.7	
18-3 1 10	18 11 1 22	19-6 1 35	20-1 1 48	20-8 1 61	21 3 1 75	21 10 1 89	22-4 2 03	22-10 2 18	23 11 2.48		16 0	2x10
16-8 1 01	17 3 1 12	17 10 1 23	18-4 1 35	18 11 1 47	19 5 1 59	19-11 1 72	20 5 1 85	20-10 1 99	21-10 2.26		19.2	
14-11 0.90	15-5 1 00	15-11 1 10	16-5 1 21	16-11 1 31	17 4 1 43	17 10 1 54	18-3 1 66	18-8 1 78	19-6 2 02	20-8 2 41	24.0	
25-7 1 28	26-6 1 41	27-5 1 56	28-3 1 71	29 1 1 86	29-10 2 02	30-7 2 18	31 4 2 34	32-1 2 51			12.0	
24-0 1 19	24-10 1 32	25-7 1 46	26-5 1 60	27 2 1 74	27-11 1 89	28-8 2 04	29-4 2 19	30-0 2 35			13.7	
22-2 1 10	23-0 1 22	23-9 1 35	24-5 1 48	25 2 1 61	25 10 1 75	26-6 1 89	27 2 2 03	27 10 2 18	29-1 2 48		16.0	2x12
20-3 1 01	21-0 1 12	21-8 1 23	22-4 1 35	23-0 1 47	23-7 1 59	24-2 1 72	24 10 1 85	25-5 1 99	26-6 2.26		19.2	
18-1 0.90	18-9 1 00	19-4 1 10	20-0 1 21	20-6 1 31	21-1 1 43	21-8 1 54	22-2 1 66	22-8 1 78	23-9 2 02	25-2 2 41	24.0	

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

Table No. 7-G
ALLOWABLE SPAN FOR LOW OR HIGH SLOPE RAFTERS

40 Lbs. Per Sq. Ft. Live Load
(Supporting Gypsum Ceiling)

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

HOW TO USE TABLES: Enter table with span of rafters (upper figure in each square) Determine size and spacing (first column) based on stress grade (top row) and modulus of elasticity (lower figure in each square) of lumber to be used.

RAFTER SIZE	SPACING (IN)	Allowable Extreme Fiber Stress in Bending, "F_b" (psi).										
		300	400	500	600	700	800	900	1000	1100	1200	1300
2x6	12.0	5-3 0 12	6-1 0 19	6-9 0 27	7 5 0 35	8-0 0 44	8 7 0 54	9 1 0 65	9 7 0 76	10-0 0 88	10-6 1 00	10 11 1 13
	13.7	4 11 0 12	5 8 0 18	6-4 0 25	6 11 0 33	7 6 0 42	8 0 0 51	8 6 0 61	8 11 0 71	9-5 0.82	9 10 0 93	10 3 1 05
	16.0	4 6 0 11	5-3 0 17	5 10 0 23	6 5 0 31	6 11 0 39	7 5 0 47	7 10 0 56	8 3 0 66	8-8 0 76	9 1 0 86	9 5 0 98
	19.2	4-2 0 10	4-9 0 15	5-4 0 21	5 10 0 28	6 4 0 35	6 9 0 43	7 2 0 51	7 7 0 60	7 11 0 69	8 3 0 79	8 8 0 89
	24.0	3 8 0 09	4-3 0 14	4-9 0 19	5 3 0 25	5 8 0 31	6 1 0 38	6 5 0 46	6 9 0 54	7 1 0 62	7 5 0 71	7 9 0 80
2x8	12.0	6 11 0 12	8 0 0 19	8 11 0 27	9 9 0 35	10 7 0 44	11 3 0 54	12 0 0 65	12 7 0 76	13 3 0 88	13 10 1 00	14 5 1 13
	13.7	6 6 0 12	7 6 0 18	8 4 0 25	9 2 0 33	9 11 0 42	10 7 0 51	11 2 0 61	11 10 0 71	12 5 0 82	12 11 0 93	13 6 1 05
	16.0	6 0 0 11	6 11 0 17	7 9 0 23	8 6 0 31	9 2 0 39	9 9 0 47	10 4 0 56	10 11 0 66	11 6 0 76	12 0 0 86	12 6 0 98
	19.2	5 6 0 10	6 4 0 15	7 1 0 21	7 9 0 28	8 4 0 35	8 11 0 43	9 6 0 51	10 0 0 60	10 6 0 69	10 11 0 79	11 5 0 89
	24.0	4 11 0 09	5 8 0 14	6 4 0 19	6 11 0 25	7 6 0 31	8 0 0 38	8 6 0 46	8 11 0 54	9 4 0 62	9 9 0 71	10 2 0 80
2x10	12.0	8 10 0 12	10 2 0 19	11 5 0 27	12 6 0 35	13 6 0 44	14 5 0 54	15 3 0 65	16 1 0 76	16 11 0 88	17 8 1 00	18 4 1 13
	13.7	8 3 0 12	9 6 0 18	10 8 0 25	11 8 0 33	12 7 0 42	13 6 0 51	14 3 0 61	15 1 0 71	15 10 0 82	16 6 0 93	17 2 1 05
	16.0	7 8 0 11	8 10 0 17	9 10 0 23	10 10 0 31	11 8 0 39	12 6 0 47	13 3 0 56	13 11 0 66	14 8 0 76	15 3 0 86	15 11 0 98
	19.2	7 0 0 10	8 1 0 15	9 0 0 21	9 10 0 28	10 8 0 35	11 5 0 43	12 1 0 51	12 9 0 60	13 4 0 69	13 11 0 79	14 6 0 89
	24.0	6 3 0 09	7 2 0 14	8 1 0 19	8 10 0 25	9 6 0 31	10 2 0 38	10 10 0 46	11 5 0 54	11 11 0 62	12 6 0 71	13 0 0 80
2x12	12.0	10 9 0 12	12 5 0 19	13 10 0 27	15 2 0 35	16 5 0 44	17 6 0 54	18 7 0 65	19 7 0 76	20 6 0 88	21 5 1 00	22 4 1 13
	13.7	10 0 0 12	11 7 0 18	12 11 0 25	14 2 0 33	15 4 0 42	16 5 0 51	17 5 0 61	18 4 0 71	19 3 0 82	20 1 0 93	20 11 1 05
	16.0	9 3 0 11	10 9 0 17	12 0 0 23	13 2 0 31	14 2 0 39	15 2 0 47	16 1 0 56	17 0 0 66	17 9 0 76	18 7 0 86	19 4 0 98
	19.2	8 6 0 10	9 10 0 15	10 11 0 21	12 0 0 28	12 11 0 35	13 10 0 43	14 8 0 51	15 6 0 60	16 3 0 69	17 0 0 79	17 8 0 89
	24.0	7 7 0 09	8 9 0 14	9 10 0 19	10 9 0 25	11 7 0 31	12 5 0 38	13 2 0 46	13 10 0 54	14 6 0 62	15 2 0 71	15 9 0 80

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

Table No. 7-G (cont.)

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

HOW TO USE TABLES: Enter table with span of rafters (upper figure in each square). Determine size and spacing (last column) based on stress grade (top row) and modulus of elasticity (lower figure in each square) of lumber to be used.

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

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

Table No. 7-H
ALLOWABLE SPAN FOR LOW OR HIGH SLOPE RAFTERS

20 Lbs. Per Sq. Ft. Live Load
(Supporting Plaster Ceiling)

DESIGN CRITERIA:
Strength – 15 lbs. per sq. ft. dead load plus 20 lbs. per sq. ft. live load determines fiber stress.
Deflection – For 20 lbs. per sq. ft. live load. Limited to span in inches divided by 360.

HOW TO USE TABLES: Enter table with span of rafters (upper figure in each square). Determine size and spacing (first column) based on stress grade (top row) and modulus of elasticity (lower figure in each square) of lumber to be used.

RAFTER SIZE	SPACING (IN)	Allowable Extreme Fiber Stress in Bending, "F_b" (psi).									
		300	400	500	600	700	800	900	1000	1100	1200
2x6	12.0	6-7 0.18	7-7 0.28	8-6 0.40	9-4 0.52	10-0 0.66	10-9 0.80	11-5 0.96	12-0 1.12	12.7 1.29	13.2 1.48
	13.7	6-2 0.17	7-1 0.27	7-11 0.37	8-8 0.49	9-5 0.61	10-0 0.75	10-8 0.90	11.3 1.05	11.9 1.21	12.4 1.38
	16.0	5-8 0.16	6-7 0.25	7-4 0.34	8-1 0.45	8-8 0.57	9-4 0.70	9-10 0.83	10-5 0.97	10-11 1.12	11.5 1.28
	19.2	5-2 0.15	6-0 0.22	6-9 0.31	7-4 0.41	7-11 0.52	8-6 0.63	9-0 0.76	9-6 0.89	9-11 1.02	10-5 1.17
	24.0	4-8 0.13	5-4 0.20	6-0 0.28	6-7 0.37	7.1 0.46	7-7 0.57	8.1 0.68	8-6 0.79	8.11 0.92	9.4 1.04
2x8	12.0	8-8 0.18	10-0 0.28	11-2 0.40	12-3 0.52	13-3 0.66	14-2 0.80	15-0 0.96	15.10 1.12	16.7 1.29	17.4 1.48
	13.7	8-1 0.17	9-4 0.27	10-6 0.37	11-6 0.49	12-5 0.61	13-3 0.75	14-0 0.90	14.10 1.05	15.6 1.21	16.3 1.38
	16.0	7-6 0.16	8-8 0.25	9-8 0.34	10-7 0.45	11.6 0.57	12.3 0.70	13-0 0.83	13-8 0.97	14.4 1.12	15.0 1.28
	19.2	6-10 0.15	7-11 0.22	8-10 0.31	9-8 0.41	10-6 0.52	11.2 0.63	11.10 0.76	12-6 0.89	13.1 1.02	13.8 1.17
	24.0	6-2 0.13	7-1 0.20	7-11 0.28	8-8 0.37	9-4 0.46	10-0 0.57	10-7 0.68	11.2 0.79	11.9 0.92	12.3 1.04
2x10	12.0	11-1 0.18	12-9 0.28	14-3 0.40	15-8 0.52	16.11 0.66	18.1 0.80	19.2 0.96	20-2 1.12	21.2 1.29	22.1 1.48
	13.7	10-4 0.17	11.11 0.27	13-4 0.37	14-8 0.49	15.10 0.61	16.11 0.75	17.11 0.90	18.11 1.05	19.10 1.21	20.8 1.38
	16.0	9-7 0.16	11-1 0.25	12-4 0.34	13-6 0.45	14-8 0.57	15.8 0.70	16.7 0.83	17.6 0.97	18.4 1.12	19.2 1.28
	19.2	8-9 0.15	10-1 0.22	11-3 0.31	12-4 0.41	13-4 0.52	14-3 0.63	15-2 0.76	15.11 0.89	16.9 1.02	17.6 1.17
	24.0	7-10 0.13	9-0 0.20	10-1 0.28	11-1 0.37	11.11 0.46	12-9 0.57	13-6 0.68	14.3 0.79	15.0 0.92	15.8 1.04
2x12	12.0	13-5 0.18	15-6 0.28	17-4 0.40	19-0 0.52	20-6 0.66	21.11 0.80	23.3 0.96	24.7 1.12	25.9 1.29	26.11 1.48
	13.7	12-7 0.17	14-6 0.27	16-3 0.37	17-9 0.49	19-3 0.61	20-6 0.75	21.9 0.90	23-0 1.05	24.1 1.21	25.2 1.38
	16.0	11-8 0.16	13-5 0.25	15-0 0.34	16-6 0.45	17-9 0.57	19-0 0.70	20-2 0.83	21.3 0.97	22.4 1.12	23.3 1.28
	19.2	10-8 0.15	12-3 0.22	13-9 0.31	15-0 0.41	16-3 0.52	17-4 0.63	18-5 0.76	19-5 0.89	20-4 1.02	21.3 1.17
	24.0	9-6 0.13	11-0 0.20	12-3 0.28	13-5 0.37	14-6 0.46	15-6 0.57	16-6 0.68	17-4 0.79	18-2 0.92	19-0 1.04

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

Table No. 7-H (cont.)

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

HOW TO USE TABLES: Enter table with span of rafters (upper figure in each square). Determine size and spacing (last column) based on stress grade (top row) and modulus of elasticity (lower figure in each square) of lumber to be used.

Allowable Extreme Fiber Stress in Bending, "F_b" (psi).									RAFTER SPACING (IN)	SIZE (IN)
1300	1400	1500	1600	1700	1800	1900	2000	2100		
13-8 1 66	14-2 1.86	14-8 2 06	15-2 2 27	15-8 2.49					12.0	
12-10 1.56	13-3 1 74	13-9 1 93	14-2 2.12	14-8 2 33	15-1 2.54				13.7	
11-10 1 44	12-4 1.61	12-9 1.79	13-2 1.97	13-7 2.15	13 11 2.35	14-4 2 55			16.0	2x6
10-10 1 32	11-3 1 47	11-7 1 63	12-0 1 80	12-4 1.97	12-9 2.14	13-1 2 32	13-5 2 51		19.2	
9-8 1.18	10-0 1 31	10-5 1 46	10-9 1.61	11-1 1 76	11-5 1.92	11-8 2 08	12-0 2.24	12-4 2.41	24.0	
18-0 1 66	18-9 1 86	19-5 2 06	20-0 2.27	20-8 2 49					12 0	
16-10 1 56	17-6 1 74	18-2 1 93	18-9 2.12	19-4 2 33	19-10 2.54				13.7	
15 7 1 44	16 3 1 61	16-9 1.79	17-4 1.97	17 10 2.15	18-5 2.35	18-11 2 55			16.0	2x8
14-3 1 32	14-10 1 47	15-4 1 63	15-10 1 80	16-4 1 97	16-9 2 14	17 3 2 32	17-8 2 51		19.2	
12 9 1 18	13 3 1 31	13 8 1 46	14-2 1 61	14-7 1 76	15-0 1 92	15 5 2 08	15-10 2 24	16-3 2.41	24 0	
23 0 1 66	23-11 1 86	24 9 2 06	25-6 2 27	26-4 2 49					12.0	
21-6 1 56	22 4 1 74	23 2 1 93	23 11 2 12	24-7 2 33	25-4 2 54				13 7	
19-11 1 44	20-8 1 61	21-5 1 79	22 1 1 97	22 10 2 15	23-5 2 35	24 1 2 55			16 0	2x10
18-2 1 32	18 11 1 47	19 7 1 63	20-2 1 80	20-10 1 97	21 5 2 14	22 0 2 32	22 7 2 51		19.2	
16-3 1 18	16 11 1 31	17 6 1 46	18 1 1 61	18 7 1 76	19-2 1 92	19 8 2 08	20 2 2 24	20-8 2 41	24 0	
28-0 1 66	29 1 1.86	30-1 2 06	31 1 2 27	32 0 2 49					12.0	
26-2 1 56	27 2 1 74	28 2 1 93	29 1 2 12	29 11 2 33	30 10 2 54				13.7	
24-3 1 44	25 2 1 61	26 0 1 79	26 11 1 97	27 9 2 15	28 6 2 35	29 4 2 55			16.0	2x12
22 2 1 32	23-0 1 47	23-9 1 63	24 7 1 80	25 4 1 97	26 0 2 14	26 9 2 32	27 5 2 51		19 2	
19-10 1 18	20-6 1 31	21 3 1.46	21 11 1 61	22-8 1 76	23 3 1 92	23-11 2 08	24 7 2 24	25 2 2 41	24.0	

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

Table No. 7-I
ALLOWABLE SPAN FOR LOW OR HIGH SLOPE RAFTERS

30 Lbs. Per Sq. Ft. Live Load
(Supporting Plaster Ceiling)

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

HOW TO USE TABLES: Enter table with span of rafters (upper figure in each square) Determine size and spacing (first column) based on stress grade (top row) and modulus of elasticity (lower figure in each square) of lumber to be used.

RAFTER SIZE	SPACING (IN)	Allowable Extreme Fiber Stress in Bending, "F_b" (psi).									
		300	400	500	600	700	890	900	1000	1100	1200
2x6	12.0	5-10 0.19	6-8 0.29	7-6 0.41	8-2 0.54	8-10 0.68	9-6 0.83	10-0 0.99	10-7 1.15	11-1 1.33	11-7 1.52
	13.7	5-5 0.18	6-3 0.27	7-0 0.38	7-8 0.50	8-3 0.63	8-10 0.77	9-5 0.92	9-11 1.08	10-5 1.25	10-10 1.42
	16.0	5-0 0.16	5-10 0.25	6-6 0.35	7-1 0.46	7-8 0.59	8-2 0.72	8-8 0.85	9-2 1.00	9-7 1.15	10-0 1.31
	19.2	4-7 0.15	5-4 0.23	5-11 0.32	6-6 0.42	7-0 0.53	7-6 0.65	7-11 0.78	8-4 0.91	8-9 1.05	9-2 1.20
	24.0	4-1 0.13	4-9 0.21	5-4 0.29	5-10 0.38	6-3 0.48	6-8 0.58	7-1 0.70	7-6 0.82	7-10 0.94	8-2 1.07
2x8	12.0	7-8 0.19	8-10 0.29	9-10 0.41	10-10 0.54	11-8 0.68	12-6 0.83	13-3 0.99	13-11 1.15	14-8 1.33	15-3 1.52
	13.7	7-2 0.18	8-3 0.27	9-3 0.38	10-1 0.50	10-11 0.63	11-8 0.77	12-5 0.92	13-1 1.08	13-8 1.25	14-4 1.42
	16.0	6-7 0.16	7-8 0.25	8-7 0.35	9-4 0.46	10-1 0.59	10-10 0.72	11-6 0.85	12-1 1.00	12-8 1.15	13-3 1.31
	19.2	6-1 0.15	7-0 0.23	7-10 0.32	8-7 0.42	9-3 0.53	9-10 0.65	10-6 0.78	11-0 0.91	11-7 1.05	12-1 1.20
	24.0	5-5 0.13	6-3 0.21	7-0 0.29	7-8 0.38	8-3 0.48	8-10 0.58	9-4 0.70	9-10 0.82	10-4 0.94	10-10 1.07
2x10	12.0	9-9 0.19	11-3 0.29	12-7 0.41	13-9 0.54	14-11 0.68	15-11 0.83	16-11 0.99	17-10 1.15	18-8 1.33	19-6 1.52
	13.7	9-1 0.18	10-6 0.27	11-9 0.38	12-11 0.50	13-11 0.63	14-11 0.77	15-10 0.92	16-8 1.08	17-6 1.25	18-3 1.42
	16.0	8-5 0.16	9-9 0.25	10-11 0.35	11-11 0.46	12-11 0.59	13-9 0.72	14-8 0.85	15-5 1.00	16-2 1.15	16-11 1.31
	19.2	7-8 0.15	8-11 0.23	9-11 0.32	10-11 0.42	11-9 0.53	12-7 0.65	13-4 0.78	14-1 0.91	14-9 1.05	15-5 1.20
	24.0	6-11 0.13	8-0 0.21	8-11 0.29	9-9 0.38	10-6 0.48	11-3 0.58	11-11 0.70	12-7 0.82	13-2 0.94	13-9 1.07
2x12	12.0	11-10 0.19	13-8 0.29	15-4 0.41	16-9 0.54	18-1 0.68	19-4 0.83	20-6 0.99	21-8 1.15	22-8 1.33	23-9 1.52
	13.7	11-1 0.18	12-10 0.27	14-4 0.38	15-8 0.50	16-11 0.63	18-1 0.77	19-3 0.92	20-3 1.08	21-3 1.25	22-2 1.42
	16.0	10-3 0.16	11-10 0.25	13-3 0.35	14-6 0.46	15-8 0.59	16-9 0.72	17-9 0.85	18-9 1.00	19-8 1.15	20-6 1.31
	19.2	9-5 0.15	10-10 0.23	12-1 0.32	13-3 0.42	14-4 0.53	15-4 0.65	16-3 0.78	17-1 0.91	17-11 1.05	18-9 1.20
	24.0	8-5 0.13	9-8 0.21	10-10 0.29	11-10 0.38	12-10 0.48	13-8 0.58	14-6 0.70	15-4 0.82	16-1 0.94	16-9 1.07

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

Table No. 7-I (cont.)

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

HOW TO USE TABLES: Enter table with span of rafters (upper figure in each square). Determine size and spacing (last column) based on stress grade (top row) and modulus of elasticity (lower figure in each square) of lumber to be used.

Allowable Extreme Fiber Stress in Bending, "F_b" (psi).									RAFTER SPACING (IN)	SIZE (IN)
1300	1400	1500	1600	1700	1800	1900	2000	2100		
12-1 1.71	12-6 1.91	13-0 2.12	13-5 2.34	13-10 2.56					12.0	
11-3 1.60	11-9 1.79	12-2 1.98	12-6 2.19	12-11 2.39					13.7	
10-5 1.48	10-10 1.66	11-3 1.84	11-7 2.02	11-11 2.22	12-4 2.41				16.0	2x6
9-6 1.35	9-11 1.51	10-3 1.68	10-7 1.85	10-11 2.02	11-3 2.20	11-6 2.39	11-10 2.58		19.2	
8-6 1.21	8-10 1.35	9-2 1.50	9-6 1.65	9-9 1.81	10-0 1.97	10-4 2.14	10-7 2.31	10-10 2.48	24.0	
15-11 1.71	16-6 1.91	17-1 2.12	17-8 2.34	18-2 2.56					12.0	
14-11 1.60	15-5 1.79	16-0 1.98	16-6 2.19	17-0 2.39					13.7	
13-9 1.48	14-4 1.66	14-10 1.84	15-3 2.02	15-9 2.22	16-3 2.41				16.0	2x8
12-7 1.35	13-1 1.51	13-6 1.68	13-11 1.85	14-5 2.02	14-10 2.20	15-2 2.39	15-7 2.58		19.2	
11-3 1.21	11-8 1.35	12-1 1.50	12-6 1.65	12-10 1.81	13-3 1.97	13-7 2.14	13-11 2.31	14-4 2.48	24.0	
20-4 1.71	21-1 1.91	21-10 2.12	22-6 2.34	23-3 2.56					12.0	
19-0 1.60	19-8 1.79	20-5 1.98	21-1 2.19	21-9 2.39					13.7	
17-7 1.48	18-3 1.66	18-11 1.84	19-6 2.02	20-1 2.22	20-8 2.41				16.0	2x10
16-1 1.35	16-8 1.51	17-3 1.68	17-10 1.85	18-4 2.02	18-11 2.20	19-5 2.39	19-11 2.58		19.2	
14-4 1.21	14-11 1.35	15-5 1.50	15-11 1.65	16-5 1.81	16-11 1.97	17-4 2.14	17-10 2.31	18-3 2.48	24.0	
24-8 1.71	25-7 1.91	26-6 2.12	27-5 2.34	28-3 2.56					12.0	
23-1 1.60	24-0 1.79	24-10 1.98	25-7 2.19	26-5 2.39					13.7	
21-5 1.48	22-2 1.66	23-0 1.84	23-9 2.02	24-5 2.22	25-2 2.41				16.0	2x12
19-6 1.35	20-3 1.51	21-0 1.68	21-8 1.85	22-4 2.02	23-0 2.20	23-7 2.39	24-2 2.58		19.2	
17-5 1.21	18-1 1.35	18-9 1.50	19-4 1.65	20-0 1.81	20-6 1.97	21-1 2.14	21-8 2.31	22-2 2.48	24.0	

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

Table No. 7-J
ALLOWABLE SPAN FOR LOW OR HIGH SLOPE RAFTERS

40 Lbs. Per Sq. Ft. Live Load
(Supporting Plaster Ceiling)

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

HOW TO USE TABLES: Enter table with span of rafters (upper figure in each square). Determine size and spacing (first column) based on stress grade (top row) and modulus of elasticity (lower figure in each square) of lumber to be used

RAFTER SIZE	SPACING (IN)	Allowable Extreme Fiber Stress in Bending, "F_b" (psi). 300	400	500	600	700	800	900	1000	1100	1200
2x6	12.0	5-3 0.19	6-1 0.29	6-9 0.40	7-5 0.53	8-0 0.67	8-7 0.82	9-1 0.97	9-7 1.14	10-0 1.31	10-6 1.50
	13.7	4-11 0.18	5-8 0.27	6-4 0.38	6-11 0.50	7-6 0.62	8-0 0.76	8-6 0.91	8-11 1.07	9-5 1.23	9-10 1.40
	16.0	4-6 0.16	5-3 0.25	5-10 0.35	6-5 0.46	6-11 0.58	7-5 0.71	7-10 0.84	8-3 0.99	8-8 1.14	9-1 1.30
	19.2	4-2 0.15	4-9 0.23	5-4 0.32	5-10 0.42	6-4 0.53	6-9 0.64	7-2 0.77	7-7 0.90	7-11 1.04	8-3 1.18
	24.0	3-8 0.13	4-3 0.20	4-9 0.28	5-3 0.37	5-8 0.47	6-1 0.58	6-5 0.69	6-9 0.81	7-1 0.93	7-5 1.06
2x8	12.0	6-11 0.19	8-0 0.29	8-11 0.40	9-9 0.53	10-7 0.67	11-3 0.82	12-0 0.97	12-7 1.14	13-3 1.31	13-10 1.50
	13.7	6-6 0.18	7-6 0.27	8-4 0.38	9-2 0.50	9-11 0.62	10-7 0.76	11-2 0.91	11-10 1.07	12-5 1.23	12-11 1.40
	16.0	6-0 0.16	6-11 0.25	7-9 0.35	8-6 0.46	9-2 0.58	9-9 0.71	10-4 0.84	10-11 0.99	11-6 1.14	12-0 1.30
	19.2	5-6 0.15	6-4 0.23	7-1 0.32	7-9 0.42	8-4 0.53	8-11 0.64	9-6 0.77	10-0 0.90	10-6 1.04	10-11 1.18
	24.0	4-11 0.13	5-8 0.20	6-4 0.28	6-11 0.37	7-6 0.47	8-0 0.58	8-6 0.69	8-11 0.81	9-4 0.93	9-9 1.06
2x10	12.0	8-10 0.19	10-2 0.29	11-5 0.40	12-6 0.53	13-6 0.67	14-5 0.82	15-3 0.97	16-1 1.14	16-11 1.31	17-8 1.50
	13.7	8-3 0.18	9-6 0.27	10-8 0.38	11-8 0.50	12-7 0.62	13-6 0.76	14-3 0.91	15-1 1.07	15-10 1.23	16-6 1.40
	16.0	7-8 0.16	8-10 0.25	9-10 0.35	10-10 0.46	11-8 0.58	12-6 0.71	13-3 0.84	13-11 0.99	14-8 1.14	15-3 1.30
	19.2	7-0 0.15	8-1 0.23	9-0 0.32	9-10 0.42	10-8 0.53	11-5 0.64	12-1 0.77	12-9 0.90	13-4 1.04	13-11 1.18
	24.0	6-3 0.13	7-2 0.20	8-1 0.28	8-10 0.37	9-6 0.47	10-2 0.58	10-10 0.69	11-5 0.81	11-11 0.93	12-6 1.06
2x12	12.0	10-9 0.19	12-5 0.29	13-10 0.40	15-2 0.53	16-5 0.67	17-6 0.82	18-7 0.97	19-7 1.14	20-6 1.31	21-5 1.50
	13.7	10-0 0.18	11-7 0.27	12-11 0.38	14-2 0.50	15-4 0.62	16-5 0.76	17-5 0.91	18-4 1.07	19-3 1.23	20-1 1.40
	16.0	9-3 0.16	10-9 0.25	12-0 0.35	13-2 0.46	14-2 0.58	15-2 0.71	16-1 0.84	17-0 0.99	17-9 1.14	18-7 1.30
	19.2	8-6 0.15	9-10 0.23	10-11 0.32	12-0 0.42	12-11 0.53	13-10 0.64	14-8 0.77	15-6 0.90	16-3 1.04	17-0 1.18
	24.0	7-7 0.13	8-9 0.20	9-10 0.28	10-9 0.37	11-7 0.47	12-5 0.58	13-2 0.69	13-10 0.81	14-6 0.93	15-2 1.06

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

Table No. 7-J (cont.)

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

HOW TO USE TABLES: Enter table with span of rafters (upper figure in each square). Determine size and spacing (last column) based on stress grade (top row) and modulus of elasticity (lower figure in each square) of lumber to be used.

Allowable Extreme Fiber Stress in Bending, "F_b" (psi).									RAFTER SPACING (IN)	RAFTER SIZE (IN)
1300	1400	1500	1600	1700	1800	1900	2000	2100		
10-11 1.69	11-4 1.89	11-9 2.09	12-1 2.31	12-6 2.53					12.0	
10-3 1.58	10-7 1.77	11-0 1.96	11-4 2.16	11-8 2.36	12-0 2.57				13.7	
9-5 1.46	9-10 1.63	10-2 1.81	10-6 2.00	10-10 2.19	11-1 2.38	11-5 2.58			16.0	2x6
8-8 1.34	8-11 1.49	9-3 1.65	9-7 1.82	9-10 2.00	10-2 2.18	10-5 2.36	10-8 2.55		19.2	
7-9 1.19	8-0 1.33	8-3 1.48	8-7 1.63	8-10 1.79	9-1 1.95	9-4 2.11	9-7 2.28	9-10 2.45	24.0	
14-5 1.69	14-11 1.89	15-5 2.09	16-0 2.31	16-5 2.53					12.0	
13-6 1.58	14-0 1.77	14-6 1.96	14-11 2.16	15-5 2.36	15-10 2.57				13.7	
12-6 1.46	12-11 1.63	13-5 1.81	13-10 2.00	14-3 2.19	14-8 2.38	15-1 2.58			16.0	2x8
11-5 1.34	11-10 1.49	12-3 1.65	12-7 1.82	13-0 2.00	13-5 2.18	13-9 2.36	14-1 2.55		19.2	
10-2 1.19	10-7 1.33	10-11 1.48	11-3 1.63	11-8 1.79	12-0 1.95	12-4 2.11	12-7 2.28	12-11 2.45	24.0	
18-4 1.69	19-1 1.89	19-9 2.09	20-4 2.31	21-0 2.53					12.0	
17-2 1.58	17-10 1.77	18-5 1.96	19-1 2.16	19-8 2.36	20-2 2.57				13.7	
15-11 1.46	16-6 1.63	17-1 1.81	17-8 2.00	18-2 2.19	18-9 2.38	19-3 2.58			16.0	2x10
14-6 1.34	15-1 1.49	15-7 1.65	16-1 1.82	16-7 2.00	17-1 2.18	17-7 2.36	18-0 2.55		19.2	
13-0 1.19	13-6 1.33	13-11 1.48	14-5 1.63	14-10 1.79	15-3 1.95	15-8 2.11	16-1 2.28	16-6 2.45	24.0	
22-4 1.69	23-2 1.89	24-0 2.09	24-9 2.31	25-6 2.53					12.0	
20-11 1.58	21-8 1.77	22-5 1.96	23-2 2.16	23-11 2.36	24-7 2.57				13.7	
19-4 1.46	20-1 1.63	20-9 1.81	21-5 2.00	22-1 2.19	22-9 2.38	23-5 2.58			16.0	2x12
17-8 1.34	18-4 1.49	19-0 1.65	19-7 1.82	20-2 2.00	20-9 2.18	21-4 2.36	21-11 2.55		19.2	
15-9 1.19	16-5 1.33	17-0 1.48	17-6 1.63	18-1 1.79	18-7 1.95	19-1 2.11	19-7 2.28	20-1 2.45	24.0	

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

Table No. 7-K
ALLOWABLE SPAN FOR LOW SLOPE RAFTERS

Slope 3 in 12 or less – 20 Lbs. Per Sq. Ft. Live Load
(No Finished Ceiling)

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

HOW TO USE TABLES: Enter table with span of rafters (upper figure in each square). Determine size and spacing (first column) based on stress grade (top row) and modulus of elasticity (lower figure in each square) of lumber to be used

RAFTER SIZE	SPACING (IN)	Allowable Extreme Fiber Stress in Bending, "F_b" (psi).										
		300	400	500	600	700	800	900	1000	1100	1200	1300
2x6	12.0	7 1 0.15	8-2 0 24	9-2 0.33	10-0 0 44	10-10 0 55	11 7 0 67	12 4 0 80	13 0 0 94	13 7 1 09	14 2 1 24	14 9 1 40
	13.7	6-8 0.14	7-8 0.22	8-7 0 31	9-5 0 41	10-2 0 52	10 10 0 63	11 6 0 75	12 2 0 88	12 9 1 02	13 3 1 16	13 10 1 31
	16.0	6-2 0.13	7-1 0.21	7 11 0.29	8-8 0 38	9 5 0 48	10-0 0 58	10-8 0 70	11 3 0 82	11 9 0 94	12 4 1 07	12 10 1 21
	19.2	5-7 0.12	6-6 0 19	7 3 0.26	7-11 0 35	8-7 0 44	9-2 0 53	9 9 0 64	10 3 0 75	10 9 0 86	11 3 0 98	11 8 1 10
	24.0	5-0 0 11	5-10 0.17	6-6 0 24	7 1 0 31	7 8 0 39	8-2 0 48	8 8 0 57	9 2 0 67	9 7 0 77	10 0 0 88	10 5 0 99
2x8	12.0	9-4 0.15	10 10 0.24	12-1 0 33	13 3 0 44	14-4 0 55	15 3 0 67	16 3 0 80	17 1 0 94	17 11 1 09	18 9 1 24	19 6 1 40
	13.7	8-9 0.14	10-1 0 22	11 4 0 31	12 5 0 41	13 4 0 52	14 4 0 63	15 2 0 75	16 0 0 88	16 9 1 02	17 6 1 16	18 3 1 31
	16.0	8-1 0.13	9-4 0.21	10-6 0 29	11 6 0 38	12-5 0 48	13 3 0 58	14 0 0 70	14 10 0 82	15 6 0 94	16 3 1 07	16 10 1 21
	19.2	7-5 0.12	8-7 0 19	9-7 0.26	10 6 0 35	11-4 0 44	12 1 0 53	12 10 0 64	13 6 0 75	14 2 0 86	14 10 0 98	15 5 1 10
	24.0	6-7 0 11	7-8 0 17	8 7 0 24	9 4 0 31	10 1 0 39	10-10 0 48	11 6 0 57	12 1 0 67	12 8 0 77	13 3 0 88	13 9 0 99
2x10	12.0	11-11 0.15	13-9 0.24	15-5 0 33	16 11 0 44	18 3 0 55	19 6 0 67	20 8 0 80	21 10 0 94	22 10 1 09	23 11 1 24	24 10 1 40
	13.7	11-2 0.14	12 11 0.22	14-5 0 31	15 10 0 41	17 1 0 52	18 3 0 63	19 4 0 75	20 5 0 88	21 5 1 02	22 4 1 16	23 3 1 31
	16.0	10-4 0.13	11 11 0 21	13-4 0.29	14-8 0 38	15 10 0 48	16 11 0 58	17 11 0 70	18 11 0 82	19 10 0 94	20 8 1 07	21 6 1 21
	19.2	9-5 0 12	10-11 0 19	12-2 0 26	13 4 0 35	14 5 0 44	15 5 0 53	16 4 0 64	17 3 0 75	18 1 0 86	18 11 0 98	19 8 1 10
	24.0	8-5 0 11	9-9 0 17	10-11 0 24	11 11 0 31	12 11 0 39	13 9 0 48	14 8 0 57	15 5 0 67	16 2 0 77	16 11 0 88	17 7 0 99
2x12	12.0	14-6 0.15	16 9 0.24	18-9 0 33	20-6 0 44	22 2 0 55	23-9 0 67	25 2 0 80	26 6 0 94	27 10 1 09	29 1 1 24	30 3 1 40
	13.7	13-7 0.14	15 8 0.22	17-6 0 31	19 3 0 41	20 9 0 52	22 2 0 63	23 6 0 75	24 10 0 88	26 0 1 02	27 2 1 16	28 3 1 31
	16.0	12 7 0.13	14-6 0.21	16-3 0 29	17 9 0 38	19 3 0 48	20-6 0 58	21 9 0 70	23 0 0 82	24 1 0 94	25 2 1 07	26 2 1 21
	19.2	11-6 0.12	13 3 0 19	14 10 0 26	16-3 0 35	17 6 0 44	18 9 0 53	19 11 0 64	21 0 0 75	22 0 0 86	23 0 0 98	23 11 1 10
	24.0	10-3 0 11	11 10 0 17	13-3 0 24	14 6 0 31	15 8 0 39	16-9 0 48	17 9 0 57	18 9 0 67	19 8 0 77	20 6 0 88	21 5 0 99

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

Table No. 7-K (cont.)

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

HOW TO USE TABLES: Enter table with span of rafters (upper figure in each square). Determine size and spacing (last column) based on stress grade (top row) and modulus of elasticity (lower figure in each square) of lumber to be used.

Allowable Extreme Fiber Stress in Bending, "F_b" (psi).										RAFTER SPACING (IN)	SIZE (IN)
1400	1500	1600	1700	1800	1900	2000	2100	2200	2400		
15-4 1.56	15-11 1.73	16-5 1.91	16-11 2.09	17-5 2.28	17-10 2.47					12 0	
14-4 1.46	14-10 1.62	15-4 1.78	15-10 1.96	16-3 2.13	16-9 2.31	17 2 2.49				13 7	
13-3 1.35	13-9 1.50	14-2 1.65	14-8 1.81	15-1 1.97	15-6 2.14	15-11 2.31	16-3 2.48			16 0	2x6
12-2 1.23	12-7 1.37	13-0 1.51	13-4 1.65	13-9 1.80	14-2 1.95	14-6 2.11	14 10 2.27	15-2 2.43		19 2	
10-10 1.10	11-3 1.22	11-7 1.35	11-11 1.48	12-4 1.61	12-8 1.75	13-0 1.89	13-3 2.03	13-7 2.18	14-2 2.48	24 0	
20-3 1.56	20-11 1.73	21-7 1.91	22-3 2.09	22-11 2.28	23-7 2.47					12 0	
18-11 1.46	19-7 1.62	20-3 1.78	20-10 1.96	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	2x8
16-0 1.23	16-7 1.37	17-1 1.51	17-7 1.65	18-2 1.80	18-7 1.95	19-1 2.11	19-7 2.27	20-0 2.43		19 2	
14-4 1.10	14-10 1.22	15-3 1.35	15-9 1.48	16-3 1.61	16-8 1.75	17-1 1.89	17-6 2.03	17 11 2.18	18-9 2.48	24 0	
25-10 1.56	26-8 1.73	27-7 1.91	28-5 2.09	29-3 2.28	30-1 2.47					12 0	
24-2 1.46	25-0 1.62	25-10 1.78	26-7 1.95	27-4 2.13	28-1 2.31	28-10 2.49				13 7	
22-4 1.35	23-2 1.50	23-11 1.65	24-7 1.81	25-4 1.97	26-0 2.14	26-8 2.31	27-4 2.48			16 0	2x10
20-5 1.23	21-1 1.37	21-10 1.51	22-6 1.65	23-2 1.80	23-9 1.95	24-5 2.11	25-0 2.27	25-7 2.43		19 2	
18-3 1.10	18-11 1.22	19-6 1.35	20-1 1.48	20-8 1.61	21-3 1.75	21 10 1.89	22-4 2.03	22 10 2.18	23 11 2.48	24 0	
31-4 1.56	32-6 1.73	33-6 1.91	34-7 2.09	35-7 2.28	36-7 2.47					12 0	
29-4 1.46	30-5 1.62	31-4 1.78	32-4 1.95	33-3 2.13	34-2 2.31	35-1 2.49				13 7	
27-2 1.35	28-2 1.50	29-1 1.65	29-11 1.81	30-10 1.97	31-8 2.14	32-6 2.31	33-3 2.48			16 0	2x12
24-10 1.23	25-8 1.37	26-6 1.51	27-4 1.65	28-2 1.80	28-11 1.95	29-8 2.11	30-5 2.27	31 1 2.43		19 2	
22-2 1.10	23-0 1.22	23-9 1.35	24-5 1.48	25-2 1.61	25-10 1.75	26-6 1.89	27 2 2.03	27 10 2.18	29 1 2.48	24 0	

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

Table No. 7-L
ALLOWABLE SPAN FOR LOW SLOPE RAFTERS

Slope 3 in 12 or less – 30 Lbs. Per Sq. Ft. Live Load
(No Finished Ceiling)

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

HOW TO USE TABLES: Enter table with span of rafters (upper figure in each square). Determine size and spacing (first column) based on stress grade (top row) and modulus of elasticity (lower figure in each square) of lumber to be used.

RAFTER SIZE	SPACING (IN)	Allowable Extreme Fiber Stress In Bending, "F_b" (psi)										
		300	400	500	600	700	800	900	1000	1100	1200	1300
2x6	12 0	6 2 0 15	7 1 0 23	7 11 0 32	8 8 0 43	9 5 0 54	10 0 0 66	10-8 0 78	11 3 0 92	11 9 1 06	12 4 1 21	12 10 1 36
	13 7	5 9 0 14	6 8 0 22	7 5 0 30	8 2 0 40	8 9 0 50	9 5 0 61	10 0 0 73	10-6 0 86	11 0 0 99	11 6 1 13	12 0 1 27
	16 0	5 4 0 13	6 2 0 20	6 11 0 28	7 6 0 37	8 2 0 47	8 8 0 57	9 3 0 68	9-9 0 80	10-2 0 92	10 8 1 05	11 1 1 18
	19 2	4 10 0 12	5-7 0 18	6 3 0 26	6 11 0 34	7 5 0 43	7 11 0 52	8-5 0 62	8-11 0 73	9-4 0 84	9-9 0 95	10 1 1 08
	24 0	4-4 0 11	5 0 0 16	5-7 0 23	6-2 0 30	6-8 0 38	7 1 0 46	7-6 0 55	7-11 0 65	8-4 0 75	8-8 0 85	9-1 0 96
2x8	12 0	8 1 0 15	9-4 0 23	10-6 0 32	11-6 0 43	12 5 0 54	13-3 0 66	14-0 0 78	14-10 0 92	15-6 1 06	16-3 1 21	16-10 1 36
	13 7	7 7 0 14	8 9 0 22	9 9 0 30	10-9 0 40	11-7 0 50	12-5 0 61	13-2 0 73	13-10 0 86	14-6 0 99	15-2 1 13	15-9 1 27
	16 0	7 0 0 13	8 1 0 20	9 1 0 28	9-11 0 37	10-9 0 47	11-6 0 57	12-2 0 68	12-10 0 80	13-5 0 92	14-0 1 05	14 7 1 18
	19 2	6 5 0 12	7 5 0 18	8 3 0 26	9-1 0 34	9-9 0 43	10-6 0 52	11-1 0 62	11-8 0 73	12-3 0 84	12-10 0 95	13-4 1 08
	24 0	5-9 0 11	6-7 0 16	7 5 0 23	8-1 0 30	8-9 0 38	9-4 0 46	9-11 0 55	10-6 0 65	11-0 0 75	11-6 0 85	11 11 0 96
2x10	12 0	10-4 0 15	11 11 0 23	13 4 0 32	14-8 0 43	15-10 0 54	16 11 0 66	17 11 0 78	18-11 0 92	19-10 1 06	20-8 1 21	21 6 1 36
	13 7	9-8 0 14	11 2 0 22	12 6 0 30	13-8 0 40	14-9 0 50	15-10 0 61	16-9 0 73	17-8 0 86	18-6 0 99	19-4 1 13	20-2 1 27
	16 0	8 11 0 13	10-4 0 20	11 7 0 28	12 8 0 37	13-8 0 47	14-8 0 57	15-6 0 68	16-4 0 80	17 2 0 92	17-11 1 05	18 8 1 18
	19 2	8 2 0 12	9-5 0 18	10-7 0 26	11 7 0 34	12 6 0 43	13 4 0 52	14 2 0 62	14-11 0 73	15-8 0 84	16-4 0 95	17 0 1 08
	24 0	7 4 0 11	8 5 0 16	9 5 0 23	10-4 0 30	11 2 0 38	11 11 0 46	12-8 0 55	13-4 0 65	14-0 0 75	14-8 0 85	15 3 0 96
2x12	12 0	12 7 0 15	14 6 0 23	16-3 0 32	17 9 0 43	19-3 0 54	20-6 0 66	21-9 0 78	23-0 0 92	24-1 1 06	25-2 1 21	26-2 1 36
	13 7	11 9 0 14	13 7 0 22	15-2 0 30	16 8 0 40	18-0 0 50	19 3 0 61	20-5 0 73	21-6 0 86	22-6 0 99	23-6 1 13	24-6 1 27
	16 0	10-11 0 13	12 7 0 20	14-1 0 28	15 5 0 37	16-8 0 47	17 9 0 57	18-10 0 68	19-11 0 80	20-10 0 92	21-9 1 05	22-8 1 18
	19 2	9-11 0 12	11 6 0 18	12 10 0 26	14 1 0 34	15-2 0 43	16 3 0 52	17-3 0 62	18-2 0 73	19-0 0 84	19-11 0 95	20-8 1 08
	24 0	8 11 0 11	10-3 0 16	11-6 0 23	12 7 0 30	13-7 0 38	14-6 0 46	15-5 0 55	16-3 0 65	17-0 0 75	17-9 0 85	18-6 0 96

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

Table No. 7-L (cont.)

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

HOW TO USE TABLES: Enter table with span of rafters (upper figure in each square). Determine size and spacing (last column) based on stress grade (top row) and modulus of elasticity (lower figure in each square) of lumber to be used.

Allowable Extreme Fiber Stress in Bending, "F_b" (psi).										RAFTER SPACING (IN)	SIZE (IN)
1400	1500	1600	1700	1800	1900	2000	2100	2200	2400		
13-3 1.52	13-9 1.69	14-2 1.86	14-8 2.04	15-1 2.22	15-6 2.41	15-11 2.60				12.0	
12-5 1.42	12-10 1.58	13-3 1.74	13-8 1.90	14-1 2.08	14-6 2.25	14-10 2.43				13.7	
11-6 1.32	11-11 1.46	12-4 1.61	12-8 1.76	13-1 1.92	13-5 2.08	13-9 2.25	14-1 2.42	14-5 2.60		16.0	2x6
10-6 1.20	10-10 1.33	11-3 1.47	11-7 1.61	11-11 1.75	12-3 1.90	12-7 2.05	12-10 2.21	13-2 2.37		19.2	
9-5 1.08	9-9 1.19	10-0 1.31	10-4 1.44	10-8 1.57	10-11 1.70	11-3 1.84	11-6 1.98	11-9 2.12	12-4 2.41	24.0	
17-6 1.52	18-2 1.69	18-9 1.86	19-4 2.04	19-10 2.22	20-5 2.41	20-11 2.60				12.0	
16-5 1.42	16-11 1.58	17-6 1.74	18-1 1.90	18-7 2.08	19-1 2.25	19-7 2.43				13.7	
15-2 1.32	15-8 1.46	16-3 1.61	16-9 1.76	17-2 1.92	17-8 2.08	18-2 2.25	18-7 2.42	19-0 2.60		16.0	2x8
13-10 1.20	14-4 1.33	14-10 1.47	15-3 1.61	15-8 1.75	16-2 1.90	16-7 2.05	16-11 2.21	17-4 2.37		19.2	
12-5 1.08	12-10 1.19	13-3 1.31	13-8 1.44	14-0 1.57	14-5 1.70	14-10 1.84	15-2 1.98	15-6 2.12	16-3 2.41	24.0	
22-4 1.52	23-2 1.69	23-11 1.86	24-7 2.04	25-4 2.22	26-0 2.41	26-8 2.60				12.0	
20-11 1.42	21-8 1.58	22-4 1.74	23-0 1.90	23-8 2.08	24-4 2.25	25-0 2.43				13.7	
19-4 1.32	20-0 1.46	20-8 1.61	21-4 1.76	21-11 1.92	22-6 2.08	23-2 2.25	23-8 2.42	24-3 2.60		16.0	2x10
17-8 1.20	18-3 1.33	18-11 1.47	19-6 1.61	20-0 1.75	20-7 1.90	21-1 2.05	21-8 2.21	22-2 2.37		19.2	
15-10 1.08	16-4 1.19	16-11 1.31	17-5 1.44	17-11 1.57	18-5 1.70	18-11 1.84	19-4 1.98	19-10 2.12	20-8 2.41	24.0	
27-2 1.52	28-2 1.69	29-1 1.86	29-11 2.04	30-10 2.22	31-8 2.41	32-6 2.60				12.0	
25-5 1.42	26-4 1.58	27-2 1.74	28-0 1.90	28-10 2.08	29-7 2.25	30-5 2.43				13.7	
23-6 1.32	24-4 1.46	25-2 1.61	25-11 1.76	26-8 1.92	27-5 2.08	28-2 2.25	28-10 2.42	29-6 2.60		16.0	2x12
21-6 1.20	22-3 1.33	23-0 1.47	23-8 1.61	24-4 1.75	25-0 1.90	25-8 2.05	26-4 2.21	26-11 2.37		19.2	
19-3 1.08	19-11 1.19	20-6 1.31	21-2 1.44	21-9 1.57	22-5 1.70	23-0 1.84	23-6 1.98	24-1 2.12	25-2 2.41	24.0	

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

Table No. 7-M
ALLOWABLE SPAN FOR LOW SLOPE RAFTERS

Slope 3 in 12 or less - 40 Lbs Per Sq. Ft. Live Load
(No Finished Ceiling)

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

HOW TO USE TABLES: Enter table with span of rafters (upper figure in each square). Determine size and spacing (first column) based on stress grade (top row) and modulus of elasticity (lower figure in each square) of lumber to be used.

RAFTER SIZE	SPACING (IN)	Allowable Extreme Fiber Stress in Bending, "F_b" (psi) 300	400	500	600	700	800	900	1000	1100	1200	1300
2x6	12.0	5-6 0.14	6-4 0.22	7-1 0.31	7-9 0.41	8-5 0.51	9-0 0.63	9-6 0.75	10-0 0.88	10-6 1.01	11-0 1.15	11-5 1.30
	13.7	5-2 0.13	5-11 0.21	6-8 0.29	7-3 0.38	7-10 0.48	8-5 0.59	8-11 0.70	9-5 0.82	9-10 0.95	10-3 1.08	10-9 1.22
	16.0	4-9 0.12	5-6 0.19	6-2 0.27	6-9 0.35	7-3 0.44	7-9 0.54	8-3 0.65	8-8 0.76	9-1 0.88	9-6 1.00	9-11 1.12
	19.2	4-4 0.11	5-0 0.18	5-7 0.24	6-2 0.32	6-8 0.41	7-1 0.50	7-6 0.59	7-11 0.69	8-4 0.80	8-8 0.91	9-1 1.03
	24.0	3-11 0.10	4-6 0.16	5-0 0.22	5-6 0.29	5-11 0.36	6-4 0.44	6-9 0.53	7-1 0.62	7-5 0.71	7-9 0.81	8-1 0.92
2x8	12.0	7-3 0.14	8-4 0.22	9-4 0.31	10-3 0.41	11-1 0.51	11-10 0.63	12-7 0.75	13-3 0.88	13-11 1.01	14-6 1.15	15-1 1.30
	13.7	6-9 0.13	7-10 0.21	8-9 0.29	9-7 0.38	10-4 0.48	11-1 0.59	11-9 0.70	12-5 0.82	13-0 0.95	13-7 1.08	14-1 1.22
	16.0	6-3 0.12	7-3 0.19	8-1 0.27	8-11 0.35	9-7 0.44	10-3 0.54	10-11 0.65	11-6 0.76	12-0 0.88	12-7 1.00	13-1 1.12
	19.2	5-9 0.11	6-7 0.18	7-5 0.24	8-1 0.32	8-9 0.41	9-4 0.50	9-11 0.59	10-6 0.69	11-0 0.80	11-6 0.91	11-11 1.01
	24.0	5-2 0.10	5-11 0.16	6-7 0.22	7-3 0.29	7-10 0.36	8-4 0.44	8-11 0.53	9-4 0.62	9-10 0.71	10-3 0.81	10-8 0.92
2x10	12.0	9-3 0.14	10-8 0.22	11-11 0.31	12-1 0.41	14-2 0.51	15-1 0.63	16-0 0.75	16-11 0.88	17-9 1.01	18-6 1.15	19-3 1.30
	13.7	8-8 0.13	10-0 0.21	11-2 0.29	12-3 0.38	13-3 0.48	14-2 0.59	15-0 0.70	15-10 0.82	16-7 0.95	17-4 1.08	18-0 1.22
	16.0	8-0 0.12	9-3 0.19	10-4 0.27	11-4 0.35	12-3 0.44	13-1 0.54	13-11 0.65	14-8 0.76	15-4 0.88	16-0 1.00	16-8 1.12
	19.2	7-4 0.11	8-5 0.18	9-5 0.24	10-4 0.32	11-2 0.41	11-11 0.50	12-8 0.59	13-4 0.69	14-0 0.80	14-8 0.91	15-3 1.03
	24.0	6-6 0.10	7-7 0.16	8-5 0.22	9-3 0.29	10-0 0.36	10-8 0.44	11-4 0.53	11-11 0.62	12-6 0.71	13-1 0.81	13-7 0.92
2x12	12.0	11-3 0.14	13-0 0.22	14-6 0.31	15-11 0.41	17-2 0.51	18-4 0.63	19-6 0.75	20-6 0.88	21-7 1.01	22-6 1.15	23-5 1.30
	13.7	10-6 0.13	12-2 0.21	13-7 0.29	14-11 0.38	16-1 0.48	17-2 0.59	18-3 0.70	19-3 0.82	20-2 0.95	21-1 1.08	21-11 1.22
	16.0	9-9 0.12	11-3 0.19	12-7 0.27	13-9 0.35	14-11 0.44	15-11 0.54	16-11 0.65	17-9 0.76	18-8 0.88	19-6 1.00	20-3 1.12
	19.2	8-11 0.11	10-3 0.18	11-6 0.24	12-7 0.32	13-7 0.41	14-6 0.50	15-5 0.59	16-3 0.69	17-0 0.80	17-9 0.91	18-6 1.03
	24.0	7-11 0.10	9-2 0.16	10-3 0.22	11-3 0.29	12-2 0.36	13-0 0.44	13-9 0.53	14-6 0.62	15-3 0.71	15-11 0.81	16-7 0.92

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

Table No. 7-M (cont.)

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

HOW TO USE TABLES: Enter table with span of rafters (upper figure in each square). Determine size and spacing (last column) based on stress grade (top row) and modulus of elasticity (lower figure in each square) of lumber to be used.

Allowable Extreme Fiber Stress in Bending, "F_b" (psi).										RAFTER SPACING (IN)	SIZE (IN)
1400	1500	1600	1700	1800	1900	2000	2100	2200	2400		
11-11 1.45	12-4 1.61	12-8 1.77	13-1 1.94	13-6 2.12	13-10 2.30	14-2 2.48				12.0	
11-1 1.36	11-6 1.51	11-11 1.66	12-3 1.82	12-7 1.98	12-11 2.15	13-3 2.32	13-7 2.49			13.7	
10-3 1.26	10-8 1.39	11-0 1.54	11-4 1.68	11-8 1.83	12-0 1.99	12-4 2.15	12-7 2.31	12-11 2.48		16.0	2x6
9-5 1.15	9-9 1.27	10-0 1.40	10-4 1.54	10-8 1.67	10-11 1.81	11-3 1.96	11-6 2.11	11-9 2.26	12-4 2.56	19.2	
8-5 1.03	8-8 1.14	9-0 1.25	9-3 1.37	9-6 1.50	9-9 1.62	10-0 1.75	10-3 1.89	10-6 2.02	11-0 2.30	24.0	
15-8 1.45	16-3 1.61	16-9 1.77	17-3 1.94	17-9 2.12	18-3 2.30	18-9 2.48				12.0	
14-8 1.36	15-2 1.51	15-8 1.66	16-2 1.82	16-7 1.98	17-1 2.15	17-6 2.32	17-11 2.49			13.7	
13-7 1.26	14-0 1.39	14-6 1.54	14-11 1.68	15-5 1.83	15-10 1.99	16-3 2.15	16-7 2.31	17-0 2.48		16.0	2x8
12-5 1.15	12-10 1.27	13-3 1.40	13-8 1.54	14-0 1.67	14-5 1.81	14-10 1.96	15-2 2.11	15-6 2.26	16-3 2.56	19.2	
11-1 1.03	11-6 1.14	11-10 1.25	12-2 1.37	12-7 1.50	12-11 1.62	13-3 1.75	13-7 1.89	13-11 2.02	14-6 2.30	24.0	
20-0 1.45	20-8 1.61	21-4 1.77	22-0 1.94	22-8 2.12	23-3 2.30	23-11 2.48				12.0	
18-8 1.36	19-4 1.51	20-0 1.66	20-7 1.82	21-2 1.98	21-9 2.15	22-4 2.32	22-11 2.49			13.7	
17-4 1.26	17-11 1.39	18-6 1.54	19-1 1.68	19-7 1.83	20-2 1.99	20-8 2.15	21-2 2.31	21-8 2.48		16.0	2x10
15-10 1.15	16-4 1.27	16-11 1.40	17-5 1.54	17-11 1.67	18-5 1.81	18-11 1.96	19-4 2.11	19-10 2.26	20-8 2.56	19.2	
14-2 1.03	14-8 1.14	15-1 1.25	15-7 1.37	16-0 1.50	16-6 1.62	16-11 1.75	17-4 1.89	17-9 2.02	18-6 2.30	24.0	
24-4 1.45	25-2 1.61	26-0 1.77	26-9 1.94	27-7 2.12	28-4 2.30	29-1 2.48				12.0	
22-9 1.36	23-6 1.51	24-4 1.66	25-1 1.82	25-9 1.98	26-6 2.15	27-2 2.32	27-10 2.49			13.7	
21-1 1.26	21-9 1.39	22-6 1.54	23-2 1.68	23-10 1.83	24-6 1.99	25-2 2.15	25-9 2.31	26-5 2.48		16.0	2x12
19-3 1.15	19-11 1.27	20-6 1.40	21-2 1.54	21-9 1.67	22-5 1.81	23-0 1.96	23-6 2.11	24-1 2.26	25-2 2.56	19.2	
17-2 1.03	17-9 1.14	18-4 1.25	18-11 1.37	19-6 1.50	20-0 1.62	20-6 1.75	21-1 1.89	21-7 2.02	22-6 2.30	24.0	

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

Table No. 7-N
ALLOWABLE SPAN FOR HIGH SLOPE RAFTERS

Slope over 3 in 12 – 20 Lbs. Per Sq. Ft. Live Load
(Heavy Roof Covering)

DESIGN CRITERIA:
Strength – 15 lbs. per sq. ft. dead load plus 20 lbs. per sq. ft. live load determines fiber stress.
Deflection – For 20 lbs. per sq. ft. live load. Limited to span in inches divided by 180.

HOW TO USE TABLES: Enter table with span of rafters (upper figure in each square). Determine size and spacing (first column) based on stress grade (top row) and modulus of elasticity (lower figure in each square) of lumber to be used.

RAFTER SIZE	SPACING (IN)	Allowable Extreme Fiber Stress in Bending, "F_b" (psi). 200	300	400	500	600	700	800	900	1000	1100	1200	1300
2x4	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
2x6	12.0	5-4 0.05	6-7 0.09	7-7 0.14	8-6 0.20	9-4 0.26	10-0 0.33	10-9 0.40	11-5 0.48	12-0 0.56	12-7 0.65	13-2 0.74	13-8 0.83
	13.7	5-0 0.05	6-2 0.09	7-1 0.13	7-11 0.19	8-8 0.24	9-5 0.31	10-0 0.38	10-8 0.45	11-3 0.52	11-9 0.61	12-4 0.69	12-10 0.78
	16.0	4-8 0.04	5-8 0.08	6-7 0.12	7-4 0.17	8-1 0.23	8-8 0.28	9-4 0.35	9-10 0.41	10-5 0.49	10-11 0.56	11-5 0.64	11-10 0.72
	19.2	4-3 0.04	5-2 0.07	6-0 0.11	6-9 0.16	7-4 0.21	7-11 0.26	8-6 0.32	9-0 0.38	9-6 0.44	9-11 0.51	10-5 0.58	10-10 0.66
	24.0	3-10 0.04	4-8 0.07	5-4 0.10	6-0 0.14	6-7 0.18	7-1 0.23	7-7 0.28	8-1 0.34	8-6 0.40	8-11 0.46	9-4 0.52	9-8 0.59
2x8	12.0	7-1 0.05	8-8 0.09	10-0 0.14	11-2 0.20	12-3 0.26	13-3 0.33	14-2 0.40	15-0 0.48	15-10 0.56	16-7 0.65	17-4 0.74	18-0 0.83
	13.7	6-7 0.05	8-1 0.09	9-4 0.13	10-6 0.19	11-6 0.24	12-5 0.31	13-3 0.38	14-0 0.45	14-10 0.52	15-6 0.61	16-3 0.69	16-10 0.78
	16.0	6-2 0.04	7-6 0.08	8-8 0.12	9-8 0.17	10-7 0.23	11-6 0.28	12-3 0.35	13-0 0.41	13-8 0.49	14-4 0.56	15-0 0.64	15-7 0.72
	19.2	5-7 0.04	6-10 0.07	7-11 0.11	8-10 0.16	9-8 0.21	10-6 0.26	11-2 0.32	11-10 0.38	12-6 0.44	13-1 0.51	13-8 0.58	14-3 0.66
	24.0	5-0 0.04	6-2 0.07	7-1 0.10	7-11 0.14	8-8 0.18	9-4 0.23	10-0 0.28	10-7 0.34	11-2 0.40	11-9 0.46	12-3 0.52	12-9 0.59
2x10	12.0	9-0 0.05	11-1 0.09	12-9 0.14	14-3 0.20	15-8 0.26	16-11 0.33	18-1 0.40	19-2 0.48	20-2 0.56	21-2 0.65	22-1 0.74	23-0 0.83
	13.7	8-5 0.05	10-4 0.09	11-11 0.13	13-4 0.19	14-8 0.24	15-10 0.31	16-11 0.38	17-11 0.45	18-11 0.52	19-10 0.61	20-8 0.69	21-6 0.78
	16.0	7-10 0.04	9-7 0.08	11-1 0.12	12-4 0.17	13-6 0.23	14-8 0.28	15-8 0.35	16-7 0.41	17-6 0.49	18-4 0.56	19-2 0.64	19-11 0.72
	19.2	7-2 0.04	8-9 0.07	10-1 0.11	11-3 0.16	12-4 0.21	13-4 0.26	14-3 0.32	15-2 0.38	15-11 0.44	16-9 0.51	17-6 0.58	18-2 0.66
	24.0	6-5 0.04	7-10 0.07	9-0 0.10	10-1 0.14	11-1 0.18	11-11 0.23	12-9 0.28	13-6 0.34	14-3 0.40	15-0 0.46	15-8 0.52	16-3 0.59

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

Table No. 7-N (cont.)

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

HOW TO USE TABLES: Enter table with span of rafters (upper figure in each square). Determine size and spacing (last column) based on stress grade (top row) and modulus of elasticity (lower figure in each square) of lumber to be used.

Allowable Extreme Fiber Stress in Bending, "F_b" (psi).												RAFTER SPACING (IN)	SIZE (IN)
1400	1500	1600	1700	1800	1900	2000	2100	2200	2400	2700	3000		
9 0 0 93	9 4 1 03	9 8 1 14	9 11 1 24	10 3 1 36	10 6 1 47	10 10 1 59	11 1 1 71	11 4 1 83	11 10 2 09	12 7 2 49		12 0	
8 5 0 87	8 9 0 96	9 0 1 06	9 4 1 16	9 7 1 27	9 10 1 37	10 1 1 48	10 4 1 60	10 7 1 71	11 1 1 95	11 9 2 33		13 7	
7 10 0 80	8 1 0 89	8 4 0 98	8 7 1 08	8 10 1 17	9 1 1 27	9 4 1 37	9 7 1 48	9 10 1 59	10 3 1 81	10 10 2 16	11 5 2 53	16 0	2x4
7 2 0 73	7 5 0 81	7 8 0 90	7 10 0 98	8 1 1 07	8 4 1 16	8 6 1 25	8 9 1 35	8 11 1 45	9 4 1 65	9 11 1 97	10 5 2 31	19 2	
6 5 0 66	6 7 0 73	6 10 0 80	7 0 0 88	7 3 0 96	7 5 1 04	7 8 1 12	7 10 1 21	8 0 1 29	8 4 1 48	8 10 1 76	9 4 2 06	24 0	
14 2 0 93	14 8 1 03	15 2 1 14	15 8 1 24	16 1 1 36	16 7 1 47	17 0 1 59	17 5 1 71	17 10 1 83	18 7 2 09	19 9 2 49		12 0	
13 3 0 87	13 9 0 96	14 2 1 06	14 8 1 16	15 1 1 27	15 6 1 37	15 11 1 48	16 3 1 60	16 8 1 71	17 5 1 95	18 5 2 33		13 7	
12 4 0 80	12 9 0 89	13 2 0 98	13 7 1 08	13 11 1 17	14 4 1 27	14 8 1 37	15 1 1 48	15 5 1 59	16 1 1 81	17 1 2 16	18 0 2 53	16 0	2x6
11 3 0 73	11 7 0 81	12 0 0 90	12 4 0 98	12 9 1 07	13 1 1 16	13 5 1 25	13 9 1 35	14 1 1 45	14 8 1 65	15 7 1 97	16 5 2 31	19 2	
10 0 0 66	10 5 0 73	10 9 0 80	11 1 0 88	11 5 0 96	11 8 1 04	12 0 1 12	12 4 1 21	12 7 1 29	13 2 1 48	13 11 1 76	14 8 2 06	24 0	
18 9 0 93	19 5 1 03	20 0 1 14	20 8 1 24	21 3 1 36	21 10 1 47	22 4 1 59	22 11 1 71	23 6 1 83	24 6 2 09	26 0 2 49		12 0	
17 6 0 87	18 2 0 96	18 9 1 06	19 4 1 16	19 10 1 27	20 5 1 37	20 11 1 48	21 5 1 60	21 11 1 71	22 11 1 95	24 4 2 33		13 7	
16 3 0 80	16 9 0 89	17 4 0 98	17 10 1 08	18 5 1 17	18 11 1 27	19 5 1 37	19 10 1 48	20 4 1 59	21 3 1 81	22 6 2 16	23 9 2 53	16 0	2x8
14 10 0 73	15 4 0 81	15 10 0 90	16 4 0 98	16 9 1 07	17 3 1 16	17 8 1 25	18 2 1 35	18 7 1 45	19 5 1 65	20 7 1 97	21 8 2 31	19 2	
13 3 0 66	13 8 0 73	14 2 0 80	14 7 0 88	15 0 0 96	15 5 1 04	15 10 1 12	16 3 1 21	16 7 1 29	17 4 1 48	18 5 1 76	19 5 2 06	24 0	
23 11 0 93	24 9 1 03	25 6 1 14	26 4 1 24	27 1 1 36	27 10 1 47	28 7 1 59	29 3 1 71	29 11 1 83	31 3 2 09	33 2 2 49		12 0	
22 4 0 87	23 2 0 96	23 11 1 06	24 7 1 16	25 4 1 27	26 0 1 37	26 8 1 48	27 4 1 60	28 0 1 71	29 3 1 95	31 0 2 33		13 7	
20 8 0 80	21 5 0 89	22 1 0 98	22 10 1 08	23 5 1 17	24 1 1 27	24 9 1 37	25 4 1 48	25 11 1 59	27 1 1 81	28 9 2 16	30 3 2 53	16 0	2x10
18 11 0 73	19 7 0 81	20 2 0 90	20 10 0 98	21 5 1 07	22 0 1 16	22 7 1 25	23 2 1 35	23 8 1 45	24 9 1 65	26 3 1 97	27 8 2 31	19 2	
16 11 0 66	17 6 0 73	18 1 0 80	18 7 0 88	19 2 0 96	19 8 1 04	20 2 1 12	20 8 1 21	21 2 1 29	22 1 1 48	23 5 1 76	24 9 2 06	24 0	

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

Table No. 7-0
ALLOWABLE SPAN FOR HIGH SLOPE RAFTERS

Slope over 3 in 12 – 30 Lbs. Per Sq. Ft. Live Load
(Heavy Roof Covering)

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

HOW TO USE TABLES: Enter table with span of rafters (upper figure in each square). Determine size and spacing (first column) based on stress grade (top row) and modulus of elasticity (lower figure in each square) of lumber to be used.

RAFTER SIZE (IN)	SPACING (IN)	Allowable Extreme Fiber Stress in Bending, "F_b" (psi)											
		200	300	400	500	600	700	800	900	1000	1100	1200	1300
2×4	12.0	3.0 0.05	3.8 0.09	4.3 0.15	4.9 0.20	5.3 0.27	5.8 0.34	6.0 0.41	6.5 0.49	6.9 0.58	7.1 0.67	7.5 0.76	7.8 0.86
	13.7	2.10 0.05	3.5 0.09	4.0 0.14	4.5 0.19	4.11 0.25	5.3 0.32	5.8 0.39	6.0 0.46	6.4 0.54	6.7 0.62	6.11 0.71	7.2 0.80
	16.0	2.7 0.04	3.2 0.08	3.8 0.13	4.1 0.18	4.6 0.23	4.11 0.29	5.3 0.36	5.6 0.43	5.10 0.50	6.1 0.58	6.5 0.66	6.8 0.74
	19.2	2.5 0.04	2.11 0.08	3.4 0.12	3.9 0.16	4.1 0.21	4.5 0.27	4.9 0.33	5.1 0.39	5.4 0.46	5.7 0.53	5.10 0.60	6.1 0.68
	24.0	2.2 0.04	2.7 0.07	3.0 0.10	3.4 0.14	3.8 0.19	4.0 0.24	4.3 0.29	4.6 0.35	4.9 0.41	5.0 0.47	5.3 0.54	5.5 0.61
2×6	12.0	4.9 0.05	5.10 0.09	6.8 0.15	7.6 0.20	8.2 0.27	8.10 0.34	9.6 0.41	10.0 0.49	10.7 0.58	11.1 0.67	11.7 0.76	12.1 0.86
	13.7	4.5 0.05	5.5 0.09	6.3 0.14	7.0 0.19	7.8 0.25	8.3 0.32	8.10 0.39	9.5 0.46	9.11 0.54	10.5 0.62	10.10 0.71	11.3 0.80
	16.0	4.1 0.04	5.0 0.08	5.10 0.13	6.6 0.18	7.1 0.23	7.8 0.29	8.2 0.36	8.8 0.43	9.2 0.50	9.7 0.58	10.0 0.66	10.5 0.74
	19.2	3.9 0.04	4.7 0.08	5.4 0.12	5.11 0.16	6.6 0.21	7.0 0.27	7.6 0.33	7.11 0.39	8.4 0.46	8.9 0.53	9.2 0.60	9.6 0.68
	24.0	3.4 0.04	4.1 0.07	4.9 0.10	5.4 0.14	5.10 0.19	6.3 0.24	6.8 0.29	7.1 0.35	7.6 0.41	7.10 0.47	8.2 0.54	8.6 0.61
2×8	12.0	6.3 0.05	7.8 0.09	8.10 0.15	9.10 0.20	10.10 0.27	11.8 0.34	12.6 0.41	13.3 0.49	13.11 0.58	14.8 0.67	15.3 0.76	15.11 0.86
	13.7	5.10 0.05	7.2 0.09	8.3 0.14	9.3 0.19	10.1 0.25	10.11 0.32	11.8 0.39	12.5 0.46	13.1 0.54	13.8 0.62	14.4 0.71	14.11 0.80
	16.0	5.5 0.04	6.7 0.08	7.8 0.13	8.7 0.18	9.4 0.23	10.1 0.29	10.10 0.36	11.6 0.43	12.1 0.50	12.8 0.58	13.3 0.66	13.9 0.74
	19.2	4.11 0.04	6.1 0.08	7.0 0.12	7.10 0.16	8.7 0.21	9.3 0.27	9.10 0.33	10.6 0.39	11.0 0.46	11.7 0.53	12.1 0.60	12.7 0.68
	24.0	4.5 0.04	5.5 0.07	6.3 0.10	7.0 0.14	7.8 0.19	8.3 0.24	8.10 0.29	9.4 0.35	9.10 0.41	10.4 0.47	10.10 0.54	11.3 0.61
2×10	12.0	8.0 0.05	9.9 0.09	11.3 0.15	12.7 0.20	13.9 0.27	14.11 0.34	15.11 0.41	16.11 0.49	17.10 0.58	18.8 0.67	19.6 0.76	20.4 0.86
	13.7	7.5 0.05	9.1 0.09	10.6 0.14	11.9 0.19	12.11 0.25	13.11 0.32	14.11 0.39	15.10 0.46	16.8 0.54	17.6 0.62	18.3 0.71	19.0 0.80
	16.0	6.11 0.04	8.5 0.08	9.9 0.13	10.11 0.18	11.11 0.23	12.11 0.29	13.9 0.36	14.8 0.43	15.5 0.50	16.2 0.58	16.11 0.66	17.7 0.74
	19.2	6.4 0.04	7.8 0.08	8.11 0.12	9.11 0.16	10.11 0.21	11.9 0.27	12.7 0.33	13.4 0.39	14.1 0.46	14.9 0.53	15.5 0.60	16.1 0.68
	24.0	5.8 0.04	6.11 0.07	8.0 0.10	8.11 0.14	9.9 0.19	10.6 0.24	11.3 0.29	11.11 0.35	12.7 0.41	13.2 0.47	13.9 0.54	14.4 0.61

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

Table No. 7-0 (cont.)

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

HOW TO USE TABLES: Enter table with span of rafters (upper figure in each square). Determine size and spacing (last column) based on stress grade (top row) and modulus of elasticity (lower figure in each square) of lumber to be used.

Allowable Extreme Fiber Stress in Bending, "F_b" (psi)												RAFTER SPACING SIZE	
1400	1500	1600	1700	1800	1900	2000	2100	2200	2400	2700	3000	(IN)	(IN)
8 0 0 96	8 3 1 06	8 6 1 17	8 9 1 28	9 0 1 39	9 3 1 51	9 6 1 63	9 9 1 76	10 0 1 88	10 5 2 15	11 1 2 56		12 0	
7 5 0 89	7 9 0 99	8 0 1 09	8 3 1 20	8 5 1 30	8 8 1 41	8 11 1 53	9 2 1 64	9 4 1 76	9 9 2 01	10 4 2 40		13 7	
6 11 0 83	7 2 0 92	7 5 1 01	7 7 1 11	7 10 1 21	8 0 1 31	8 3 1 41	8 5 1 52	8 8 1 63	9 0 1 86	9 7 2 22	10 1 2 40	16 0	2×4
6 4 0 76	6 6 0 84	6 9 0 92	6 11 1 01	7 2 1 10	7 4 1 20	7 6 1 29	7 9 1 39	7 11 1 49	8 3 1 70	8 9 2 03	9 3 2 37	19 2	
5 8 0 68	5 10 0 75	6 0 0 83	6 3 0 90	6 5 0 99	6 7 1 07	6 9 1 15	6 11 1 24	7 1 1 33	7 5 1 52	7 10 1 81	8 3 2 12	24 0	
12 6 0 96	13 0 1 06	13 5 1 17	13 10 1 28	14 2 1 39	14 7 1 51	15 0 1 63	15 4 1 76	15 8 1 88	16 5 2 15	17 5 2 56		12 0	
11 9 0 89	12 2 0 99	12 6 1 09	12 11 1 20	13 3 1 30	13 8 1 41	14 0 1 53	14 4 1 64	14 8 1 76	15 4 2 01	16 3 2 40		13 7	
10 10 0 83	11 3 0 92	11 7 1 01	11 11 1 11	12 4 1 21	12 8 1 31	13 0 1 41	13 3 1 52	13 7 1 63	14 2 1 86	15 1 2 22	15 11 2 60	16 0	2×6
9 11 0 76	10 3 0 84	10 7 0 92	10 11 1 01	11 3 1 10	11 6 1 20	11 10 1 29	12 2 1 39	12 5 1 49	13 0 1 70	13 9 2 03	14 6 2 37	19 2	
8 10 0 68	9 2 0 75	9 6 0 83	9 9 0 90	10 0 0 99	10 4 1 07	10 7 1 15	10 10 1 24	11 1 1 33	11 7 1 52	12 4 1 81	13 0 2 12	24 0	
16 6 0 96	17 1 1 06	17 8 1 17	18 2 1 28	18 9 1 39	19 3 1 51	19 9 1 63	20 3 1 76	20 8 1 88	21 7 2 15	22 11 2 56		12 0	
15 5 0 89	16 0 0 99	16 6 1 09	17 0 1 20	17 6 1 30	18 0 1 41	18 5 1 53	18 11 1 64	19 4 1 76	20 3 2 01	21 5 2 40		13 7	
14 4 0 83	14 10 0 92	15 3 1 01	15 9 1 11	16 3 1 21	16 8 1 31	17 1 1 41	17 6 1 52	17 11 1 63	18 9 1 86	19 10 2 22	20 11 2 60	16 0	2×8
13 1 0 76	13 6 0 84	13 11 0 92	14 5 1 01	14 10 1 10	15 2 1 20	15 7 1 29	16 0 1 39	16 4 1 49	17 1 1 70	18 2 2 03	19 1 2 37	19 2	
11 8 0 68	12 1 0 75	12 6 0 83	12 10 0 90	13 3 0 99	13 7 1 07	13 11 1 15	14 4 1 24	14 8 1 33	15 3 1 52	16 3 1 81	17 1 2 12	24 0	
21 1 0 96	21 10 1 06	22 6 1 17	23 3 1 28	23 11 1 39	24 6 1 51	25 2 1 63	25 10 1 76	26 5 1 88	27 7 2 15	29 3 2 56		12 0	
19 8 0 89	20 5 0 99	21 1 1 09	21 9 1 20	22 4 1 30	22 11 1 41	23 7 1 53	24 2 1 64	24 8 1 76	25 10 2 01	27 4 2 40		13 7	
18 3 0 83	18 11 0 92	19 6 1 01	20 1 1 11	20 8 1 21	21 3 1 31	21 10 1 41	22 4 1 52	22 10 1 63	23 11 1 86	25 4 2 22	26 8 2 60	16 0	2×10
16 8 0 76	17 3 0 84	17 10 0 92	18 4 1 01	18 11 1 10	19 5 1 20	19 11 1 29	20 5 1 39	20 10 1 49	21 10 1 70	23 2 2 03	24 5 2 37	19 2	
14 11 0 68	15 5 0 75	15 11 0 83	16 5 0 90	16 11 0 99	17 4 1 07	17 10 1 15	18 3 1 24	18 8 1 33	19 6 1 52	20 8 1 81	21 10 2 12	24 0	

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

Table No. 7-P
ALLOWABLE SPAN FOR HIGH SLOPE RAFTERS

Slope over 3 in 12 – 40 Lbs. Per Sq. Ft. Live Load
(Heavy Roof Covering)

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

HOW TO USE TABLES: Enter table with span of rafters (upper figure in each square). Determine size and spacing (first column) based on stress grade (top row) and modulus of elasticity (lower figure in each square) of lumber to be used.

RAFTER SIZE	SPACING (IN)	Allowable Extreme Fiber Stress in Bending, "F_b" (psi).											
		200	300	400	500	600	700	800	900	1000	1100	1200	1300
2×4	12.0	2 9 0 05	3 4 0 09	3 10 0 14	4 4 0 20	4 9 0 26	5 1 0 33	5 5 0 41	5 9 0 49	6 1 0 57	6 5 0 66	6 8 0 75	6 11 0 84
	13.7	2 7 0 05	3 1 0 09	3 7 0 13	4 0 0 19	4 5 0 25	4 9 0 31	5 1 0 38	5 5 0 46	5 8 0 53	6 0 0 61	6 3 0 70	6 6 0 79
	16.0	2 4 0 04	2 11 0 08	3 4 0 12	3 9 0 17	4 1 0 23	4 5 0 29	4 9 0 35	5 0 0 42	5 3 0 49	5 6 0 57	5 9 0 65	6 0 0 73
	19.2	2 2 0 04	2 8 0 07	3 1 0 11	3 5 0 16	3 9 0 21	4 0 0 26	4 4 0 32	4 7 0 38	4 10 0 45	5 1 0 52	5 3 0 59	5 6 0 67
	24.0	1 11 0 04	2 4 0 07	2 9 0 10	3 1 0 14	3 4 0 19	3 7 0 24	3 10 0 29	4 1 0 34	4 4 0 40	4 6 0 46	4 9 0 53	4 11 0 60
2×6	12.0	4 3 0 05	5 3 0 09	6 1 0 14	6 9 0 20	7 5 0 26	8 0 0 33	8 7 0 41	9 1 0 49	9 7 0 57	10 0 0 66	10 6 0 75	10 11 0 84
	13.7	4 0 0 05	4 11 0 09	5 8 0 13	6 4 0 19	6 11 0 25	7 6 0 31	8 0 0 38	8 6 0 46	8 11 0 53	9 5 0 61	9 10 0 70	10 3 0 79
	16.0	3 8 0 04	4 6 0 08	5 3 0 12	5 10 0 17	6 5 0 23	6 11 0 29	7 5 0 35	7 10 0 42	8 3 0 49	8 8 0 57	9 1 0 65	9 5 0 73
	19.2	3 5 0 04	4 2 0 07	4 9 0 11	5 4 0 16	5 10 0 21	6 4 0 26	6 9 0 32	7 2 0 38	7 7 0 45	7 11 0 52	8 3 0 59	8 8 0 67
	24.0	3 0 0 04	3 8 0 07	4 3 0 10	4 9 0 14	5 3 0 19	5 8 0 24	6 1 0 29	6 5 0 34	6 9 0 40	7 1 0 46	7 5 0 53	7 9 0 60
2×8	12.0	5 8 0 05	6 11 0 09	8 0 0 14	8 11 0 20	9 9 0 26	10 7 0 33	11 3 0 41	12 0 0 49	12 7 0 57	13 3 0 66	13 10 0 75	14 5 0 84
	13.7	5 3 0 05	6 6 0 09	7 6 0 13	8 4 0 19	9 2 0 25	9 11 0 31	10 7 0 28	11 2 0 46	11 10 0 53	12 5 0 61	12 11 0 70	13 6 0 79
	16.0	4 11 0 04	6 0 0 08	6 11 0 12	7 9 0 17	8 6 0 23	9 2 0 29	9 9 0 35	10 4 0 42	10 11 0 49	11 6 0 57	12 0 0 65	12 6 0 73
	19.2	4 6 0 04	5 6 0 07	6 4 0 11	7 1 0 16	7 9 0 21	8 4 0 26	8 11 0 32	9 6 0 38	10 0 0 45	10 6 0 52	10 11 0 59	11 5 0 67
	24.0	4 0 0 04	4 11 0 07	5 8 0 10	6 4 0 14	6 11 0 19	7 6 0 24	8 0 0 29	8 6 0 34	8 11 0 40	9 4 0 46	9 9 0 53	10 2 0 60
2×10	12.0	7 2 0 05	8 10 0 09	10 2 0 14	11 5 0 20	12 6 0 26	13 6 0 33	14 5 0 41	15 3 0 49	16 1 0 57	16 11 0 66	17 8 0 75	18 4 0 84
	13.7	6 9 0 05	8 3 0 09	9 6 0 13	10 8 0 19	11 8 0 25	12 7 0 31	13 6 0 38	14 3 0 46	15 1 0 53	15 10 0 61	16 6 0 70	17 2 0 79
	16.0	6 3 0 04	7 8 0 08	8 10 0 12	9 10 0 17	10 10 0 23	11 8 0 29	12 6 0 35	13 3 0 42	13 11 0 49	14 8 0 57	15 3 0 65	15 11 0 73
	19.2	5 8 0 04	7 0 0 07	8 1 0 11	9 0 0 16	9 10 0 21	10 8 0 26	11 5 0 32	12 1 0 38	12 9 0 45	13 4 0 52	13 11 0 59	14 6 0 67
	24.0	5 1 0 04	6 3 0 07	7 2 0 10	8 1 0 14	8 10 0 19	9 6 0 24	10 2 0 29	10 10 0 34	11 5 0 40	11 11 0 46	12 6 0 53	13 0 0 60

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

Table No. 7-P (cont.)

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

HOW TO USE TABLES: Enter table with span of rafters (upper figure in each square). Determine size and spacing (last column) based on stress grade (top row) and modulus of elasticity (lower figure in each square) of lumber to be used.

Allowable Extreme Fiber Stress in Bending, "F_b" (psi).												RAFTER SPACING (IN)	SIZE (IN)
1400	1500	1600	1700	1800	1900	2000	2100	2200	2400	2700	3000		
7-3 0.94	7-6 1.05	7-8 1.15	7-11 1.26	8-2 1.38	8-5 1.49	8-7 1.61	8-10 1.73	9-0 1.86	9-5 2.12	10-0 2.53		12.0	
6-9 0.88	7-0 0.98	7-3 1.08	7-5 1.18	7-8 1.29	7-10 1.40	8-1 1.51	8-3 1.62	8-5 1.74	8-10 1.98	9-4 2.36		13.7	
6-3 0.82	6-6 0.91	6-8 1.00	6-11 1.09	7-1 1.19	7-3 1.29	7-6 1.40	7-8 1.50	7-10 1.61	8-2 1.83	8-8 2.19	9-2 2.56	16.0	2×4
5-8 0.75	5-11 0.83	6-1 0.91	6-3 1.00	6-6 1.09	6-8 1.18	6-10 1.27	7-0 1.37	7-2 1.47	7-6 1.67	7-11 2.00	8-4 2.34	19.2	
5-1 0.67	5-3 0.74	5-5 0.82	5-7 0.89	5-9 0.97	5-11 1.06	6-1 1.14	6-3 1.23	6-5 1.31	6-8 1.50	7-1 1.79	7-6 2.09	24.0	
11-4 0.94	11-9 1.05	12-1 1.15	12-6 1.26	12-10 1.38	13-2 1.49	13-6 1.61	13-10 1.73	14-2 1.86	14-10 2.12	15-9 2.53		12.0	
10-7 0.88	11-0 0.98	11-4 1.08	11-8 1.18	12-0 1.29	12-4 1.40	12-8 1.51	13-0 1.62	13-3 1.74	13-10 1.98	14-9 2.36		13.7	
9-10 0.82	10-2 0.91	10-6 1.00	10-10 1.09	11-1 1.19	11-5 1.29	11-9 1.40	12-0 1.50	12-4 1.61	12-10 1.83	13-7 2.19	14-4 2.56	16.0	2×6
9-3 0.75	9-7 0.83	9-10 0.91	10-2 1.00	10-5 1.09	10-8 1.18	11-0 1.27	11-3 1.37	11-7 1.47	11-9 1.67	12-5 2.00	13-1 2.34	19.2	
8-0 0.67	8-3 0.74	8-7 0.82	8-10 0.89	9-1 0.97	9-4 1.06	9-7 1.14	9-10 1.23	10-0 1.31	10-6 1.50	11-1 1.79	11-9 2.09	24.0	
14-11 0.94	15-5 1.05	16-0 1.15	16-5 1.26	16-11 1.38	17-5 1.49	17-10 1.61	18-3 1.73	18-9 1.86	19-7 2.12	20-9 2.53		12.0	
14-0 0.88	14-6 0.98	14-11 1.08	15-5 1.18	15-10 1.29	16-3 1.40	16-8 1.51	17-1 1.62	17-6 1.74	18-3 1.98	19-5 2.36		13.7	
12-11 0.82	13-5 0.91	13-10 1.00	14-3 1.09	14-8 1.19	15-1 1.29	15-5 1.40	15-10 1.50	16-3 1.61	16-11 1.83	18-0 2.19	18-11 2.56	16.0	2×8
11-10 0.75	12-3 0.83	12-7 0.91	13-0 1.00	13-5 1.09	13-9 1.18	14-1 1.27	14-6 1.37	14-10 1.47	15-5 1.67	16-5 2.00	17-3 2.34	19.2	
10-7 0.67	10-11 0.74	11-3 0.82	11-8 0.89	12-0 0.97	12-4 1.06	12-7 1.14	12-11 1.23	13-3 1.31	13-10 1.50	14-8 1.79	15-5 2.09	24.0	
19-1 0.94	19-9 1.05	20-4 1.15	21-0 1.26	21-7 1.38	22-2 1.49	22-9 1.61	23-4 1.73	23-11 1.86	24-11 2.12	26-6 2.53		12.0	
17-10 0.88	18-5 0.98	19-1 1.08	19-8 1.18	20-2 1.29	20-9 1.40	21-4 1.51	21-10 1.62	22-4 1.74	23-4 1.98	24-9 2.36		13.7	
16-6 0.82	17-1 0.91	17-8 1.00	18-2 1.09	18-9 1.19	19-3 1.29	19-9 1.40	20-2 1.50	20-8 1.61	21-7 1.83	22-11 2.19	24-2 2.56	16.0	2×10
15-1 0.75	15-7 0.83	16-1 0.91	16-7 1.00	17-1 1.09	17-7 1.18	18-0 1.27	18-5 1.37	18-11 1.47	19-9 1.67	20-11 2.00	22-1 2.34	19.2	
13-6 0.67	13-11 0.74	14-5 0.82	14-10 0.89	15-3 0.97	15-8 1.06	16-1 1.14	16-6 1.23	16-11 1.31	17-8 1.50	18-9 1.79	19-9 2.09	24.0	

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

Table No. 7-Q

ALLOWABLE SPAN FOR HIGH SLOPE RAFTERS

Slope over 3 in 12 – 20 Lbs. Per Sq. Ft. Live Load
(Light Roof Covering)

DESIGN CRITERIA:
Strength - 7 lbs. per sq. ft. dead load plus 20 lbs. per sq. ft. live load determines fiber stress.
Deflection - For 20 lbs. per sq. ft. live load. Limited to span in inches divided by 180

HOW TO USE TABLES: Enter table with span of rafters (upper figure in each square) Determine size and spacing (first column) based on stress grade (top row) and modulus of elasticity (lower figure in each square) of lumber to be used

RAFTER SIZE	SPACING (IN.)	Allowable Extreme Fiber Stress in Bending, "F_b" (psi) 200	300	400	500	600	700	800	900	1000	1100	1200	1300
2x4	12.0	3 11 0 07	4 9 0 14	5 6 0 21	6 2 0 29	6 9 0 38	7 3 0 49	7 9 0 59	8 3 0 71	8 8 0 83	9 1 0 96	9 6 1 09	9 11 1 23
	13.7	3 8 0 07	4 5 0 13	5 2 0 20	5 9 0 27	6 4 0 36	6 10 0 45	7 3 0 55	7 9 0 66	8 2 0 77	8 6 0 89	8 11 1 02	9 3 1 15
	16.0	3 4 0 06	4 1 0 12	4 9 0 18	5 4 0 25	5 10 0 33	6 4 0 42	6 9 0 51	7 2 0 61	7 6 0 72	7 11 0 83	8 3 0 94	8 7 1 06
	19.2	3 1 0 06	3 9 0 11	4 4 0 17	4 10 0 23	5 4 0 30	5 9 0 38	6 2 0 47	6 6 0 56	6 10 0 65	7 3 0 76	7 6 0 86	7 10 0 97
	24.0	2 9 0 05	3 4 0 10	3 11 0 15	4 4 0 21	4 9 0 27	5 2 0 34	5 6 0 42	5 10 0 50	6 2 0 59	6 5 0 68	6 9 0 77	7 0 0 87
2x6	12.0	6 1 0 07	7 6 0 14	8 8 0 21	9 8 0 29	10 7 0 38	11 5 0 49	12 3 0 59	13 0 0 71	13 8 0 83	14 4 0 96	15 0 1 09	15 7 1 23
	13.7	5 9 0 07	7 0 0 13	8 1 0 20	9 0 0 27	9 11 0 36	10 8 0 45	11 5 0 55	12 2 0 66	12 9 0 77	13 5 0 89	14 0 1 02	14 7 1 15
	16.0	5 4 0 06	6 6 0 12	7 6 0 18	8 4 0 25	9 2 0 33	9 11 0 42	10 7 0 51	11 3 0 61	11 10 0 72	12 5 0 83	13 0 0 94	13 6 1 06
	19.2	4 10 0 06	5 11 0 11	6 10 0 17	7 8 0 23	8 4 0 30	9 0 0 38	9 8 0 47	10 3 0 56	10 10 0 65	11 4 0 76	11 10 0 86	12 4 0 97
	24.0	4 4 0 05	5 4 0 10	6 1 0 15	6 10 0 21	7 6 0 27	8 1 0 34	8 8 0 42	9 2 0 50	9 8 0 59	10 2 0 68	10 7 0 77	11 0 0 87
2x8	12.0	8 1 0 07	9 10 0 14	11 5 0 21	12 9 0 29	13 11 0 38	15 1 0 49	16 1 0 59	17 1 0 71	18 0 0 83	18 11 0 96	19 9 1 09	20 6 1 23
	13.7	7 6 0 07	9 3 0 13	10 8 0 20	11 11 0 27	13 1 0 36	14 1 0 45	15 1 0 55	16 0 0 66	16 10 0 77	17 8 0 89	18 5 1 02	19 3 1 15
	16.0	7 0 0 06	8 7 0 12	9 10 0 18	11 0 0 25	12 1 0 33	13 1 0 42	13 11 0 51	14 10 0 61	15 7 0 72	16 4 0 83	17 1 0 94	17 9 1 06
	19.2	6 4 0 06	7 10 0 11	9 0 0 17	10 1 0 23	11 0 0 30	11 11 0 38	12 9 0 47	13 6 0 56	14 3 0 65	14 11 0 76	15 7 0 86	16 3 0 97
	24.0	5 8 0 05	7 0 0 10	8 1 0 15	9 0 0 21	9 10 0 27	10 8 0 34	11 5 0 42	12 1 0 50	12 9 0 59	13 4 0 68	13 11 0 77	14 6 0 87
2x10	12.0	10 3 0 07	12 7 0 14	14 6 0 21	16 3 0 29	17 10 0 38	19 3 0 49	20 7 0 59	21 10 0 71	23 0 0 83	24 1 0 96	25 2 1 09	26 2 1 23
	13.7	9 7 0 07	11 9 0 13	13 7 0 20	15 2 0 27	16 8 0 36	18 0 0 45	19 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

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

Table No. 7-Q (cont.)

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

HOW TO USE TABLES: Enter table with span of rafters (upper figure in each square). Determine size and spacing (last column) based on stress grade (top row) and modulus of elasticity (lower figure in each square) of lumber to be used.

Allowable Extreme Fiber Stress in Bending, "F_b" (psi).											RAFTER SPACING (IN)	SIZE (IN)
1400	1500	1600	1700	1800	1900	2000	2100	2200	2400	2700		
10-3 1.37	10-8 1.52	11-0 1.68	11-4 1.84	11-8 2.00	12-0 2.17	12-4 2.34	12-7 2.52				12.0	
9-7 1.28	10-0 1.42	10-3 1.57	10-7 1.72	10-11 1.87	11-3 2.03	11-6 2.19	11-9 2.36	12-1 2.53			13.7	
8-11 1.19	9-3 1.32	9-6 1.45	9-10 1.59	10-1 1.73	10-5 1.88	10-8 2.03	10-11 2.18	11-2 2.34			16.0	2x4
8-2 1.08	8-5 1.20	8-8 1.33	9-0 1.45	9-3 1.58	9-6 1.71	9-9 1.85	10-0 1.99	10-2 2.14	10-8 2.43		19.2	
7-3 0.97	7-6 1.08	7-9 1.19	8-0 1.30	8-3 1.41	8-6 1.53	8-8 1.66	8-11 1.78	9-1 1.91	9-6 2.18	10-1 2.60	24.0	
16-2 1.37	16-9 1.52	17-3 1.68	17-10 1.84	18-4 2.00	18-10 2.17	19-4 2.34	19-10 2.52				12.0	
15-1 1.28	15-8 1.42	16-2 1.57	16-8 1.72	17-2 1.87	17-7 2.03	18-1 2.19	18-6 2.36	19-0 2.53			13.7	
14-0 1.19	14-6 1.32	15-0 1.45	15-5 1.59	15-11 1.73	16-4 1.88	16-9 2.03	17-2 2.18	17-7 2.34			16.0	2x6
12-9 1.08	13-3 1.20	13-8 1.33	14-1 1.45	14-6 1.58	14-11 1.71	15-3 1.85	15-8 1.99	16-0 2.14	16-9 2.43		19.2	
11-5 0.97	11-10 1.08	12-3 1.19	12-7 1.30	13-0 1.41	13-4 1.53	13-8 1.66	14-0 1.78	14-4 1.91	15-0 2.18	15-11 2.60	24.0	
21-4 1.37	22-1 1.52	22-9 1.68	23-6 1.84	24-2 2.00	24-10 2.17	25-6 2.34	26-1 2.52				12.0	
19-11 1.28	20-8 1.42	21-4 1.57	22-0 1.72	22-7 1.87	23-3 2.03	23-10 2.19	24-5 2.36	25-0 2.53			13.7	
18-5 1.19	19-1 1.32	19-9 1.45	20-4 1.59	20-11 1.73	21-6 1.88	22-1 2.03	22-7 2.18	23-2 2.34			16.0	2x8
16-10 1.08	17-5 1.20	18-0 1.33	18-7 1.45	19-1 1.58	19-8 1.71	20-2 1.85	20-8 1.99	21-1 2.14	22-1 2.43		19.2	
15-1 0.97	15-7 1.08	16-1 1.19	16-7 1.30	17-1 1.41	17-7 1.53	18-0 1.66	18-5 1.78	18-11 1.91	19-9 2.18	20-11 2.60	24.0	
27-2 1.37	28-2 1.52	29-1 1.68	30-0 1.84	30-10 2.00	31-8 2.17	32-6 2.34	33-4 2.52				12.0	
25-5 1.28	26-4 1.42	27-2 1.57	28-0 1.72	28-10 1.87	29-8 2.03	30-5 2.19	31-2 2.36	31-11 2.53			13.7	
23-7 1.19	24-5 1.32	25-2 1.45	25-11 1.59	26-8 1.73	27-5 1.88	28-2 2.03	28-10 2.18	29-6 2.34			16.0	2x10
21-6 1.08	22-3 1.20	23-0 1.33	23-8 1.45	24-5 1.58	25-1 1.71	25-8 1.85	26-4 1.99	26-11 2.14	28-2 2.43		19.2	
19-3 0.97	19-11 1.08	20-7 1.19	21-2 1.30	21-10 1.41	22-5 1.53	23-0 1.66	23-7 1.78	24-1 1.91	25-2 2.18	26-8 2.60	24.0	

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

Table No. 7-R

ALLOWABLE SPAN FOR HIGH SLOPE RAFTERS

Slope over 3 in 12 – 30 Lbs. Per Sq. Ft. Live Load

(Light Roof Covering)

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

HOW TO USE TABLES: Enter table with span of rafters (upper figure in each square). Determine size and spacing (first column) based on stress grade (top row) and modulus of elasticity (lower figure in each square) of lumber to be used.

RAFTER SIZE	SPACING (IN)	Allowable Extreme Fiber Stress in Bending, "F_b" (psi)											
		200	300	400	500	600	700	800	900	1000	1100	1200	1300
2x4	12.0	3-4 0.07	4-1 0.13	4-8 0.20	5-3 0.27	5-9 0.36	6-3 0.45	6-8 0.55	7-1 0.66	7-5 0.77	7-9 0.89	8-2 1.02	8-6 1.15
	13.7	3-1 0.06	3-10 0.12	4-5 0.18	4-11 0.26	5-5 0.34	5-10 0.42	6-3 0.52	6-7 0.62	6-11 0.72	7-3 0.84	7-7 0.95	7-11 1.07
	16.0	2-11 0.06	3-6 0.11	4-1 0.17	4-7 0.24	5-0 0.31	5-5 0.39	5-9 0.48	6-1 0.57	6-5 0.67	6-9 0.77	7-1 0.88	7-4 0.99
	19.2	2-8 0.05	3-3 0.10	3-9 0.15	4-2 0.22	4-7 0.28	4-11 0.36	5-3 0.44	5-7 0.52	5-10 0.61	6-2 0.71	6-5 0.80	6-8 0.91
	24.0	2-4 0.05	2-11 0.09	3-4 0.14	3-9 0.19	4-1 0.25	4-5 0.32	4-8 0.39	5-0 0.47	5-3 0.55	5-6 0.63	5-9 0.72	6-0 0.81
2x6	12.0	5-3 0.07	6-5 0.13	7-5 0.20	8-3 0.27	9-1 0.36	9-9 0.45	10-5 0.55	11-1 0.66	11-8 0.77	12-3 0.89	12-9 1.02	13-4 1.15
	13.7	4-11 0.06	6-0 0.12	6-11 0.18	7-9 0.26	8-5 0.34	9-2 0.42	9-9 0.52	10-4 0.62	10-11 0.72	11-5 0.84	12-0 0.95	12-5 1.07
	16.0	4-6 0.06	5-6 0.11	6-5 0.17	7-2 0.24	7-10 0.31	8-5 0.39	9-1 0.48	9-7 0.57	10-1 0.67	10-7 0.77	11-1 0.88	11-8 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	10-8 0.91
	24.0	3-8 0.05	4-6 0.09	5-3 0.14	5-10 0.19	6-5 0.25	6-11 0.32	7-5 0.39	7-10 0.47	8-3 0.55	8-8 0.63	9-1 0.72	9-5 0.81
2x8	12.0	6-11 0.07	8-5 0.13	9-9 0.20	10-11 0.27	11-11 0.36	12-10 0.45	13-9 0.55	14-7 0.66	15-5 0.77	16-2 0.89	16-10 1.02	17-7 1.15
	13.7	6-5 0.06	7-11 0.12	9-1 0.18	10-2 0.26	11-2 0.34	12-1 0.42	12-10 0.52	13-8 0.62	14-5 0.72	15-1 0.84	15-9 0.95	16-5 1.07
	16.0	6-0 0.06	7-4 0.11	8-5 0.17	9-5 0.24	10-4 0.31	11-2 0.39	11-11 0.48	12-8 0.57	13-4 0.67	14-0 0.77	14-7 0.88	15-2 0.99
	19.2	5-5 0.05	6-8 0.10	7-8 0.15	8-7 0.22	9-5 0.28	10-2 0.36	10-11 0.44	11-6 0.52	12-2 0.61	12-9 0.71	13-4 0.80	13-10 0.91
	24.0	4-10 0.05	6-0 0.09	6-11 0.14	7-8 0.19	8-5 0.25	9-1 0.32	9-9 0.39	10-4 0.47	10-11 0.55	11-5 0.63	11-11 0.72	12-5 0.81
2x10	12.0	8-9 0.07	10-9 0.13	12-5 0.20	13-11 0.27	15-2 0.36	16-5 0.45	17-7 0.55	18-7 0.66	19-8 0.77	20-7 0.89	21-6 1.02	22-5 1.15
	13.7	8-3 0.06	10-1 0.12	11-7 0.18	13-0 0.26	14-3 0.34	15-4 0.42	16-5 0.52	17-5 0.62	18-4 0.72	19-3 0.84	20-1 0.95	20-11 1.07
	16.0	7-7 0.07	9-4 0.12	10-9 0.19	12-0 0.26	13-2 0.34	14-3 0.43	15-2 0.53	16-2 0.63	17-0 0.74	17-10 0.85	18-7 0.97	19-5 1.09
	19.2	6-11 0.06	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

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

Table No. 7-R (cont.)

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

HOW TO USE TABLES: Enter table with span of rafters (upper figure in each square). Determine size and spacing (last column) based on stress grade (top row) and modulus of elasticity (lower figure in each square) of lumber to be used.

Allowable Extreme Fiber Stress in Bending, "F_b" (psi).											RAFTER SPACING (IN)	SIZE (IN)
1400	1500	1600	1700	1800	1900	2000	2100	2200	2400	2700		
8-9 1.28	9-1 1.42	9-5 1.57	9-8 1.72	10-0 1.87	10-3 2.03	10-6 2.19	10-9 2.36	11-0 2.53			12.0	
8-3 1.20	8-6 1.33	8-9 1.47	9-1 1.61	9-4 1.75	9-7 1.90	9-10 2.05	10-1 2.20	10-4 2.36			13.7	
7-7 1.11	7-11 1.23	8-2 1.36	8-5 1.49	8-8 1.62	8-10 1.76	9-1 1.90	9-4 2.04	9-7 2.19	10-0 2.49		16.0	2x4
6-11 1.01	7-2 1.12	7-5 1.24	7-8 1.36	7-11 1.48	8-1 1.60	8-4 1.73	8-6 1.86	8-9 2.00	9-1 2.28		19.2	
6-3 0.91	6-5 1.01	6-8 1.11	6-10 1.21	7-1 1.32	7-3 1.43	7-5 1.55	7-7 1.67	7-9 1.79	8-2 2.04	8-8 2.43	24.0	
13-10 1.28	14-4 1.42	14-9 1.57	15-3 1.72	15-8 1.87	16-1 2.03	16-6 2.19	16-11 2.36	17-4 2.53			12.0	
12-11 1.20	13-4 1.33	13-10 1.47	14-3 1.61	14-8 1.75	15-1 1.90	15-5 2.05	15-10 2.20	16-2 2.36			13.7	
12-0 1.11	12-5 1.23	12-9 1.36	13-2 1.49	13-7 1.62	13-11 1.76	14-4 1.90	14-8 2.04	15-0 2.19	15-8 2.49		16.0	2x6
10-11 1.01	11-4 1.12	11-8 1.24	12-0 1.36	12-5 1.48	12-9 1.60	13-1 1.73	13-4 1.86	13-8 2.00	14-4 2.28		19.2	
9-9 0.91	10-1 1.01	10-5 1.11	10-9 1.21	11-1 1.32	11-5 1.43	11-8 1.55	12-0 1.67	12-3 1.79	12-9 2.04	13-7 2.43	24.0	
18-2 1.28	18-10 1.42	19-6 1.57	20-1 1.72	20-8 1.87	21-3 2.03	21-9 2.19	22-4 2.36	22-10 2.53			12.0	
17-0 1.20	17-8 1.33	18-2 1.47	18-9 1.61	19-4 1.75	19-10 1.90	20-4 2.05	20-10 2.20	21-4 2.36			13.7	
15-9 1.11	16-4 1.23	16-10 1.36	17-4 1.49	17-11 1.62	18-4 1.76	18-10 1.90	19-4 2.04	19-9 2.19	20-8 2.49		16.0	2x8
14-5 1.01	14-11 1.12	15-5 1.24	15-10 1.36	16-4 1.48	16-9 1.60	17-2 1.73	17-8 1.86	18-1 2.00	18-10 2.28		19.2	
12-10 0.91	13-4 1.01	13-9 1.11	14-2 1.21	14-7 1.32	15-0 1.43	15-5 1.55	15-9 1.67	16-2 1.79	16-10 2.04	17-11 2.43	24.0	
23-3 1.28	24-1 1.42	24-10 1.57	25-7 1.72	26-4 1.87	27-1 2.03	27-9 2.19	28-5 2.36	29-1 2.53			12.0	
21-9 1.20	22-6 1.33	23-3 1.47	23-11 1.61	24-8 1.75	25-4 1.90	26-0 2.05	26-7 2.20	27-3 2.36			13.7	
20-1 1.22	20-10 1.35	21-6 1.49	22-2 1.63	22-10 1.78	23-5 1.93	24-1 2.08	24-8 2.24	25-3 2.40			18.0	2x10
18-4 1.01	19-0 1.12	19-8 1.24	20-3 1.36	20-10 1.48	21-5 1.60	21-11 1.73	22-6 1.86	23-0 2.00	24-1 2.28		19.2	
16-5 0.91	17-0 1.01	17-7 1.11	18-1 1.21	18-7 1.32	19-2 1.43	19-8 1.55	20-1 1.67	20-7 1.79	21-6 2.04	22-10 2.43	24.0	

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

Table No. 7-S

ALLOWABLE SPAN FOR HIGH SLOPE RAFTERS

Slope over 3 in 12 – 40 Lbs. Per Sq. Ft. Live Load
(Light Roof Covering)

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

HOW TO USE TABLES: Enter table with span of rafters (upper figure in each square). Determine size and spacing (first column) based on stress grade (top row) and modulus of elasticity (lower figure in each square) of lumber to be used.

RAFTER SIZE	SPACING (IN)	Allowable Extreme Fiber Stress in Bending, "F_b" (psi).											
		200	300	400	500	600	700	800	900	1000	1100	1200	1300
2x4	12.0	2-11 0.06	3-7 0.12	4-2 0.18	4-8 0.25	5-1 0.34	5-6 0.42	5-11 0.52	6-3 0.62	6-7 0.72	6-11 0.83	7-3 0.95	7-6 1.07
	13.7	2-9 0.06	3-5 0.11	3-11 0.17	4-4 0.24	4-9 0.31	5-2 0.40	5-6 0.48	5-10 0.58	6-2 0.67	6-6 0.78	6-9 0.89	7-0 1.00
	16.0	2-7 0.06	3-2 0.10	3-7 0.16	4-0 0.22	4-5 0.29	4-9 0.37	5-1 0.45	5-5 0.53	5-8 0.62	6-0 0.72	6-3 0.82	6-6 0.93
	19.2	2-4 0.05	2-10 0.09	3-4 0.14	3-8 0.20	4-0 0.26	4-4 0.33	4-8 0.41	4-11 0.49	5-3 0.57	5-6 0.66	5-8 0.75	5-11 0.85
	24.0	2-1 0.05	2-7 0.08	2-11 0.13	3-4 0.18	3-7 0.24	3-11 0.30	4-2 0.36	4-5 0.44	4-8 0.51	4-11 0.59	5-1 0.67	5-4 0.76
2x6	12.0	4-8 0.06	5-8 0.12	6-7 0.18	7-4 0.25	8-0 0.34	8-8 0.42	9-3 0.52	9-10 0.62	10-4 0.72	10-10 0.83	11-4 0.95	11-10 1.07
	13.7	4-4 0.06	5-4 0.11	6-2 0.17	6-10 0.24	7-6 0.31	8-1 0.40	8-8 0.48	9-2 0.58	9-8 0.67	10-2 0.78	10-7 0.89	11-1 1.00
	16.0	4-0 0.06	4-11 0.10	5-8 0.16	6-4 0.22	6-11 0.29	7-6 0.37	8-0 0.45	8-8 0.53	9-0 0.62	9-5 0.72	9-10 0.82	10-3 0.93
	19.2	3-8 0.05	4-6 0.09	5-2 0.14	5-9 0.20	6-4 0.26	6-10 0.33	7-4 0.41	7-9 0.49	8-2 0.57	8-7 0.66	9-0 0.75	9-4 0.85
	24.0	3-3 0.05	4-0 0.08	4-8 0.13	5-2 0.18	5-8 0.24	6-2 0.30	6-7 0.36	6-11 0.44	7-4 0.51	7-8 0.59	8-0 0.67	8-4 0.76
2x8	12.0	6-1 0.06	7-6 0.12	8-8 0.18	9-8 0.25	10-7 0.34	11-5 0.42	12-3 0.52	12-11 0.62	13-8 0.72	14-4 0.83	14-11 0.95	15-7 1.07
	13.7	5-9 0.06	7-0 0.11	8-1 0.17	9-0 0.24	9-11 0.31	10-8 0.40	11-5 0.48	12-1 0.58	12-9 0.67	13-5 0.78	14-0 0.89	14-7 1.00
	16.0	5-3 0.06	6-6 0.10	7-6 0.16	8-4 0.22	9-2 0.29	9-11 0.37	10-7 0.45	11-3 0.53	11-10 0.62	12-5 0.72	12-11 0.82	13-6 0.93
	19.2	4-10 0.05	5-11 0.09	6-10 0.14	7-8 0.20	8-4 0.26	9-0 0.33	9-8 0.41	10-3 0.49	10-10 0.57	11-4 0.66	11-10 0.75	12-4 0.85
	24.0	4-4 0.05	5-3 0.08	6-1 0.13	6-10 0.18	7-6 0.24	8-1 0.30	8-8 0.36	9-2 0.44	9-8 0.51	10-2 0.59	10-7 0.67	11-0 0.76
2x10	12.0	7-9 0.06	9-6 0.12	11-0 0.18	12-4 0.25	13-6 0.34	14-7 0.42	15-7 0.52	16-6 0.62	17-5 0.72	18-3 0.83	19-1 0.95	19-10 1.07
	13.7	7-3 0.06	8-11 0.11	10-4 0.17	11-6 0.24	12-7 0.31	13-8 0.40	14-7 0.48	15-5 0.58	16-4 0.67	17-1 0.78	17-10 0.89	18-7 1.00
	16.0	6-9 0.06	8-3 0.10	9-6 0.16	10-8 0.22	11-8 0.29	12-7 0.37	13-6 0.45	14-4 0.53	15-1 0.62	15-10 0.72	16-6 0.82	17-2 0.93
	19.2	6-2 0.05	7-7 0.09	8-9 0.14	9-9 0.20	10-8 0.26	11-6 0.33	12-4 0.41	13-1 0.49	13-9 0.57	14-5 0.66	15-1 0.75	15-8 0.85
	24.0	5-6 0.05	6-9 0.08	7-9 0.13	8-9 0.18	9-6 0.24	10-4 0.30	11-0 0.36	11-8 0.44	12-4 0.51	12-11 0.59	13-6 0.67	14-1 0.76

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

Table No. 7-S (cont.)

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

HOW TO USE TABLES: Enter table with span of rafters (upper figure in each square). Determine size and spacing (last column) based on stress grade (top row) and modules of elasticity (lower figure in each square) of lumber to be used.

Allowable Extreme Fiber Stress in Bending, "F_b" (psi).											RAFTER SPACING (IN)	SIZE (IN)
1400	1500	1600	1700	1800	1900	2000	2100	2200	2400	2700		
7-10	8-1	8-4	8-7	8-10	9-1	9-4	9-7	9-9				
1.19	1.32	1.46	1.60	1.74	1.89	2.04	2.19	2.35			12.0	
7-4	7-7	7-10	8-0	8-3	8-6	8-9	8-11	9-2	9-7			
1.12	1.24	1.37	1.50	1.63	1.77	1.91	2.05	2.20	2.51		13.7	
6-9	7-0	7-3	7-5	7-8	7-10	8-1	8-3	8-6	8-10			
1.03	1.15	1.26	1.38	1.51	1.64	1.77	1.90	2.04	2.32		16.0	2x4
6-2	6-5	6-7	6-10	7-0	7-2	7-4	7-7	7-9	8-1	8-7		
0.94	1.05	1.15	1.26	1.38	1.49	1.61	1.74	1.86	2.12	2.53	19.2	
5-6	5-8	5-11	6-1	6-3	6-5	6-7	6-9	6-11	7-3	7-8		
0.84	0.94	1.03	1.13	1.23	1.34	1.44	1.55	1.66	1.90	2.26	24.0	
12-3	12-8	13-1	13-6	13-11	14-3	14-8	15-0	15-4				
1.19	1.32	1.46	1.60	1.74	1.89	2.04	2.19	2.35			12.0	
11-6	11-10	12-3	12-8	13-0	13-4	13-8	14-0	14-4	15-0			
1.12	1.24	1.37	1.50	1.63	1.77	1.91	2.05	2.20	2.51		13.7	
10-7	11-0	11-4	11-8	12-0	12-4	12-8	13-0	13-4	13-11			
1.03	1.15	1.26	1.38	1.51	1.64	1.77	1.90	2.04	2.32		16.0	2x6
9-8	10-0	10-4	10-8	11-0	11-3	11-7	11-10	12-2	12-8	13-5		
0.94	1.05	1.15	1.26	1.38	1.49	1.61	1.74	1.86	2.12	2.53	19.2	
8-8	9-0	9-3	9-7	9-10	10-1	10-4	10-7	10-10	11-4	12-0		
0.84	0.94	1.03	1.13	1.23	1.34	1.44	1.55	1.66	1.90	2.26	24.0	
16-2	16-9	17-3	17-10	18-4	18-10	19-4	19-9	20-3				
1.19	1.32	1.46	1.60	1.74	1.89	2.04	2.19	2.35			12.0	
15-1	15-8	16-2	16-8	17-2	17-7	18-1	18-6	18-11	19-9			
1.12	1.24	1.37	1.50	1.63	1.77	1.91	2.05	2.20	2.51		13.7	
14-0	14-6	14-11	15-5	15-10	16-4	16-9	17-2	17-6	18-4			
1.03	1.15	1.26	1.38	1.51	1.64	1.77	1.90	2.04	2.32		16.0	2x8
12-9	13-3	13-8	14-1	14-6	14-11	15-3	15-8	16-0	16-9	17-9		
0.94	1.05	1.15	1.26	1.38	1.49	1.61	1.74	1.86	2.12	2.53	19.2	
11-5	11-10	12-3	12-7	12-11	13-4	13-8	14-0	14-4	14-11	15-10		
0.84	0.94	1.03	1.13	1.23	1.34	1.44	1.55	1.66	1.90	2.26	24.0	
20-7	21-4	22-0	22-9	23-4	24-0	24-8	25-3	25-10				
1.19	1.32	1.46	1.60	1.74	1.89	2.04	2.19	2.35			12.0	
19-3	19-11	20-7	21-3	21-10	22-6	23-1	23-7	24-2	25-3			
1.12	1.24	1.37	1.50	1.63	1.77	1.91	2.05	2.20	2.51		13.7	
17-10	18-6	19-1	19-8	20-3	20-10	21-4	21-10	22-4	23-4			
1.03	1.15	1.26	1.38	1.51	1.64	1.77	1.90	2.04	2.32		16.0	2x10
16-4	16-10	17-5	17-11	18-6	19-0	19-6	19-11	20-5	21-4	22-8		
0.94	1.05	1.15	1.26	1.38	1.49	1.61	1.74	1.86	2.12	2.53	19.2	
14-7	15-1	15-7	16-1	16-6	17-0	17-5	17-10	18-3	19-1	20-3		
0.84	0.94	1.03	1.13	1.23	1.34	1.44	1.55	1.66	1.90	2.26	24.0	

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

Table No. 6/7A – DESIGN VALUES FOR JOISTS AND RAFTERS–VISUAL GRADING

These "Fb" Values are for use where repetative members are spaced not more than 24 inches wider spacing, the "Fb" values should be reduced 13 percent.
Values for surfaced dry or surfaced green lumber apply at 19 per cent maximum moisture co in use.

Species and Grade	Size	Normal Duration	Design Value inBending "Fb" Snow Loading	7-Day Loading	Modules of Elasticity "E"	Grading Rules[4] Agency
ASPEN						
Select Structural		1510	1735	1885	1100000	
No. 1		1080	1240	1350	1100000	
No. 2		1035	1190	1295	1000000	
No. 3	2"x4"	605	695	755	900000	
Stud		600	690	750	900000	
Construction		805	925	1005	900000	Northeastern
Standard		430	495	540	900000	Lumber
Utility		200	230	250		Manufacturers
						Association
Select Structural		1310	1505	1635	1100000	
No. 1		935	1075	1170	1100000	
No. 2	2"x6"	895	1030	1120	1000000	Northern
No. 3		525	600	655	900000	Softwood
Stud		545	630	685	900000	Lumber
						Bureau
Select Structural		1210	1390	1510	1100000	
No. 1		865	990	1080	1100000	Western
No. 2	2"x8"	830	950	1035	1000000	Wood
No. 3		485	555	605	900000	Products
						Association
Select Structural		1105	1275	1385	1100000	
No. 1		790	910	990	1100000	
No. 2	2"x10"	760	875	950	1000000	(See notes 1
No. 3		445	510	555	900000	and2)
Select Structural		1005	1155	1260	1100000	
No. 1		720	825	900	1100000	
No. 2	2"x12"	690	795	865	1000000	
No. 3		405	465	505	900000	
BEECH-BIRCH-HICKORY						
Select Structural		2500	2875	3125	1700000	
No. 1		1810	2085	2265	1600000	
No. 2		1725	1985	2155	1500000	
No. 3	2"x4"	990	1140	1240	1300000	
Stud		980	1125	1225	1300000	
Construction		1325	1520	1655	1400000	
Standard		750	860	935	1300000	
Utility		345	395	430	1200000	
Select Structural		2170	2495	2710	1700000	
No. 1		1570	1805	1960	1600000	Northeastern
No. 2	2"x6"	1495	1720	1870	1500000	Lumber
No. 3		860	990	1075	1300000	Manufacturers
Stud		890	1025	1115	1300000	Association
Select Structural		2000	2300	2500	1700000	
No. 1		1450	1665	1810	1600000	
No. 2	2"x8"	1380	1585	1725	1500000	(See notes 1
No. 3		795	915	990	1300000	and 2)
Select Structural		1835	2110	2295	1700000	
No. 1		1330	1525	1660	1600000	
No. 2	2"x10"	1265	1455	1580	1500000	
No. 3		725	835	910	1300000	
Select Structural		1670	1920	2085	1700000	
No. 1		1210	1390	1510	1600000	
No. 2	2"x12"	1150	1325	1440	1500000	
No. 3		660	760	825	1300000	

Table No. 6/7A – DESIGN VALUES FOR JOISTS AND RAFTERS–VISUAL GRADING (Continued)

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

Values for surfaced dry or surfaced green lumber apply at 19 per cent maximum moisture co in use.

Species and Grade	Size	Normal Duration	Design Value inBending "Fb" Snow Loading	7-Day Loading	Modules of Elasticity "E"	Grading Rules[4] Agency
COTTONWOOD						
Select Structural		1510	1735	1885	1200000	
No. 1		1080	1240	1350	1200000	
No. 2		1080	1240	1350	1100000	
No. 3	2"x4"	605	695	755	1000000	
Stud		600	690	750	1000000	
Construction		805	925	1005	1000000	
Standard		460	530	575	900000	
Utility		200	230	250	900000	
Select Structural		1310	1505	1635	1200000	
No. 1		935	1075	1170	1200000	Northern
No. 2	2"x6"	935	1075	1170	1100000	Softwood
No. 3		525	600	655	1000000	Lumber
Stud		545	630	685	1000000	Bureau
Select Structural		1210	1390	1510	1200000	
No. 1		865	990	1080	1200000	
No. 2	2"x8"	865	990	1080	1100000	(See notes 1
No. 3		485	555	605	1000000	and 2)
Select Structural		1105	1275	1385	1200000	
No. 1		790	910	990	1200000	
No. 2	2"x10"	790	910	990	1100000	
No. 3		445	510	555	1000000	
Select Structural		1005	1155	1260	1200000	
No. 1		720	825	900	1200000	
No. 2	2"x12"	720	825	900	1100000	
No. 3		405	465	505	1000000	
DOUGLAS FIR-LARCH						
Select Structural		2500	2875	3125	1900000	
No. 1 & Btr		1985	2280	2480	1800000	
No. 1		1725	1985	2155	1700000	
No. 2	2"x4"	1510	1735	1885	1600000	
No. 3		865	990	1080	1400000	
Stud		855	980	1065	1400000	
Construction		1150	1325	1440	1500000	
Standard		635	725	790	1400000	
Utility		315	365	395	1300000	
Select Structural		2170	2495	2710	1900000	West Coast
No. 1 & Btr		1720	1975	2150	1800000	Lumber
No. 1	2"x6"	1495	1720	1870	1700000	Inspection
No. 2		1310	1505	1635	1600000	Bureau
No. 3		750	860	935	1400000	
Stud		775	895	970	1400000	Western
Select Structural		2000	2300	2500	1900000	Wood
No. 1 & Btr		1585	1825	1985	1800000	Products
No. 1	2"x8"	1380	1585	1725	1700000	Association
No. 2		1210	1390	1510	1600000	
No. 3		690	795	865	1400000	(See notes 1
						and 2)
Select Structural		1835	2110	2295	1900000	
No. 1 & Btr		1455	1675	1820	1800000	
No. 1	2"x10"	1265	1455	1580	1700000	
No. 2		1105	1275	1385	1600000	
No. 3		635	725	790	1400000	

Table No. 6/7A – DESIGN VALUES FOR JOISTS AND RAFTERS–VISUAL GRADING (Continued)

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

Values for surfaced dry or surfaced green lumber apply at 19 per cent maximum moisture co in use.

Species and Grade	Size	Normal Duration	Design Value inBending "Fb" Snow Loading	7-Day Loading	Modules of Elasticity "E"	Grading Rules[4] Agency
Select Structural		1670	1920	2085	1900000	
No. 1 & Btr		1325	1520	1655	1800000	
No. 1	2"x12"	1150	1325	1440	1700000	
No. 2		1005	1155	1260	1600000	
No. 3		575	660	720	1400000	
DOUGLAS FIR-LARCH (NORTH)						
Select Structural		2245	2580	2805	1900000	
No. 1/No. 2		1425	1635	1780	1600000	
No. 3		820	940	1025	1400000	
Stud	2"x4"	820	945	1030	1400000	
Construction		1095	1255	1365	1500000	
Standard		605	695	755	1400000	
Utility		290	330	360	1300000	
Select Structural		1945	2235	2430	1900000	National
No. 1/No. 2	2"x6"	1235	1420	1540	1600000	Lumber
No. 3		710	815	890	1400000	Grades
Stud		750	860	935	1400000	Authority
Select Structural		1795	2065	2245	1900000	
No. 1/No.2	2"x8"	1140	1310	1425	1600000	(See notes 1
No. 3		655	755	820	1400000	and 2)
Select Structural		1645	1890	2055	1900000	
No. 1/No.2	2"x10"	1045	1200	1305	1600000	
No. 3		600	690	750	1400000	
Select Structural		1495	1720	1870	1900000	
No.1/No. 2	2"x12"	950	1090	1185	1600000	
No. 3		545	630	685	1400000	
DOUGLAS FIR-SOUTH						
Select Structural		2245	2580	2805	1400000	
No. 1		1555	1785	1940	1300000	
No. 2		1425	1635	1780	1200000	
No. 3	2"x4"	820	940	1025	1100000	
Stud		820	945	1030	1100000	
Construction		1065	1225	1330	1200000	
Standard		605	695	755	1100000	
Utility		290	330	360	1000000	
Select Structural		1945	2235	2430	1400000	
No. 1		1345	1545	1680	1300000	Western
No. 2	2"x6"	1235	1420	1540	1200000	Wood
No. 3		710	815	890	1100000	Products
Stud		750	860	935	1100000	Association
Select Structutal		1795	2065	2245	1400000	
No. 1		1240	1430	1555	1300000	
No. 2	2"x8"	1140	1310	1425	1200000	(See notes 1
No. 3		655	755	820	1100000	and 2)
Select Structural		1645	1890	2055	1400000	
No. 1		1140	1310	1425	1300000	
No. 2	2"x10"	1045	1200	1305	1200000	
No. 3		600	690	750	1100000	
Select Structural		1495	1720	1870	1400000	
No. 1		1035	1190	1295	1300000	
No. 2	2"x12"	950	1090	1185	1200000	
No. 3		545	630	685	1100000	

Table No. 6/7A – DESIGN VALUES FOR JOISTS AND RAFTERS–VISUAL GRADING (Continued)

These "Fb" Values are for use where repetative members are spaced not more than 24 inches wider spacing, the "Fb" values should be reduced 13 percent.
Values for surfaced dry or surfaced green lumber apply at 19 per cent maximum moisture co in use.

Species and Grade	Size	Normal Duration	Design Value inBending "Fb" Snow Loading	7-Day Loading	Modules of Elasticity "E"	Grading Rules[4] Agency
EASTERN HEMLOCK-TAMARACK						
Select Structural		2155	2480	2695	1200000	
No. 1		1335	1535	1670	1100000	
No. 2		990	1140	1240	1100000	
No. 3	2"x4"	605	695	755	900000	
Stud		570	655	710	900000	
Construction		775	895	970	1000000	
Standard		430	495	540	900000	
Utility		200	230	250	800000	Northeastern Lumber Manufacturers Association Northern Softwood Lumber Bureau (See notes 1 and 2)
Select Structural		1870	2150	2335	1200000	
No. 1		1160	1330	1450	1100000	
No. 2	2"x6"	860	990	1075	1100000	
No. 3		525	600	655	900000	
Stud		520	595	645	900000	
Select Structural		1725	1985	2155	1200000	
No. 1		1070	1230	1335	1100000	
No. 2	2"x8"	795	915	990	1100000	
No. 3		485	555	605	900000	
Select Structural		1580	1820	1975	1200000	
No. 1		980	1125	1225	1100000	
No. 2	2"x10"	725	835	910	1100000	
No. 3		445	510	555	900000	
Select Structural		1440	1655	1795	1200000	
No. 1		890	1025	1115	1100000	
No. 2	2"x12"	660	760	825	1100000	
No. 3		405	465	505	900000	
EASTERN SOFTWOODS						
Select Structural		2155	2480	2695	1200000	
No. 1		1335	1535	1670	1100000	
No. 2		990	1140	1240	1100000	
No. 3	2"x4"	605	695	755	900000	
Stud		570	655	710	900000	
Construction		775	895	970	1000000	
Standard		430	495	540	900000	
Utility		200	230	250	800000	Northeastern Lumber Manufacturer Association Northern Softwood Lumber Bureau (See notes 1 and 2)
Select Structural		1870	2150	2335	1200000	
No. 1		1160	1330	1450	1100000	
No. 2	2"x6"	860	990	1075	1100000	
No. 3		525	600	655	900000	
Stud		520	595	645	900000	
Select Structural		1725	1985	2155	1200000	
No. 1		1070	1230	1335	1100000	
No. 2	2"x8"	795	915	990	1100000	
No. 3		485	555	605	900000	
Select Structural		1580	1820	1975	1200000	
No. 1		980	1125	1225	1100000	
No. 2	2"x10"	725	835	910	1100000	
No. 3		445	510	555	900000	
Select Structural		1440	1655	1795	1200000	
No. 1		890	1025	1115	1100000	
No. 2	2"x12"	660	760	825	1100000	
No. 3		405	465	505	900000	

Table No. 6/7A – DESIGN VALUES FOR JOISTS AND RAFTERS–VISUAL GRADING (Continued)

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

Values for surfaced dry or surfaced green lumber apply at 19 per cent maximum moisture co in use.

Species and Grade	Size	Normal Duration	Design Value inBending "Fb" Snow Loading	7-Day Loading	Modules of Elasticity "E"	Grading Rules[4] Agency
EASTERN WHITE PINE						
Select Structural		2155	2480	2695	1200000	
No. 1		1335	1535	1670	1100000	
No. 2		990	1140	1240	1100000	
No. 3	2"x4"	605	695	755	900000	
Stud		570	655	710	900000	
Construction		775	895	970	1000000	
Standard		430	495	540	900000	
Utility		200	230	250	800000	Northeastern Lumber Manufacturers Association
Select Structural		1870	2150	2335	1200000	
No. 1		1160	1330	1450	1100000	
No. 2	2"x6"	860	990	1075	1100000	
No. 3		525	600	655	900000	Northern Softwood Lumber Bureau
Stud		520	595	645	900000	
Select Structural		1725	1985	2155	1200000	
No. 1		1070	1230	1335	1100000	
No. 2	2"x8"	795	915	990	1100000	
No. 3		485	555	605	900000	
Select Structural		1580	1820	1975	1200000	(See notes 1 and 2)
No. 1		980	1125	1225	1100000	
No. 2	2"x10"	725	835	910	1100000	
No. 3		445	510	555	900000	
Select Structural		1440	1655	1795	1200000	
No. 1		890	1025	1115	1100000	
No. 2	2"x12"	660	760	825	1100000	
No. 3		405	465	505	900000	
HEM-FIR						
Select Structural		2415	2775	3020	1600000	
No. 1 & Btr		1810	2085	2265	1500000	
No. 1		1640	1885	2050	1500000	
No. 2	2"x4"	1465	1685	1835	1300000	
No. 3		865	990	1080	1200000	
Stud		855	980	1065	1200000	
Construction		1120	1290	1400	1300000	
Standard		635	725	790	1200000	
Utility		290	330	360	1100000	
Select Structural		2095	2405	2615	1600000	West Coast Lumber Inspection Bureau
No. 1 & Btr		1570	1805	1960	1500000	
No. 1	2"x6"	1420	1635	1775	1500000	
No. 2		1270	1460	1590	1300000	
No. 3		750	860	935	1200000	
Stud		775	895	970	1200000	Western Wood Products Association
Select Structural		1930	2220	2415	1600000	
No. 1 & Btr		1450	1665	1810	1500000	
No. 1	2"x8"	1310	1510	1640	1500000	
No. 2		1175	1350	1465	1300000	
No. 3		690	795	865	1200000	(See notes 1 and 2)
Select Structural		1770	2035	2215	1600000	
No. 1 & Btr		1330	1525	1660	1500000	
No. 1	2"x10"	1200	1380	1500	1500000	
No. 2		1075	1235	1345	1300000	
No. 3		635	725	790	1200000	

Table No. 6/7A – DESIGN VALUES FOR JOISTS AND RAFTERS–VISUAL GRADING (Continued)

These "Fb" Values are for use where repetative members are spaced not more than 24 inches wider spacing, the "Fb" values should be reduced 13 percent.
Values for surfaced dry or surfaced green lumber apply at 19 per cent maximum moisture co in use.

Species and Grade	Size	Normal Duration	Design Value inBending "Fb" Snow Loading	7-Day Loading	Modules of Elasticity "E"	Grading Rules[4] Agency
Select Structural		1610	1850	2015	1600000	
No. 1 & Btr		1210	1390	1510	1500000	
No. 1	2"x12"	1095	1255	1365	1500000	
No. 2		980	1125	1220	1300000	
No. 3		575	660	720	1200000	
HEM-FIR (NORTH)						
Select Structural		2245	2580	2805	1700000	
No. 1/No.2		1725	1985	2155	1600000	
No. 3		990	1140	1240	1400000	
Stud	2"x4"	980	1125	1225	1400000	
Construction		1325	1520	1655	1500000	
Standard		720	825	900	1400000	
Utility		345	395	430	1300000	
Select Structural		1945	2235	2430	1700000	National
No. 1/No. 2	2"x6"	1495	1720	1870	1600000	Lumber
No. 3		860	990	1075	1400000	Grades
Stud		890	1025	1115	1400000	Authority
Select Structural		1795	2065	2245	1700000	
No. 1/No. 2	2"x8"	1380	1585	1725	1600000	(See note 1
No. 3		795	915	990	1400000	and 2)
Select Structural		1645	1890	2055	1700000	
No. 1/No. 2	2"x10"	1265	1455	1580	1600000	
No. 3		725	835	910	1400000	
Select Structural		1495	1720	1870	1700000	
No. 1/No. 2	2"x12"	1150	1325	1440	1600000	
No. 3		660	760	825	1400000	
MIXED MAPLE						
Select Structural		1725	1985	2155	1300000	
No. 1		1250	1440	1565	1200000	
No. 2		1210	1390	1510	1100000	
No. 3	2"x4"	690	795	865	1000000	
Stud		695	800	870	1000000	
Construction		920	1060	1150	1100000	
Standard		520	595	645	1000000	
Utility		260	300	325	900000	
Select Structural		1495	1720	1870	1300000	
No. 1		1085	1245	1355	1200000	Northeastern
No. 2	2"x6"	1045	1205	1310	1100000	Lumber
No. 3		600	690	750	1000000	Manufacturers
Stud		635	725	790	1000000	Association
Select Structural		1380	1585	1725	1300000	
No. 1		1000	1150	1250	1200000	
No. 2	2"x8"	965	1110	1210	1100000	(See notes 1
No. 3		550	635	690	1000000	and 2)
Select Structural		1265	1455	1580	1300000	
No. 1		915	1055	1145	1200000	
No. 2	2"x10"	885	1020	1105	1100000	
No. 3		505	580	635	1000000	
Select Structural		1150	1325	1440	1300000	
No. 1		835	960	1040	1200000	
No. 2	2"x12"	805	925	1005	1100000	
No. 3		460	530	575	1000000	

Table No. 6/7A – DESIGN VALUES FOR JOISTS AND RAFTERS–VISUAL GRADING (Continued)

These "Fb" Values are for use where repetative members are spaced not more than 24 inches wider spacing, the "Fb" values should be reduced 13 percent.
Values for surfaced dry or surfaced green lumber apply at 19 per cent maximum moisture co in use.

Species and Grade	Size	Normal Duration	Design Value inBending "Fb" Snow Loading	7-Day Loading	Modules of Elasticity "E"	Grading Rules[4] Agency
MIXED OAKS						
Select Structural		1985	2280	2480	1100000	
No. 1		1425	1635	1780	1000000	
No. 2		1380	1585	1725	900000	
No. 3	2"x4"	820	940	1025	800000	
Stud		790	910	990	800000	
Construction		1065	1225	1330	900000	
Standard		605	695	755	800000	
Utility		290	330	360	800000	
Select Structural		1720	1975	2150	1100000	
No. 1		1235	1420	1540	1000000	Northeastern
No. 2	2"x6"	1195	1375	1495	900000	Lumber
No. 3		710	815	890	800000	Manufacturers
Stud		720	825	900	800000	Association
Select Structural		1585	1825	1985	1100000	
No. 1		1140	1310	1425	1000000	
No. 2	2"x8"	1105	1270	1380	900000	(See notes 1
No. 3		655	755	820	800000	and 2)
Select Structural		1455	1675	1820	1100000	
No. 1		1045	1200	1305	1000000	
No. 2	2"x10"	1010	1165	1265	900000	
No. 3		600	690	750	800000	
Select Structural		1325	1520	1655	1100000	
No. 1		950	1090	1185	1000000	
No. 2	2"x12"	920	1060	1150	900000	
No. 3		545	630	685	800000	
MIXED SOUTHERN PINE						
Select Structural		2360	2710	2945	1600000	
No. 1		1670	1920	2085	1500000	
No. 2		1495	1720	1870	1400000	
No. 3	2"x4"	865	990	1080	1200000	
Stud		890	1025	1115	1200000	
Construction		1150	1325	1440	1300000	
Standard		635	725	790	1200000	
Utility		315	365	395	1100000	
Select Structural		2130	2445	2660	1600000	
No. 1		1495	1720	1870	1500000	
No. 2	2"x6"	1325	1520	1655	1400000	
No. 3		775	895	970	1200000	Southern
Stud		775	895	970	1200000	Pine
Select Structural		2015	2315	2515	1600000	Inspection
No. 1		1380	1585	1725	1500000	Bureau
No. 2	2"x8"	1210	1390	1510	1400000	
No. 3		720	825	900	1200000	(See notes 1
Select Structural		1725	1985	2155	1600000	and 2)
No. 1		1210	1390	1510	1500000	
No. 2	2"x10"	1065	1225	1330	1400000	
No. 3		605	695	755	1200000	
Select Structural		1610	1850	2015	1600000	
No. 1		1120	1290	1400	1500000	
No. 2	2"x12"	1005	1155	1260	1400000	
No. 3		575	660	720	1200000	

Table No. 6/7A – DESIGN VALUES FOR JOISTS AND RAFTERS–VISUAL GRADING (Continued)

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

Values for surfaced dry or surfaced green lumber apply at 19 per cent maximum moisture co in use.

Species and Grade	Size	Normal Duration	Design Value inBending "Fb" Snow Loading	7-Day Loading	Modules of Elasticity "E"	Grading Rules[4] Agency
NORTHERN RED OAK						
Select Structural		2415	2775	3020	1400000	
No. 1		1725	1985	2155	1400000	
No. 2		1680	1935	2100	1300000	
No. 3	2"x4"	950	1090	1185	1200000	
Stud		950	1090	1185	1200000	
Construction		1265	1455	1580	1200000	
Standard		720	825	900	1100000	
Utility		345	395	430	1000000	
Select Structural		2095	2405	2615	1400000	
No. 1		1495	1720	1870	1400000	Northeastern
No. 2	2"x6"	1460	1675	1820	1300000	Lumber
No. 3		820	945	1030	1200000	Manufacturers
Stud		865	990	1080	1200000	Association
Select Structural		1930	2220	2415	1400000	
No. 1		1380	1585	1725	1400000	
No. 2	2"x8"	1345	1545	1680	1300000	(See notes 1
No. 3		760	875	950	1200000	and 2)
Select Structural		1770	2035	2215	1400000	
No. 1		1265	1455	1580	1400000	
No. 2	2"x10"	1235	1420	1540	1300000	
No. 3		695	800	870	1200000	
Select Structural		1610	1850	2015	1400000	
No. 1		1150	1325	1440	1400000	
No. 2	2"x12"	1120	1290	1400	1300000	
No. 3		635	725	790	1200000	
NORTHERN SPECIES						
Select Structural		1640	1885	2050	1100000	
No. 1/No. 2		990	1140	1240	1100000	
No. 3		605	695	755	1000000	
Stud	2"x4"	570	655	710	1000000	
Construction		775	895	970	1000000	
Standard		430	495	540	900000	
Utility		200	230	250	900000	
Select Structural		1420	1635	1775	1100000	National
No. 1/No. 2	2"x6"	860	990	1075	1100000	Lumber
No. 3		525	600	655	1000000	Grades
Stud		520	595	645	1000000	Authority
Select Structural		1310	1510	1640	1100000	
No. 1/No. 2	2"x8"	795	915	990	1100000	(See notes 1
No. 3		485	555	605	1000000	and 2)
Select Structural		1200	1380	1500	1100000	
No. 1/No. 2	2"x10"	725	835	910	1100000	
No. 3		445	510	555	1000000	
Select Structural		1095	1255	1365	1100000	
No. 1/No. 2	2"x12"	660	760	825	1100000	
No. 3		405	465	505	1000000	

Table No. 6/7A – DESIGN VALUES FOR JOISTS AND RAFTERS–VISUAL GRADING (Continued)

These "Fb" Values are for use where repetative members are spaced not more than 24 inches wider spacing, the "Fb" values should be reduced 13 percent.
Values for surfaced dry or surfaced green lumber apply at 19 per cent maximum moisture co in use.

Species and Grade	Size	Normal Duration	Design Value inBending "Fb" Snow Loading	7-Day Loading	Modules of Elasticity "E"	Grading Rules[4] Agency
NORTHERN WHITE CEDAR						
Select Structural		1335	1535	1670	800000	
No. 1		990	1140	1240	700000	
No. 2		950	1090	1185	700000	
No. 3	2"x4"	560	645	700	600000	
Stud		540	620	670	600000	
Construction		720	825	900	700000	
Standard		405	465	505	600000	
Utility		200	230	250	600000	
Select Structural		1160	1330	1450	800000	
No. 1		860	990	1075	700000	Northeastern
No. 2	2"x6"	820	945	1030	700000	Lumber
No. 3		485	560	605	600000	Manufacturers
Stud		490	560	610	600000	Assocation
Select Structural		1070	1230	1335	800000	
No. 1		795	915	990	700000	
No. 2	2"x8"	760	875	950	700000	(See notes 1
No. 3		450	515	560	600000	and 2)
Select Structural		980	1125	1225	800000	
No. 1		725	835	910	700000	
No. 2	2"x10"	695	800	870	700000	
No. 3		410	475	515	600000	
Select Structural		890	1025	1115	800000	
No. 1		660	760	825	700000	
No. 2	2"x12"	635	725	790	700000	
No. 3		375	430	465	600000	
RED MAPLE						
Select Structural		2245	2580	2805	1700000	
No. 1		1595	1835	1995	1600000	
No. 2		1555	1785	1940	1500000	
No. 3	2"x4"	905	1040	1130	1300000	
Stud		885	1020	1105	1300000	
Construction		1210	1390	1510	1400000	
Standard		660	760	825	1300000	
Utility		315	365	395	1200000	
Select Structural		1945	2235	2430	1700000	
No. 1		1385	1590	1730	1600000	Northeastern
No. 2	2"x6"	1345	1545	1680	1500000	Lumber
No. 3		785	905	980	1300000	Manufacturers
Stud		805	925	1005	1300000	Association
Select Structural		1795	2065	2245	1700000	
No. 1		1275	1470	1595	1600000	
No. 2	2"x8"	1240	1430	1555	1500000	(See notes 1
No. 3		725	835	905	1300000	and 2)
Select Structural		1645	1890	2055	1700000	
No. 1		1170	1345	1465	1600000	
No. 2	2"x10"	1140	1310	1425	1500000	
No. 3		665	765	830	1300000	
Select Structural		1495	1720	1870	1700000	
No. 1		1065	1225	1330	1600000	
No. 2	2"x12"	1035	1190	1295	1500000	
No. 3		605	695	755	1300000	

Table No. 6/7A – DESIGN VALUES FOR JOISTS AND RAFTERS–VISUAL GRADING (Continued)

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

Values for surfaced dry or surfaced green lumber apply at 19 per cent maximum moisture co in use.

Species and Grade	Size	Normal Duration	Design Value inBending "Fb" Snow Loading	7-Day Loading	Modules of Elasticity "E"	Grading Rules[4] Agency
RED OAK						
Select Structural		1985	2280	2480	1400000	
No. 1		1425	1635	1780	1300000	
No. 2		1380	1585	1725	1200000	
No. 3	2"x4"	820	940	1025	1100000	
Stud		790	910	990	1100000	
Construction		1065	1225	1330	1200000	
Standard		605	695	755	1100000	
Utility		290	330	360	1000000	
Select Structural		1720	1975	2150	1400000	
No. 1		1235	1420	1540	1300000	Northeastern
No. 2	2"x6"	1195	1375	1495	1200000	Lumber
No. 3		710	815	890	1100000	Manufacturers
Stud		720	825	900	1100000	Association
Select Structural		1585	1825	1985	1400000	
No. 1		1140	1310	1425	1300000	
No. 2	2"x8"	1105	1270	1380	1200000	(See notes 1
No. 3		655	755	820	1100000	and 2)
Select Structural		1455	1675	1820	1400000	
No. 1		1045	1200	1305	1300000	
No. 2	2"x10"	1010	1165	1265	1200000	
No. 3		600	690	750	1100000	
Select Structural		1325	1520	1655	1400000	
No. 1		950	1090	1185	1300000	
No. 2	2"x12"	920	1060	1150	1200000	
No. 3		545	630	685	1100000	
REDWOOD						
Clear Structural		3020	3470	3775	1400000	
Select Structural		2330	2680	2910	1400000	
Select Structural, open grain		1900	2180	2370	1100000	
No. 1		1680	1935	2100	1300000	
No. 1, open grain		1335	1535	1670	1100000	
No. 2		1595	1835	1995	1200000	
No. 2, open grain	2"x4"	1250	1440	1565	1000000	
No. 3		905	1040	1130	1100000	
No. 3, open grain		735	845	915	900000	
Stud		725	835	910	900000	
Construction		950	1090	1185	900000	
Standard		520	595	645	900000	
Utility		260	300	325	800000	
Clear Structural		2615	3010	3270	1400000	
Select Structural		2020	2320	2525	1400000	
Select Structural, open grain		1645	1890	2055	1100000	
No. 1		1460	1675	1820	1300000	
No. 1, open grain		1160	1330	1450	1100000	
No. 2		1385	1590	1730	1200000	
No. 2, open grain	2"x6"	1085	1245	1335	1000000	
No. 3		785	905	980	1100000	
No. 3, open grain		635	730	795	900000	
Stud		660	760	825	900000	

Table No. 6/7A – DESIGN VALUES FOR JOISTS AND RAFTERS–VISUAL GRADING (Continued)

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

Values for surfaced dry or surfaced green lumber apply at 19 per cent maximum moisture co in use.

Species and Grade	Size	Normal Duration	Design Value inBending "Fb" Snow Loading	7-Day Loading	Modules of Elasticity "E"	Grading Rules[4] Agency
Clear Structural		2415	2775	3020	1400000	Redwood
Select Structural		1865	2140	2330	1400000	Inspection
Select Structural, open grain		1520	1745	1900	1100000	Service
No. 1		1345	1545	1680	1300000	
No. 1, open grain	2"x8"	1070	1230	1335	1100000	
No. 2		1275	1470	1595	1200000	
No. 2, open grain		1000	1150	1250	1000000	(See notes 1
No. 3		725	835	905	1100000	and 2)
No. 3, open grain		585	675	735	900000	
Clear Structural		2215	2545	2765	1400000	
Select Structural		1710	1965	2135	1400000	
Select Structural, open grain		1390	1600	1740	1100000'	
No. 1		1235	1420	1540	1300000	
No. 1, open grain	2"x10"	980	1125	1225	1100000	
No. 2		1170	1345	1465	1200000	
No. 2, open grain		915	1035	1145	1000000	
No. 3		665	765	830	1100000	
No. 3, open grain		540	620	670	900000	
Clear Structural		2015	2315	2515	1400000	
Select Structural		1555	1785	1940	1400000	
Select Structural, open grain		1265	1455	1580	1100000	
No. 1		1120	1290	1400	1300000	
No. 1, open grain	2"x12"	890	1025	1115	1100000	
No. 2		1065	1225	1330	1200000	
No. 2, open grain		835	960	1040	1000000	
No. 3		605	695	755	1100000	
No. 3, open grain		490	560	610	900000	
SOUTHERN PINE						
Dense Select Structural		3510	4035	4385	1900000	
Select Structural		3280	3770	4095	1800000	
Non-Dense Select Structural		3050	3505	3810	1700000	
No. 1 Dense		2300	2645	2875	1800000	
No. 1		2130	2445	2660	1700000	
No. 1 Non-Dense		1955	2250	2445	1600000	
No. 2 Dense	2"x4"	1955	2250	2445	1700000	
No. 2		1725	1985	2155	1600000	
No. 2 Non-Dense		1555	1785	1940	1400000	
No. 3		980	1125	1220	1400000	
Stud		1005	1155	1260	1400000	
Construction		1265	1455	1580	1500000	
Standard		720	825	900	1300000	
Utility		345	395	430	1300000	
Dense Select Structural		3105	3570	3880	1900000	
Select Structural		2935	3370	3665	1800000	
Non-Dense Select Structural		2705	3110	3380	1700000	
No. 1 Dense		2015	2315	2515	1800000	
No. 1		1900	2180	2370	1700000	
No. 1 Non-Dense	2"x6"	1725	1985	2155	1600000	
No. 2 Dense		1670	1920	2085	1700000	
No. 2		1440	1655	1795	1600000	
No. 2 Non-Dense		1325	1520	1655	1400000	
No. 3		865	990	1080	1400000	
Stud		890	1025	1115	1400000	

Table No. 6/7A – DESIGN VALUES FOR JOISTS AND RAFTERS–VISUAL GRADING (Continued)

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

Values for surfaced dry or surfaced green lumber apply at 19 per cent maximum moisture co in use.

Species and Grade	Size	Normal Duration	Design Value inBending "Fb" Snow Loading	7-Day Loading	Modules of Elasticity "E"	Grading Rules[4] Agency
Dense Select Structural		2820	3240	3520	1900000	Southern
Select Structural		2645	3040	3305	1800000	Pine
Non-Dense Select Structural		2415	2775	3020	1700000	Inspection
No 1 Dense		1900	2180	2370	1800000	Bureau
No. 1		1725	1985	2155	1700000	
No. 1 Non-Dense	2"x8"	1555	1785	1940	1600000	
No. 2 Dense		1610	1850	2015	1700000	(See notes 1
No. 2		1380	1585	1725	1600000	and 2)
No. 2 Non-Dense		1265	1455	1580	1400000	
No. 3		805	925	1005	1400000	
Dense Select Structural		2475	2845	3090	1900000	
Select Structural		2360	2710	2945	1800000	
Non-Dense Select Structural		2130	2445	2660	1700000	
No. 1 Dense		1670	1920	2085	1800000	
No. 1		1495	1720	1870	1700000	
No. 1 Non-Dense	2"x10"	1380	1585	1725	1600000	
No. 2 Dense		1380	1585	1725	1700000	
No. 2		1210	1390	1510	1600000	
No. 2 Non-Dense		1095	1255	1365	1400000	
No. 3		690	795	865	1400000	
Dense Select Structural		2360	2710	2945	1900000	
Select Structural		2185	2515	2730	1800000	
Non-Dense Select Structural		2015	2315	2515	1700000	
No. 1 Dense		1555	1785	1940	1800000	
No. 1		1440	1655	1795	1700000	
No. 1 Non-Dense	2"x12"	1325	1520	1655	1600000	
No. 2 Dense		1325	1520	1655	1700000	
No. 2		1120	1290	1400	1600000	
No. 2 Non-Dense		1035	1190	1295	1400000	
No. 3		660	760	825	1400000	
SPRUCE-PINE-FIR						
Select Structural		2155	2480	2695	1500000	
No. 1/No. 2		1510	1735	1885	1400000	
No. 3		865	990	1080	1200000	
Stud	2"x4"	855	980	1065	1200000	
Construction		1120	1290	1400	1300000	
Standard		635	725	790	1200000	
Utility		290	330	360	1100000	
Select Structural		1870	2150	2335	1500000	National
No. 1/No. 2	2"x6"	1310	1505	1635	1400000	Lumber
No. 3		750	860	935	1200000	Grades
Stud		775	895	970	1200000	Authority
Select Structural		1725	1985	2155	1500000	
No. 1/No. 2	2"x8"	1210	1390	1510	1400000	(See notes 1
No. 3		690	795	865	1200000	and 2)
Select Structural		1580	1820	1975	1500000	
No. 1/No. 2	2"x10"	1105	1275	1385	1400000	
No. 3		635	725	790	1200000	
Select Structural		1440	1655	1795	1500000	
No. 1/No. 2	2"x12"	1005	1155	1260	1400000	
No. 3		575	660	720	1200000	

Table No. 6/7A – DESIGN VALUES FOR JOISTS AND RAFTERS–VISUAL GRADING (Continued)

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

Values for surfaced dry or surfaced green lumber apply at 19 per cent maximum moisture co in use.

Species and Grade	Size	Normal Duration	Design Value inBending "Fb" Snow Loading	7-Day Loading	Modules of Elasticity "E"	Grading Rules[4] Agency
SPRUCE-PINE-FIR (SOUTH)						
Select Structural		2245	2580	2805	1300000	
No. 1		1465	1685	1835	1200000	
No. 2		1295	1490	1615	1100000	
No. 3	2"x4"	735	845	915	1000000	Northeastern
Stud		725	835	910	1000000	Lumber
Construction		980	1125	1220	1000000	Manufacturers
Standard		545	630	685	900000	Association
Utility		260	300	325	900000	
Select Structural		1945	2235	2430	1300000	Northern
No. 1		1270	1460	1590	1200000	Softwood
No. 2	2"x6"	1120	1290	1400	1100000	Lumber
No. 3		635	730	795	1000000	Bureau
Stud		660	760	825	1000000	
Select Structural		1795	2065	2245	1300000	West Coast
No. 1		1175	1350	1465	1200000	Lumber
No. 2	2"x8"	1035	1190	1295	1100000	Inspection
No. 3		585	675	735	1000000	Bureau
Select Structural		1645	1890	2055	1300000	Western
No. 1		1075	1235	1345	1200000	Wood
No. 2	2"x10"	950	1090	1185	1100000	Products
No. 3		540	620	670	1000000	Association
Select Structural		1495	1720	1870	1300000	(See notes 1
No. 1		980	1125	1220	1200000	and 2)
No. 2	2"x12"	865	990	1080	1100000	
No. 3		490	560	610	1000000	
WESTERN CEDARS						
Select Structural		1725	1985	2155	1100000	
No. 1		1250	1440	1565	1000000	
No. 2		1210	1390	1510	1000000	
No. 3	2"x4"	690	795	865	900000	
Stud		695	800	870	900000	
Construction		920	1060	1150	900000	
Standard		520	595	645	800000	
Utility		260	300	325	800000	
Select Structural		1495	1720	1870	1100000	West Coast
No. 1		1085	1245	1355	1000000	Lumber
No. 2	2"x6"	1045	1205	1310	1000000	Inspection
No. 3		600	690	750	900000	Bureau
Stud		635	725	790	900000	
Select Structural		1380	1585	1725	1100000	Western
No. 1		1000	1150	1250	1000000	Wood
No. 2	2"x8"	965	1110	1210	1000000	Products
No. 3		550	635	690	900000	Association
Select Structural		1265	1455	1580	1100000	(See notes 1
No. 1		915	1055	1145	1000000	and 2)
No. 2	2"x10"	885	1020	1105	1000000	
No. 3		505	580	635	900000	
Select Structural		1150	1325	1440	1100000	
No. 1		835	960	1040	1000000	
No. 2	2"x12"	805	925	1005	1000000	
No. 3		460	530	575	900000	

Table No. 6/7A – DESIGN VALUES FOR JOISTS AND RAFTERS–VISUAL GRADING (Continued)

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

Values for surfaced dry or surfaced green lumber apply at 19 per cent maximum moisture co in use.

Species and Grade	Size	Normal Duration	Design Value inBending "Fb" Snow Loading	7-Day Loading	Modules of Elasticity "E"	Grading Rules[4] Agency
WESTERN WOODS						
Select Structural		1510	1735	1885	1200000	
No. 1		1120	1290	1400	1100000	
No. 2		1120	1290	1400	1000000	
No. 3	2"x4"	645	745	810	900000	
Stud		635	725	790	900000	
Construction		835	960	1040	1000000	
Standard		460	530	575	900000	
Utility		230	265	290	800000	
Select Structural		1310	1505	1635	1200000	West Coast
No. 1		970	1120	1215	1100000	Lumber
No. 2	2"x6"	970	1120	1215	1000000	Inspection
No. 3		560	645	700	900000	Bureau
Stud		575	660	720	900000	
Select Structural		1210	1390	1510	1200000	Western
No. 1		895	1030	1120	1100000	Wood
No. 2	2"x8"	895	1030	1120	1000000	Products
No. 3		520	595	645	900000	Association
Select Structural		1105	1275	1385	1200000	(See notes 1
No. 1		820	945	1030	1100000	and 2)
No. 2	2"x10"	820	945	1030	1000000	
No. 3		475	545	594	900000	
Select Structural		1005	1155	1260	1200000	
No. 1		750	860	935	1100000	
No. 2	2"x12"	750	860	935	1000000	
No. 3		430	495	540	900000	
WHITE OAK						
Select Structural		2070	2380	2590	1100000	
No. 1		1510	1735	1885	1000000	
No. 2		1465	1685	1835	900000	
No. 3	2"x4"	820	940	1025	800000	
Stud		820	945	1030	800000	
Construction		1095	1255	1365	900000	
Standard		605	695	755	800000	
Utility		290	330	360	800000	
Select Structural		1795	2065	2245	1100000	
No. 1		1310	1505	1635	1000000	Northeastern
No. 2	2"x6"	1270	1460	1590	900000	Lumber
No. 3		710	815	890	800000	Manufacturers
Stud		750	860	935	800000	Association
Select Structural		1655	1905	2070	1100000	
No. 1		1210	1390	1510	1000000	
No. 2	2"x8"	1175	1350	1465	900000	(See notes 1
No. 3		655	755	820	800000	and 2)
Select Structural		1520	1745	1900	1100000	
No. 1		1105	1275	1385	1000000	
No. 2	2"x10"	1075	1235	1345	900000	
No. 3		600	690	750	800000	
Select Structural		1380	1585	1725	1100000	
No. 1		1005	1155	1260	1000000	
No. 2	2"x12"	980	1125	1220	900000	
No. 3		545	630	685	800000	

Table No. 6/7A – DESIGN VALUES FOR JOISTS AND RAFTERS–VISUAL GRADING (Continued)

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

Values for surfaced dry or surfaced green lumber apply at 19 per cent maximum moisture co in use.

Species and Grade	Size	Normal Duration	Design Value inBending "Fb" Snow Loading	7-Day Loading	Modules of Elasticity "E"	Grading Rules[4] Agency
YELLOW POPLAR						
Select Structural		1725	1985	2155	1500000	
No. 1		1250	1440	1565	1400000	
No. 2		1210	1390	1510	1300000	
No. 3	2"x4"	690	795	865	1200000	
Stud		695	800	870	1200000	
Construction		920	1060	1150	1300000	
Standard		520	595	645	1100000	
Utility		230	265	290	1100000	
Select Structural		1495	1720	1870	1500000	
No. 1		1085	1245	1355	1400000	Northern
No. 2	2"x6"	1045	1205	1310	1300000	Softwood
No. 3		600	690	750	1200000	Lumber
Stud		635	725	790	1200000	Bureau
Select Structural		1380	1585	1725	1500000	
No. 1		1000	1150	1250	1400000	
No. 2	2"x8"	965	1110	1210	1300000	(See notes 1
No. 3		550	635	690	1200000	and 2)
Select Structural		1265	1455	1580	1500000	
No. 1		915	1055	1145	1400000	
No. 2	2"x10"	885	1020	1105	1300000	
No. 3		505	580	635	1200000	
Select Structural		1150	1325	1440	1500000	
No. 1		835	960	1040	1400000	
No. 2	2"x12"	805	925	1005	1300000	
No. 3		460	530	575	1200000	

Table No. 6/7B—DESIGN VALUES FOR JOISTS AND RAFTERS—MACHINE STRESS RATED

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

Values apply at 19 percent maximum moisture content in use.

Grade Designation	Grading Rules Agency (see footnotes 1,2,3,4)	Size Classification	Design Value in Bending "F_b"			Modulus of Elasticity "E"
			Normal Duration	Snow Loading	7-Day Loading	
900f-1.0E	3,4	Machine rated lumber, 2x4 and wider	1050	1210	1310	1,000,000
1200f-1.2E	1,2,3,4		1400	1610	1750	1,200,000
1350f-1.3E	2,4		1550	1780	1940	1,300,000
1450f-1.3E	1,3,4		1650	1900	2060	1,300,000
1500f-1.3E	2		1750	2010	2190	1,300,000
1500f-1.4E	1,2,3,4		1750	2010	2190	1,400,000
1650f-1.4E	2		1900	2190	2370	1,400,000
1650f-1.5E	1,2,3,4		1900	2180	2380	1,500,000
1800f-1.6E	1,2,3,4		2050	2360	2560	1,600,000
1950f-1.5E	2		2250	2590	2810	1,500,000
1950f-1.7E	1,2,4		2250	2590	2810	1,700,000
2100f-1.8E	1,2,3,4		2400	2760	3000	1,800,000
2250f-1.6E	2		2600	2990	3250	1,600,000
2250f-1.9E	1,2,4		2600	2990	3250	1,900,000
2400f-1.7E	2		2750	3160	3440	1,700,000
2400f-2.0E	1,2,3,4		2750	3160	3440	2,000,000
2550f-2.1E	1,2,4		2950	3390	3690	2,100,000
2700f-2.2E	1,2,3,4		3100	3570	3880	2,200,000
2850f-2.3E	2		3300	3800	4130	2,300,000
3000f-2.4E	1,2		3450	3970	4310	2,400,000
3150f-2.5E	2		3600	4140	4500	2,500,000
3300f-2.6E	2		3800	4370	4750	2,600,000
900f-1.0E	1,2,3	See footnotes	1050	1210	1310	1,000,000
900f-1.2E	1,2,3		1050	1210	1310	1,200,000
1200f-1.5E	1,2,3		1400	1610	1750	1,500,000
1350f-1.8E	1,2		1550	1780	1940	1,800,000
1500f-1.8E	3		1750	2010	2190	1,800,000
1800f-2.1E	1,2,3		2050	2360	2560	2,100,000

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 Manufacturers Association (NELMA) 272 Tuttle Road, P.O. Box 87A, Cumberland Center, Maine 04021	NELMA, NLGA, NSCB, 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, Novato, California 94949	RIS, WCLIB, WWPA
Southern Pine Inspection Bureau (SPIB) 4709 Scenic Highway, Pensacola, Florida 32504	SPIB, WWPA, WCLIB, 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
National Lumber Grades Authority (NLGA) 260-1055 W. Hastings Street, Vancouver, B.C., Canada V6E 2E9	NLGA
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 NELMA, NSLB, NLGA
Alberta Forest Products Association	NLGA
Canadian Lumbermen's Association	NLGA
Cariboo Lumber Manufacturers Association	NLGA, NELMA
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

Appendix C
WOOD DECKS

1. A deck is an exposed exterior wood floor structure which may be attached to the structure or freestanding. Roofed porches (open or screened-in) may be constructed using these provisions.
   Computer deck design program printouts may be accepted by the Code Enforcement Official.

2. Support posts shall be supported by a footing.

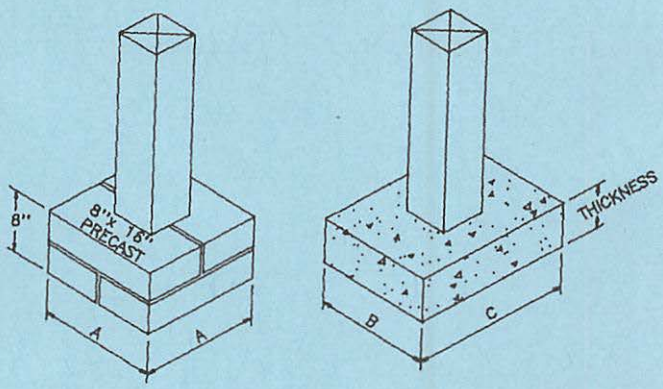


FIGURE C-1

FOOTING CHART

SIZE (inches)		TRIBUTARY AREA	THICKNESS (inches)	
A x A	B x C	(square feet)	Precast	Cast-in-place
8 x 16	8 x 16	36	4	6
12 x 12	12 x 12	40	4	6
16 x 16	16 x 16	70	8	8
	16 x 24	100		8
	24 x 24	150		8

3. When attached to a structure, the structure to which attached shall have a treated wood band for the length of the deck, or metal flashing shall be used to prevent moisture from coming in contact with the untreated framing of the structure. The deck band and the structure band shall be constructed in contact with each other except on brick veneer structures and where plywood sheathing is required and properly flashed. Siding shall not be installed between the structure and the deck band. If attached to a brick veneer structure, neither flashing nor a treated band for the brick structure is required. In addition, the treated deck band shall be constructed in contact with the brick veneer.
4. When the deck is supported at the structure by attaching the deck to the structure, the following attachment schedules shall apply for attaching the deck band to the structure.

A. **All Structures Except Brick Veneer Structures:**

Fasteners	8' Max Joist Span	16' Max Joist Span
5/8" Hot Dipped Galv. Bolts with Washers*	1 @ 3' 6" o.c.	1 @ 1' 8" o.c.
and	**and**	**and**
12d Common Hot Dipped Galv. Nails**	2 @ 8" o.c.	3 @ 6" o.c.

*Minimum edge distance for bolts is 2 1/2 inches.
**Nails must penetrate the supporting structure band a minimum of 1 1/2 inches.

B. **Brick Veneer Structures:**

Fasteners	8' Max Joist Span	16' Max Joist Span
5/8" Hot Dipped Galv. Bolts*	1 @ 2' 4" o.c.	1 @ 1' 4" o.c.

*Minimum edge distance for bolts is 2 1/2 inches.

C. **Masonry Ledge Support:**
If the deck band is supported by a minimum of 1/2 inch masonry ledge along the foundation wall. 5/8 inch hot dipped galvanized bolts with washers spaced at 48 inches o.c. may be used for support.

D. Other means of support such as joist hangers may be connected to treated house band and properly flashed.

5. Girders shall bear directly on posts or be connected to the side of posts with 2 @ 5/8 inch hot dipped galvanized bolts.

6. Floor decking shall be No. 2 grade treated Southern Pine or equivalent. The minimum floor decking thickness shall be as follows:

Joist Spacing	Decking (Nominal)
12" o.c.	1" S4S
16" o.c.	1" T & G
24" o.c.	1 1/4" S4S
32" o.c.	2" S4S

7. Maximum Height of Deck Support Posts as follows:

Post Size*	Unbraced Max. Post Height**
4 x 4	8' -0"
6 x 6	20" -0"
***	over 20' -0"

* This table is based on No. 2 treated Southern Pine posts. Maximum tributary area is based on 128 total square feet which may be located at different levels.
** From top of footing to bottom of girder.
*** Decks with post heights over 20'-0" shall be designed and sealed by a Professional Engineer or Registered Architect.

8. Decks shall be braced to provide lateral stability by one of the following methods:

A. When the deck floor height is less than 4'-0" and the deck is attached to the structure in accordance with Section (4) above, lateral bracing is not required.

B. 4x4 wood knee braces may be provided on each column in both directions. The knee braces shall attach to each post at a point not less than 1/3 of the post length from the top of the post, and the braces shall be angled between 45° and 60° from the horizontal. Knee braces shall be bolted to the post and the girder with one 5/8 inch hot dipped galvanized bolt at each end of the brace.

C. For freestanding decks without knee braces or diagonal bracing, lateral stability may be provided by embedding the posts in accordance with the following:

Post Size	Max. Tributary Area	Max Post Height	Embedment Depth	Concrete Diameter
4x4	48 SF	4'-0"	2'-6"	1'-0"
6x6	120SF	6'-0"	3'-6"	1'-8"

D. 2 X 6 diagonal vertical cross bracing may be provided in two perpendicular directions for freestanding decks or parallel to the structure at the exterior column line for attached decks. The 2 X 6's shall be attached to the posts with one 5/8" hot dipped galvanized bolt at each end of each bracing member.

E. For embedment of piles in Coastal Regions, see Chapter 27.

(Remove pages 377-386)

Appendix D
ENGINEERED PROCEDURE FOR SIZING PLUMBING VENTS

Table Nos. D.1, D.2, and D.3 provide an engineered method for sizing vents. Use of these tables and Figure Nos. D.1 through D.6 shall require a formal plan review prior to installation.

In most residential applications, individual fixtures or small fixture groups may be vented by a ½-, ¾- or 1-inch pipe. Under these conditions, the general rule is to increase a branch vent one size larger than the largest fixture vent served.

A more detailed procedure for sizing branch vents is required where larger fixture vents are required or where more than three fixture vents connect to a branch vent, using the following formula and internal cross-sectional areas listed in Table No. D.2.

$$A_B = \sqrt{A_L} \times \Sigma A_V$$

WHERE:

A_B = Area of branch vent
A_L = Area of largest vent served
A_V = Area of all other vents served

Table No. D.1
MINIMUM SIZE FOR DRY VENTS

Venting Application	Load Served (d.f.u)	Vent Size[1] (In.)
Individual fixture vent (single trap only)	3.9 or less	½
	4.0 or more	¾
Common vent, waste stack vent or wet vent extension	3.9 or less	¾
	4.0 to 6.9	1
	7.0 to 15.9	1¼
Soil stack vent	6.9 or less	1
	7.0 to 15.9	1¼
	16.0 to 30.0	1½
Vent stack	10.9 or less	1¼
	11.0 to 30.0	1½

(Continued)

Table No. D.1 (Continued)
MINIMUM SIZE FOR DRY VENTS

Venting Application	Number of fixture vents served	Pipe sizes larger than largest fixture vent served
Branch vent	Two	One
	Three (largest = ¾ in.)	One
	Three (largest = 1 in. or more)	Usually one[2]
	Four or more	Compute size[3]

[1] Increase one nominal pipe size if:
a. Vent length exceeds 30 feet.
b. If effluent from trap arm falls more than one story before being diverted into a horizontal drain pipe.

[2] Up to two 1-inch, plus ½- or ¾-inch fixture vents require branch vent to be one pipe size larger. Other combinations with fixture vents larger than 1-inch may require branch vent to be two pipe sizes larger. See Table No. D.3, Combinations of Three-Fixture Vents Requiring Two-Pipe-Size Increase in Branch Vent

[3] Compute pipe size using Table No. D.2, Internal Cross-Sectional Areas of Various Nominal Sizes of Pipes, and formula given above Table No. D.1.

Table No. D.2
INTERNAL CROSS-SECTIONAL AREAS OF VARIOUS NOMINAL SIZES OF PIPE

NOMINAL PIPE SIZE, (In.)	INTERNAL CROSS-SECTIONAL AREAS*		
	SCHEDULE 40 PIPE METALLIC OR NONMETALLIC (Sq. In.)	COPPER TUBE	
		Type M (Sq. In.)	Type DWV (Sq. In.)
½	0.304	0.254	———
¾	0.533	0.517	———
1	0.864	0.874	———
1¼	1.495	———	1.317
1½	2.036	———	1.865
2	3.355	———	3.272
3	7.393	———	7.235

*Areas for other piping materials and wall thickness may be obtained or calculated from the respective ASTM standards or the manufacturer's specifications.

Table No. D.3 lists combinations of three-fixture vents that include larger sizes requiring a two-pipe-size increase in a branch vent, based on the above design procedure.

Table No. D.3
COMBINATIONS OF THREE-FIXTURE VENTS REQUIRING TWO-PIPE-SIZE INCREASE IN BRANCH VENT

SIZES OF THE THREE-FIXTURE VENTS SERVED BY BRANCH VENT (Inches)			BRANCH VENT SIZE REQUIRED (Inches)
Largest	Intermediate	Smallest	
1	1	1	1 1/2
1 1/4	1	3/4	2
1 1/4	1	1	2
1 1/4	1 1/4	3/4	2
1 1/4	1 1/4	1	2
1 1/4	1 1/4	1 1/4	2
1 1/2	1 1/2	1 1/4	3
1 1/2	1 1/2	1 1/2	3

Figure No. D.1
TYPICAL SINGLE-BATH WET-VENT ARRANGEMENTS

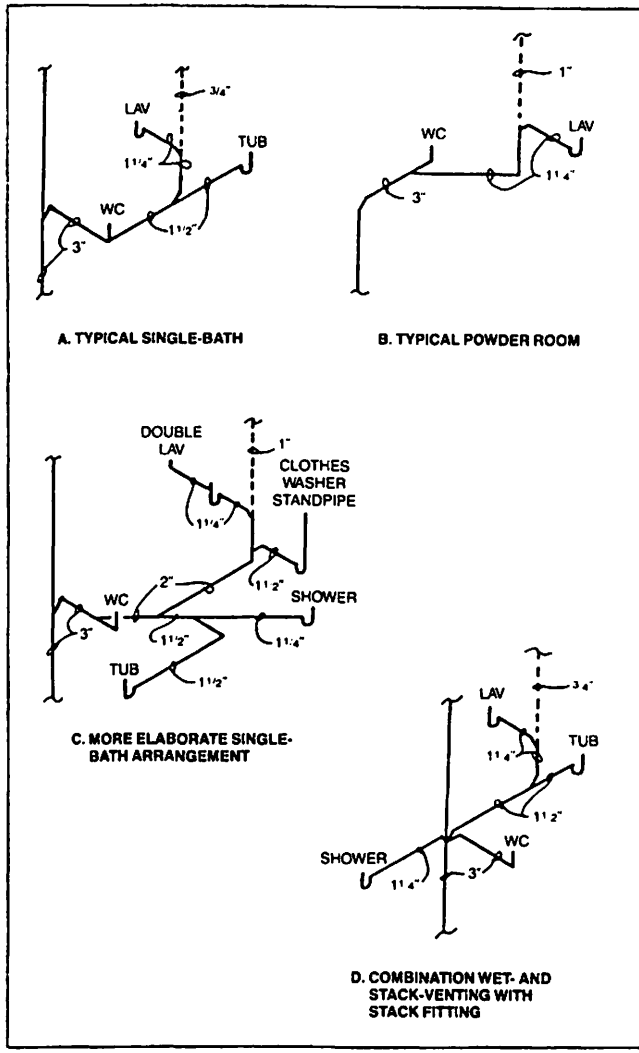


Figure No. D.2
TYPICAL DOUBLE-BATH WET-VENT ARRANGEMENTS

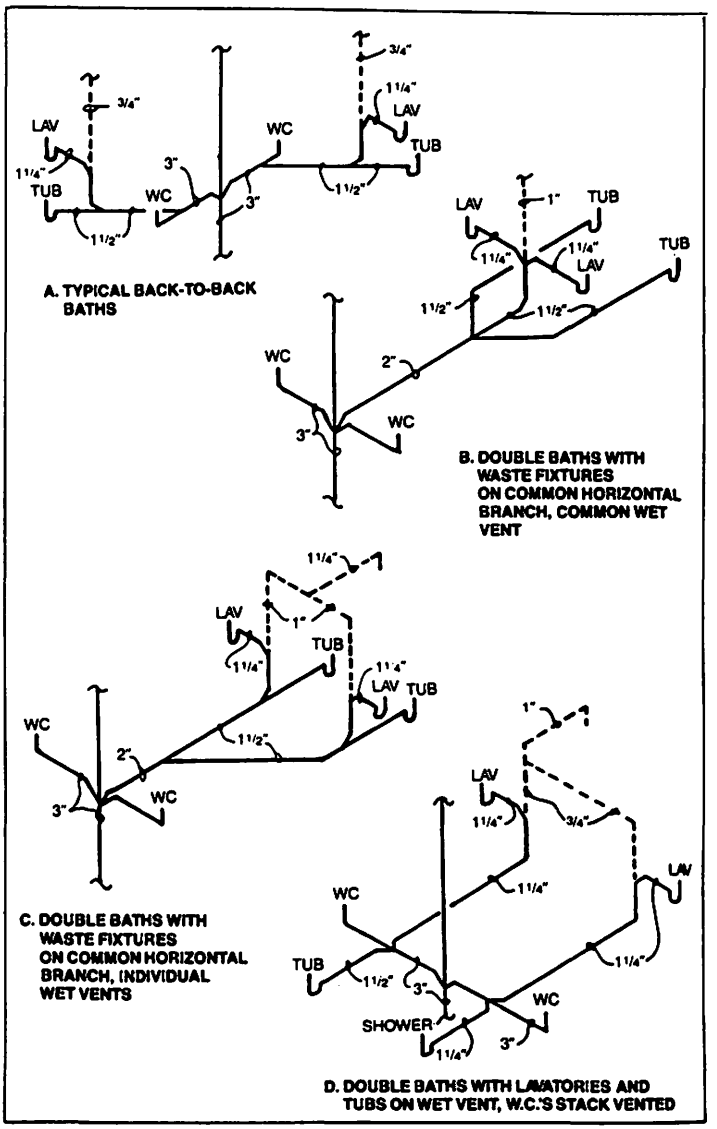


Figure No. D.3
WASTE STACK SERVING AS WET VENT FOR LAUNDRY GROUP

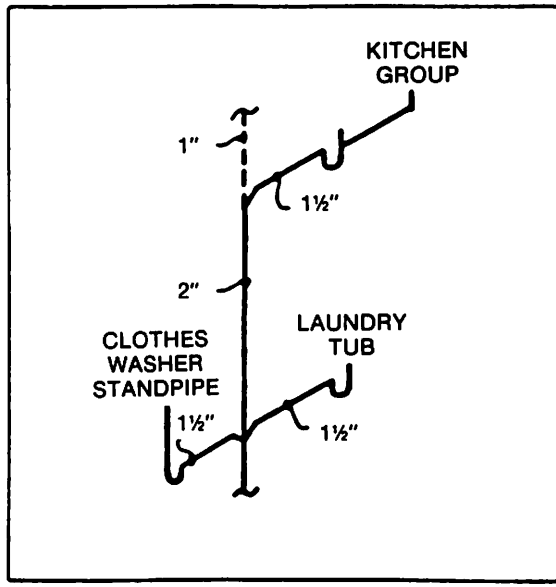
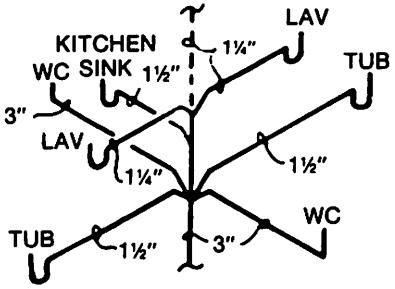
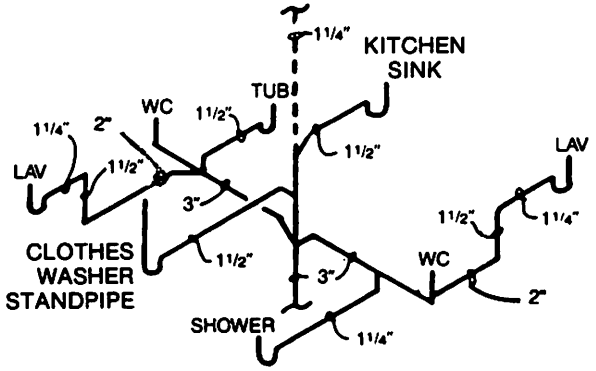


Figure No. D.4
TYPICAL METHODS OF CONNECTING FIXTURE DRAINS TO STACK IN STACK-VENTED SYSTEMS



A. WASTE FIXTURES CONNECTED DIRECTLY TO STACK



B. WASTE FIXTURES CONNECTED TO WATER CLOSET HORIZONTAL BRANCH

Figure No. D.5
TYPICAL UNIFORMLY SIZED HORIZONTAL BRANCH SYSTEM

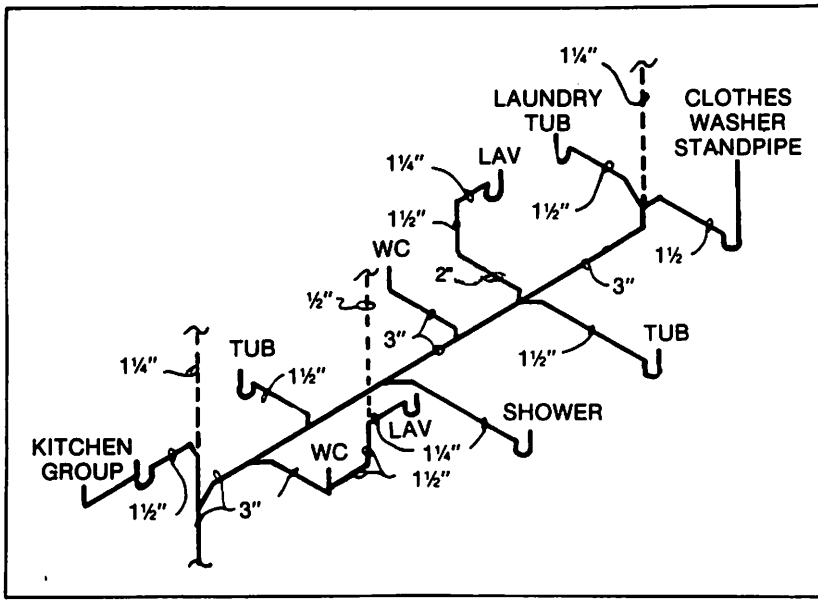
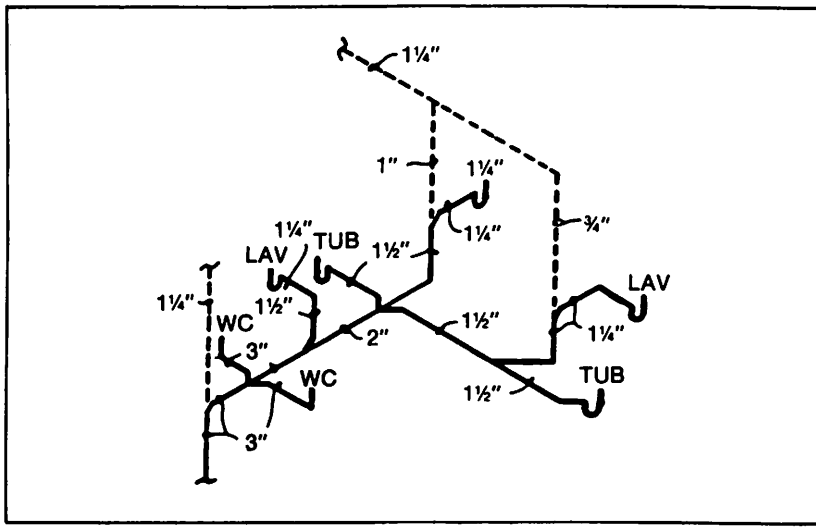


Figure No. D.6
TYPICAL HORIZONTAL BRANCH SYSTEM REDUCING IN SIZE UTILIZING WET VENTING



Appendix E
DETAILED PROCEDURE FOR SIZING THE BUILDING WATER SUPPLY SYSTEM

E.1—Introduction.

This appendix presents a detailed engineering method that may be used for sizing water-service and distribution piping in single-family homes. It complements Chapter 24 of this code, which presents a simplified method based on velocity limitation that may be used where available water-supply pressures are at least 40 psi and the elevation of the highest fixture above the service valve does not exceed 25 feet.

The detailed method presented herein provides greater precision than the simplified method and can be used for determining pipe sizes for any given supply pressure where nonwater-conserving or unusual fixtures will be installed, or in any other case where an engineered design is required.

Preliminary data that should be obtained and recorded are as follows:

1. Piping materials to be used for the water-service pipe and distribution piping, and related standards.

2. Corrosivity and scale-forming tendency of the water supply.

3. Maximum and minimum pressures in the public main or in a private well-water supply system.

4. Developed length of the service pipe from the public main to the building service valve, and the developed length of the longest run of piping from the service valve to the highest and most distant water outlet on the system.

5. Relative elevations of points where the water-service pipe connects to the public main, or building service valve, and of each floor on which plumbing fixtures and appliances are to be installed.

6. Minimum flow pressure required at highest water outlets (deemed to be 8 psi for common plumbing fixtures, and as recommended by manufacturers of plumbing appliances).

E.2—Uniform Friction Drop Method of Pipe Sizing.

This detailed method may be used for buildings of any height and for any available pressure. It may also be used for reference or verification purposes when reviewing a design performed in accordance with the simplified velocity limitation method presented in Chapter 24. In the event a larger size is calculated by the uniform friction drop method than by the velocity limitation method, the larger size should be selected for design. In applying the uniform friction drop method, the following steps are recommended:

a. A detailed and accurate schematic of the water-supply system should be prepared of a sufficiently large size to permit the recording of certain preliminary data, as indicated in E.1, together with the detailed results obtained from the calculations described in this section. The results obtained in each step should be marked on the schematic at the appropriate locations.

b. Calculate the equivalent length of the basic design circuit (BDC*), identify the

*The basic design circuit (BDC) is the longest run of piping from the water source to the highest and most remote fixture or water outlet on the system. In most systems, the BDC may be assumed to consist, first, of the cold-water supply piping extending from the source to the water heater, and then the hot-water supply piping extending from the water heater to the highest and most remote hot-water outlet on the system (terminal fixture).

BDC on the system schematic and determine total equivalent length, including water-service pipe and appropriate distribution piping to the highest and most remote fixture on the BDC. For the purposes of this determination, it may be sufficient to assume that the equivalent length to be added for valves and fittings will be 50 percent of the developed length of the circuit.

For a more accurate allowance of equivalent length for valves and fittings, see Tables Nos. E.1 (a) and E.1 (b). In order to apply such data, it is necessary first to estimate the size appropriate to the pipe element in which the fitting or valve is to be installed. This estimate may also be obtained by means of the velocity limitation sizing procedure, described in Chapter 24.

After obtaining the equivalent length corresponding to all valves and fittings in the BDC as described above, this sum is added to the developed length of the BDC. The result is the total equivalent length of the BDC. This value is essential to an accurate determination of the friction loss design factor (see Item d below).

c. Calculate the pressure available for overcoming friction. The minimum static pressure at the main or other source is reduced by elevation rise up to and within the building and also by pressure losses produced by flow through certain equipment, e.g., a water meter, and by flow through fixture branches. Also, a residual or "flow pressure" must be provided at the terminal fixture while the water is flowing at the predicted demand rate.

Where equipment such as a water meter, water softener, check valve or instantaneous or tankless water heater is provided in the basic design circuit, the friction loss in such equipment corresponding to the demand for the pipe element in which it is to be installed should be determined from the manufacturer or other reliable source. The friction loss in such equipment corresponding to the appropriate demand should be deducted from the minimum static pressure at the source in determining the pressure available for overcoming friction. Figure No. E.1 may be used to obtain estimates of friction losses in water meters. The curves in Figure No. E.1 are based on the assumption that pressure loss is proportional to the square of the flow rate.

In summary, calculate pressure available for overcoming friction by subtracting from the minimum static pressure, in psi, at the main or other source, the sum of Items Nos. 1, 2, 3 and 4 below:

1. Required minimum flow pressure at the terminal fixture of the basic design circuit. In most residential systems using tank-type water closets, a minimum flow pressure of 8 psi may be assumed at the terminal fixture.

2. Friction loss, in psi, due to flow through fixture-supply branches. For this purpose, a value of 5 psi may be assumed.

3. Elevation head loss, in psi, from main or other source up to terminal fixture. This is calculated as the product of the elevation difference, in feet, times the factor 0.433 psi per foot.

4. The sum of friction losses, in psi, caused by certain equipment which is to be installed in the basic design circuit, as described above. The most common source of such losses is the water meter. The appropriate value may be obtained from Figure No. E.1.

d. Calculate the friction loss design factor, Δp, psi/100 feet, for the basic design circuit. This is obtained by dividing the pressure available for friction (see Item c above) by the total equivalent length of the basic design circuit (see Item b above) and multiplying the result by 100:

$$\Delta p = \frac{\text{psi available for friction}}{\text{total equivalent length}} \times 100$$

This factor must be computed as a prerequisite to sizing the hot and cold building mains, as well as the primary branches and risers (see Item g below).

e. Determine the total fixture unit load and equivalent demand flow rate for the service pipe, the hot and cold building mains, and each primary branch and riser. See Table No. E.2 and Figure No. E.2 (or Table No. P-2406.3 in Chapter 24).

f. Size the service pipe by the use of the appropriate table in Table Nos. E.3 (a) through E.3 (f). Enter the appropriate table with the service pipe demand rate obtained in Item e above, the pressure available for friction as obtained in Item c above and the total equivalent legnth of the basic design circuit obtained in Item b above. Values may be interpolated. The size for the service pipe obtained in this way should be the smallest size which will furnish the required flow rate for the given equivalent length and available pressure.

As an alternate approach, Table No. E.4 may be used to size the service pipe.

g. Size each hot and cold building main, as well as each primary branch and riser, by the use of Table No. E.4. Enter the portion of the table for the appropriate piping material with the appropriate demand rate obtained in Item e above and the friction loss design factor, Δp, obtained in Item d above. The size for each pipe element obtained in this way should be the smallest size which will furnish the required flow rate for the given friction loss design factor.

As an alternate approach, the water-distribution system may be sized from Table Nos. E.3 (a) through E.3 (f).

Table No. E.1 (a)
ALLOWANCE IN EQUIVALENT LENGTH FOR FRICTION LOSS IN VALVES AND FITTINGS*
(Streamline Connections, Soldered, Brazed or Solvent Cemented)

FITTING OR VALVE	EQUIVALENT FEET OF TUBE FOR VARIOUS SIZES (In.)					
	1/4	3/8	1/2	3/4	1	1 1/4
Coupling	0.2	0.2	0.5	0.5	0.5	0.5
45° Elbow	0.2	0.3	0.5	0.5	1.0	1.0
90° Elbow	0.4	0.5	0.5	1.0	1.0	2.0
Tee, run	0.2	0.2	0.5	0.5	0.5	0.5
Tee, branch	0.6	0.8	1.0	2.0	3.0	4.0
Compression stop	5.0	8.0	13.0	—	—	—
Globe valve	4.0	4.0	8.0	10.0	12.0	18.0
Gate valve	0.1	0.1	0.2	0.3	0.4	0.5

*From "Copper Tube Handbook," 404-0 (1980), by Copper Development Association Inc.

In the absence of specific recommendation from the manufacturer, listed values may be applied also to CPVC plasic piping using solvent-cemented fittings, and five times the listed values may be applied to plastic piping systems using insert-type fittings.

Table No. E.1 (b)
ALLOWANCE IN EQUIVALENT LENGTH FOR FRICTION LOSS IN VALVES AND FITTINGS* (Threaded, Galvanized Steel, Brass or Copper, Standard Wall Schedule 40)

FITTING OR VALVE	EQUIVALENT FEET OF TUBE FOR VARIOUS SIZES (In.)					
	1/4	3/8	1/2	3/4	1	1 1/4
Coupling	0.2	0.4	0.6	0.8	0.9	1.2
45° Elbow	0.5	1.0	1.2	1.5	1.8	2.4
90° Elbow	0.8	1.5	2.0	2.5	3.0	4.0
Tee, run	0.2	0.4	0.6	0.8	0.9	1.2
Tee, branch	1.2	2.0	3.0	4.0	5.0	6.0
Compression stop	5.0	8.0	13.0	—	—	—
Globe valve	6.0	10.0	15.0	20.0	25.0	35.0
Gate valve	0.3	0.3	0.4	0.5	0.6	0.8

*From *National Standard Plumbing Code*, 1983, by National Association of Plumbing-Heating-Cooling Contractors, Inc., for sizes 1/2 through 1 1/4 inch. Values for 1/4 and 1/8 inch are extrapolated.

Table No. E.2
WATER-SUPPLY FIXTURE-UNIT VALUES FOR VARIOUS PLUMBING FIXTURES AND FIXTURE GROUPS

TYPE OF FIXTURE OR GROUP OF FIXTURES	WATER-SUPPLY FIXTURE-UNIT VALUE (w.s.f.u.)		
	Hot	Cold	Combined
Bathtub (with/without overhead shower head)	1.0	1.0	1.4
Clothes washer	1.0	1.0	1.4
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 (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:			
1½ baths	2.0	3.3	4.4
2 baths	2.6	3.9	5.2
2½ baths	2.8	4.2	5.6
3 baths	3.2	4.7	6.3
3½ baths	3.4	5.1	6.8
Additional ½ bath if part of group	.3	.6	.8

*The fixture-unit value 2.5 assumes a flow demand of 2.5 gpm, such as for an individual lawn sprinkler device. If a hose bibb/sill cock will be required to furnish a greater flow rate, the equivalent fixture-unit value may be obtained from Figure No. E.1.

Table No. E.3 (a)
MAXIMUM FLOW RATES, *Q*, WHICH YIELD VELOCITIES NOT EXCEEDING 8 fps AT INDICATED AVAILABLE PRESSURES COPPER WATER TUBE, TYPE K (ASTM B 88) WATER-SERVICE PIPE

NOMINAL PIPE SIZE, IN.	EQUIVALENT LENGTH OF LINE, FT.[1]							
	10	20	40	60	80	100	150	200
	FLOW RATE, GPM[2]							
Pressure Available for Friction[3] - 5 psi								
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

(Continued)

Table No. E.3 (a)—(Continued)

NOMINAL PIPE SIZE, IN.	EQUIVALENT LENGTH OF LINE, FT.[1]							
	10	20	40	60	80	100	150	200
	FLOW RATE, GPM[2]							
Pressure Available for Friction[3] - 50 psi								
3/4	←							10.9
1	←							19.4
1 1/4	←							30.3
Pressure Available for Friction[3] - 60 psi								
3/4	←							10.9
1	←							19.4
1 1/4	←							30.3
Pressure Available for Friction[3] - 70 psi								
3/4	←							10.9
1	←							19.4
1 1/4	←							30.3

[1]Developed length of primary circuit plus equivalent length of fittings.

[2]Values may be interpolated according to length.

[3]Minimum static pressure at source minus pressure drop due to elevation, minus pressure drop due to water meter and certain other equipment in BDC, minus minimum allowable flow pressure at highest and most remote fixture.

NOTE: Limiting flow rates corresponding to a velocity of 8 fps. See Table No. E.4 for hydraulic formula.

Table No. E.3 (b)
MAXIMUM FLOW RATES, *Q*, WHICH YIELD VELOCITIES NOT EXCEEDING 8 fps AT INDICATED AVAILABLE PRESSURES COPPER WATER TUBE, TYPE L (ASTM B 88) WATER-SERVICE PIPE

NOMINAL PIPE SIZE, IN.	EQUIVALENT LENGTH OF LINE, FT.[1]							
	10	20	40	60	80	100	150	200
	FLOW RATE, GPM[2]							
Pressure Available for Friction[3] - 5 psi								
3/4	←	12.1	9.6	7.7	6.6	5.8	4.6	4.0
1	←	20.6	19.5	15.7	13.3	11.6	9.5	8.1
1 1/4	←		31.3	27.3	23.5	20.2	16.6	14.2
Pressure Available for Friction[3] - 10 psi								
3/4	←		12.1	11.2	9.6	8.4	6.8	5.8
1	←			20.6	19.5	17.1	14.0	11.6
1 1/4	←				31.3	29.1	24.2	20.2
Pressure Available for Friction[3] - 15 psi								
3/4	←				12.1	10.7	8.4	7.3
1	←					20.6	17.1	14.8
1 1/4	←					31.3	29.1	26.0
Pressure Available for Friction[3] - 20 psi								
3/4	←					12.1	10.7	8.4
1	←					20.6	20.1	17.1
1 1/4	←						31.3	29.1
Pressure Available for Friction[3] - 25 psi								
3/4	←					12.1	11.2	9.6
1	←						20.6	19.5
1 1/4	←							31.3
Pressure Available for Friction[3] - 30 psi								
3/4	←						12.1	10.7
1	←							20.6
1 1/4	←							31.3
Pressure Available for Friction[3] - 35 psi								
3/4	←						12.1	11.5
1	←							20.6
1 1/4	←							31.3
Pressure Available for Friction[3] - 40 psi								
3/4	←							12.1
1	←							20.6
1 1/4	←							31.3
Pressure Available for Friction[3] - 45 psi								
3/4	←							12.1
1	←							20.6
1 1/4	←							31.3

(Continued)

Table No. E.3 (b)—(Continued)

NOMINAL PIPE SIZE, IN.	EQUIVALENT LENGTH OF LINE, FT.[1]							
	10	20	40	60	80	100	150	200
	FLOW RATE, GPM[2]							
Pressure Available for Friction[3] - 50 psi								
3/4	←							12.1
1	←							20.6
1 1/4	←							31.3
Pressure Available for Friction[3] - 60 psi								
3/4	←							12.1
1	←							20.6
1 1/4	←							31.3
Pressure Available for Friction[3] - 70 psi								
3/4	←							12.1
1	←							20.6
1 1/4	←							31.3

[1]Developed length of primary circuit plus equivalent length of fittings.

[2]Values may be interpolated according to length.

[3]Minimum static pressure at source minus pressure drop due to elevation, minus pressure drop due to water meter and certain other equipment in BDC, minus minimum allowable flow pressure at highest and most remote fixture.

NOTE: Limiting flow rates corresponding to a velocity of 8 fps. See Table No. E.4 for hydraulic formula.

Table No. E.3 (c)
MAXIMUM FLOW RATES, *Q*, WHICH YIELD VELOCITIES NOT EXCEEDING 8 fps AT INDICATED AVAILABLE PRESSURES COPPER WATER TUBE, TYPE M (ASTM B 88) WATER-SERVICE PIPE

NOMINAL PIPE SIZE, IN.	EQUIVALENT LENGTH OF LINE, FT.[1]							
	10	20	40	60	80	100	150	200
	FLOW RATE, GPM[2]							
Pressure Available for Friction[3] - 5 psi								
3/4	←	12.9	10.4	8.2	7.1	6.3	5.0	4.2
1	←	21.8	20.8	16.6	19.1	12.5	10.0	8.5
1 1/4	←		32.6	28.5	24.1	21.3	17.1	14.6
Pressure Available for Friction[3] - 10 psi								
3/4	←		12.9	12.2	10.4	9.2	7.4	6.3
1	←			21.8	20.8	18.4	14.7	12.5
1 1/4	←				32.6	30.7	25.1	21.4
Pressure Available for Friction[3] - 15 psi								
3/4	←				12.9	11.5	9.2	7.8
1	←					21.8	18.4	15.7
1 1/4	←					32.6	31.5	27.0
Pressure Available for Friction[3] - 20 psi								
3/4	←					12.9	10.8	9.2
1	←					21.8	21.6	18.4
1 1/4	←						32.6	30.7
Pressure Available for Friction[3] - 25 psi								
3/4	←					12.9	12.2	10.4
1	←						21.8	20.8
1 1/4	←							32.6
Pressure Available for Friction[3] - 30 psi								
3/4	←						12.9	11.5
1	←							21.8
1 1/4	←							32.6
Pressure Available for Friction[3] - 35 psi								
3/4	←						12.9	12.5
1	←							21.8
1 1/4	←							32.6
Pressure Available for Friction[3] - 40 psi								
3/4	←							12.9
1	←							21.8
1 1/4	←							32.6
Pressure Available for Friction[3] - 45 psi								
3/4	←							12.9
1	←							21.8
1 1/4	←							32.6

(Continued)

Table No. E.3 (c)—Continued)

NOMINAL PIPE SIZE, IN.	EQUIVALENT LENGTH OF LINE, FT.[1]							
	10	20	40	60	80	100	150	200
	FLOW RATE, GPM[2]							
Pressure Available for Friction[3] - 50 psi								
3/4	←							12.9
1	←							21.8
1 1/4	←							32.6
Pressure Available for Friction[3] - 60 psi								
3/4	←							12.9
1	←							21.8
1 1/4	←							32.6
Pressure Available for Friction[3] - 70 psi								
3/4	←							12.9
1	←							21.8
1 1/4	←							32.6

[1]Developed length of primary circuit plus equivalent length of fittings.

[2]Values may be interpolated according to length.

[3]Minimum static pressure at source minus pressure drop due to elevation, minus pressure drop due to water meter and certain other equipment in BDC, minus minimum allowable flow pressure at highest and most remote fixture.

NOTE: Limiting flow rates corresponding to a velocity of 8 fps. See Table No. E.4 for hydraulic formula.

Table No. E.3 (d)
MAXIMUM FLOW RATES, *Q*, WHICH YIELD VELOCITIES NOT EXCEEDING 10 fps AT INDICATED AVAILABLE PRESSURES STEEL PIPE, STANDARD WALL SCHEDULE 40 (ASTM A 120/A 53) WATER-SERVICE PIPE

NOMINAL PIPE SIZE, IN.	EQUIVALENT LENGTH OF LINE, FT.[1]							
	10	20	40	60	80	100	150	200
	FLOW RATE, GPM[2]							
Pressure Available for Friction[3] - 5 psi								
3/4	16.6	16.2	11.1	8.7	7.5	6.7	5.4	4.6
1	←	26.9	21.0	16.7	14.3	12.7	10.1	8.6
1 1/4	←	46.6	42.5	34.0	29.0	25.8	20.8	17.8
Pressure Available for Friction[3] - 10 psi								
3/4	←	16.6	16.2	12.9	11.1	9.8	7.8	6.7
1	←		26.9	24.3	21.0	18.4	15.0	12.7
1 1/4	←			46.6	42.5	37.5	30.2	25.8
Pressure Available for Friction[3] - 15 psi								
3/4	←			16.6	13.7	12.2	9.8	8.3
1	←			26.9	26.0	23.1	18.4	15.8
1 1/4	←					46.6	37.5	32.2
Pressure Available for Friction[3] - 20 psi								
3/4	←			16.6	16.1	14.2	11.3	9.8
1	←					26.9	21.7	18.4
1 1/4	←					46.6	44.0	37.5
Pressure Available for Friction[3] - 25 psi								
3/4	←				16.6	16.1	13.0	11.1
1	←					26.9	24.5	21.0
1 1/4	←						46.6	42.5
Pressure Available for Friction[3] - 30 psi								
3/4	←					16.6	14.2	12.2
1	←						26.9	23.1
1 1/4	←							46.6
Pressure Available for Friction[3] - 35 psi								
3/4	←					16.6	15.6	13.2
1	←						26.9	25.0
1 1/4	←							46.6
Pressure Available for Friction[3] - 40 psi								
3/4	←						16.6	14.3
1	←							26.9
1 1/4	←							46.6
Pressure Available for Friction[3] - 45 psi								
3/4	←						16.6	15.2
1	←							26.9
1 1/4	←							46.6

(Continued)

Table No. E.3 (d)

NOMINAL PIPE SIZE, IN.	EQUIVALENT LENGTH OF LINE, FT.[1]							
	10	20	40	60	80	100	150	200
	FLOW RATE, GPM[2]							
Pressure Available for Friction[3] - 50 psi								
3/4	←						16.6	16.2
1	←							26.9
1 1/4	←							46.6
Pressure Available for Friction[3] - 60 psi								
3/4	←							16.6
1	←							26.9
1 1/4	←							46.6
Pressure Available for Friction[3] - 70 psi								
3/4	←							16.6
1	←							26.9
1 1/4	←							46.6

[1]Developed length of primary circuit plus equivalent length of fittings.

[2]Values may be interpolated according to length.

[3]Minimum static pressure at source minus pressure drop due to elevation, minus pressure drop due to water meter and certain other equipment in BDC, minus minimum allowable flow pressure at highest and most remote fixture.

NOTE: Limiting flow rates corresponding to a velocity of 10 fps. See Table No. E.4 for hydraulic formula.

Table No. E.3 (e)
MAXIMUM FLOW RATES, *Q*, WHICH YIELD VELOCITIES NOT EXCEEDING 12 fps AT INDICATED AVAILABLE PRESSURES POLYETHYLENE PE SCHEDULE 40 PIPE (ASTM D 2447) CHLORINATED POLYVINYL CHLORIDE CPVC SCHEDULE 40 PIPE (ASTM F 441) WATER-SERVICE PIPE

NOMINAL PIPE SIZE, IN.	EQUIVALENT LENGTH OF LINE, FT.[1]							
	10	20	40	60	80	100	150	200
	FLOW RATE, GPM[2]							
Pressure Available for Friction[3] - 5 psi								
3/4	←	20.0	11.1	8.7	7.5	6.7	5.4	4.6
1	←	32.2	21.0	16.7	14.3	12.7	10.1	8.6
1 1/4	←	56.0	42.5	34.0	29.0	25.8	20.8	17.8
Pressure Available for Friction[3] - 10 psi								
3/4	←	20.0	16.2	12.9	11.1	9.8	7.8	6.7
1	←	32.2	30.5	24.3	21.0	18.4	15.0	12.7
1 1/4	←		56.0	50.0	42.5	37.5	30.2	25.8
Pressure Available for Friction[3] - 15 psi								
3/4	←		20.0	16.2	13.7	12.2	9.8	8.3
1	←		32.2	30.5	26.0	23.1	18.4	15.8
1 1/4	←			56.0	53.0	47.0	37.5	32.2
Pressure Available for Friction[3] - 20 psi								
3/4	←		20.0	18.8	16.1	14.2	11.3	9.8
1	←			32.2	30.6	27.0	21.7	18.4
1 1/4	←				56.0	55.0	44.0	37.5
Pressure Available for Friction[3] - 25 psi								
3/4	←			20.0	18.3	16.1	13.0	11.1
1	←				32.2	30.4	24.5	21.0
1 1/4	←					56.0	50.0	42.5
Pressure Available for Friction[3] - 30 psi								
3/4	←				20.0	17.8	14.2	12.2
1	←					32.2	27.0	23.1
1 1/4	←					56.0	55.0	47.0
Pressure Available for Friction[3] - 35 psi								
3/4	←				20.0	19.5	15.6	13.2
1	←					32.2	29.5	25.0
1 1/4	←						56.0	51.0
Pressure Available for Friction[3] - 40 psi								
3/4	←					20.0	16.7	14.3
1	←					32.2	31.8	27.2
1 1/4	←						56.0	55.0
Pressure Available for Friction[3] - 45 psi								
3/4	←					20.0	17.8	15.2
1	←						32.2	29.0
1 1/4	←							56.0

(Continued)

Table No. E.3 (e)—(Continued)

NOMINAL PIPE SIZE, IN.	EQUIVALENT LENGTH OF LINE, FT.1							
	10	20	40	60	80	100	150	200
	FLOW RATE, GPM2							
Pressure Available for Friction[3] - 50 psi								
3/4	←					20.0	18.1	16.1
1	←						32.2	30.5
1 1/4	←							56.0
Pressure Available for Friction[3] - 60 psi								
3/4	←						20.0	18.1
1	←							32.2
1 1/4	←							56.0
Pressure Available for Friction[3] - 70 psi								
3/4	←						20.0	19.5
1	←							32.2
1 1/4	←							56.0

[1]Developed length of primary circuit plus equivalent length of fittings.

[2]Values may be interpolated according to length.

[3]Minimum static pressure at source minus pressure drop due to elevation, minus pressure drop due to water meter and certain other equipment in BDC, minus minimum allowable flow pressure at highest and most remote fixture.

NOTE: Limiting flow rates corresponding to a velocity of 12 fps. See Table No. E.4 for hydraulic formula.

Table No. E.3 (f)
MAXIMUM FLOW RATES, *Q*, WHICH YIELD VELOCITIES NOT EXCEEDING 12 fps AT INDICATED AVAILABLE PRESSURES POLYETHYLENE PB SDR 11 TUBING (ASTM D 3309) CHLORINATED POLYVINYL CHLORIDE CPVC SDR 11 TUBING (ASTM D 2846) WATER-SERVICE PIPE

NOMINAL PIPE SIZE, IN.	EQUIVALENT LENGTH OF LINE, FT.[1]							
	10	20	40	60	80	100	150	200
	FLOW RATE, GPM[2]							
Pressure Available for Friction[3] - 5 psi								
3/4	15.0	11.0	7.6	6.0	5.2	4.6	3.6	3.1
1	24.9	21.3	14.6	11.7	10.0	8.8	7.1	6.1
1 1/4	37.2	36.0	24.8	19.8	17.0	15.0	12.0	10.3
Pressure Available for Friction[3] - 10 psi								
3/4	←	15.0	11.0	8.8	7.6	6.7	5.4	4.6
1	←	24.9	21.3	17.1	14.6	13.0	10.3	8.9
1 1/4	←	37.2	36.0	29.0	24.8	22.0	17.5	15.0
Pressure Available for Friction[3] - 15 psi								
3/4	←	←	15.0	11.0	9.4	8.3	6.7	5.7
1	←	←	24.9	21.3	18.2	16.1	13.0	11.1
1 1/4	←	←	37.2	36.0	31.0	27.5	22.0	18.7
Pressure Available for Friction[3] - 20 psi								
3/4	←	←	15.0	12.9	11.0	9.7	7.7	6.7
1	←	←	←	24.9	21.3	19.0	15.1	13.0
1 1/4	←	←	←	37.2	36.0	32.0	25.7	22.0
Pressure Available for Friction[3] - 25 psi								
3/4	←	←	15.0	14.5	12.3	11.0	8.8	7.6
1	←	←	←	24.9	24.1	21.3	17.1	14.6
1 1/4	←	←	←	←	37.2	36.0	29.0	24.8
Pressure Available for Friction[3] - 30 psi								
3/4	←	←	←	15.0	13.2	12.2	9.7	8.3
1	←	←	←	←	24.9	23.6	19.0	16.1
1 1/4	←	←	←	←	←	37.2	32.0	27.5
Pressure Available for Friction[3] - 35 psi								
3/4	←	←	←	←	15.0	13.2	10.6	9.1
1	←	←	←	←	←	24.9	20.6	17.6
1 1/4	←	←	←	←	←	37.2	35.0	29.6
Pressure Available for Friction[3] - 40 psi								
3/4	←	←	←	←	←	15.0	11.3	9.7
1	←	←	←	←	←	24.9	22.2	19.0
1 1/4	←	←	←	←	←	←	37.2	32.0
Pressure Available for Friction[3] - 45 psi								
3/4	←	←	←	←	←	15.0	12.2	10.4
1	←	←	←	←	←	24.9	23.6	20.2
1 1/4	←	←	←	←	←	←	37.2	34.2

(Continued)

Table No. E.3 (f)—(Continued)

NOMINAL PIPE SIZE, IN.	EQUIVALENT LENGTH OF LINE, FT.[1]							
	10	20	40	60	80	100	150	200
	FLOW RATE, GPM[2]							
Pressure Available for Friction[3] - 50 psi								
3/4	←					15.0	12.9	11.0
1	←						24.9	21.3
1 1/4	←						37.2	36.0
Pressure Available for Friction[3] - 60 psi								
3/4	←					15.0	14.3	12.2
1	←						24.9	23.7
1 1/4	←							37.2
Pressure Available for Friction[3] - 70 psi								
3/4	←						15.0	13.3
1	←							24.9
1 1/4	←							37.2

[1]Developed length of primary circuit plus equivalent length of fittings.

[2]Values may be interpolated according to length.

[3]Minimum static pressure at source minus pressure drop due to elevation, minus pressure drop due to water meter and certain other equipment in BDC, minus minimum allowable flow pressure at highest and most remote fixture.

NOTE: Limiting flow rates corresponding to a velocity of 12 fps. See Table No. E.4 for hydraulic formula.

Table No. E.4
MAXIMUM FLOW RATES,[1] *Q*, FOR VARIOUS PIPING MATERIALS WHICH YIELD FRICTION LOSSES NOT EXCEEDING INDICATED VALUES AT VELOCITIES NOT EXCEEDING MAXIMUM RECOMMENDED VALUES[2] IN HOT AND COLD BUILDING MAINS, PRIMARY BRANCHES, AND RISERS OF THE WATER-DISTRIBUTION SYSTEM

NOMINAL PIPE SIZE, IN.	FRICTION LOSS DESIGN FACTOR, HEAD IN LBS. PER SQ. IN. PER 100 FT. OF LENGTH, Δp													
	2	3	4	5	10	15	20	30	40	50	60	70	80	100
	FLOW RATE, GPM[3]													
Copper Water Tube—Type K, ASTM B 88														
1/2	1.2	1.5	1.8	2.0	3.0	3.7	4.3							5.4
3/4	3.1	3.9	4.5	5.1	7.5	9.4								10.9
1	6.6	8.2	9.7	10.9	15.9									19.4
1 1/4	12.0	15.0	17.4	19.8	20.8									30.3
Copper Water Tube—Type L, ASTM B 88														
1/2	1.4	1.7	2.0	2.3	3.3	4.1	4.8							5.8
3/4	3.6	4.4	4.6	5.8	8.4	10.7								12.1
1	7.2	8.9	10.4	11.6	17.1									20.6
1 1/4	12.6	15.8	18.3	20.2	29.1									31.3
Copper Water Tube—Type M, ASTM B 88														
1/2	1.3	1.9	2.2	2.5	3.7	4.6	5.4							6.3
3/4	3.9	4.8	5.6	6.3	9.2	11.5								12.9
1	7.7	9.7	11.3	12.5	18.4									21.8
1 1/4	13.2	16.3	19.0	21.3	30.7									32.6
Steel Pipe—Standard Wall Schedule 40, ASTM A 120/A53														
1/2	1.9	2.4	2.8	3.2	4.7	5.9	6.8	8.5						9.4
3/4	4.1	5.0	5.9	6.7	9.8	12.2	14.2							16.6
1	7.7	9.5	11.2	12.7	18.4	23.1								26.9
1 1/4	15.6	19.5	22.7	25.8	37.5									46.6

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

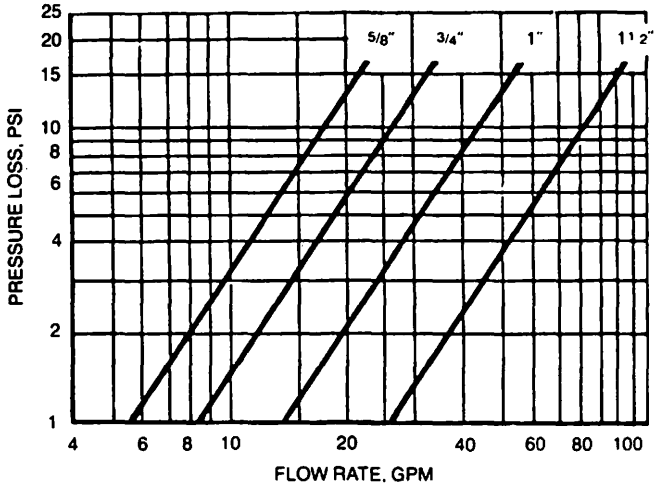
[1]Flow rates calculated for "Fairly Smooth Condition."

[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]$Q = 4.57\ \Delta p^{.0546}\ D^{2.64}$, where:

Q is in gpm.
Δp is in psi/100 feet.
D is in inches, I.D.

Figure No. E.1
PRESSURE LOSS IN COLD-WATER METERS, DISPLACEMENT TYPE (AWWA C700-77)



NOTE: Curves based on the assumption that pressure loss is proportional to the square of the flow rate.

Figure No. E.2
DEMAND FLOW RATE AS A FUNCTION OF FIXTURE-UNIT LOAD

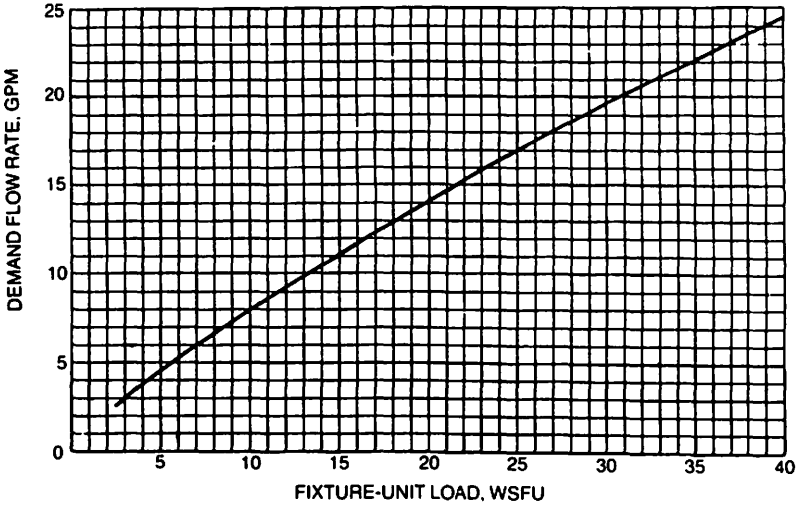


Figure No. E.3 (a)
PRESSURE LOSS (FRICTION) AS A FUNCTION OF FLOW-RATE MATERIAL: COPPER WATER TUBE—TYPE K, ASTM B 88

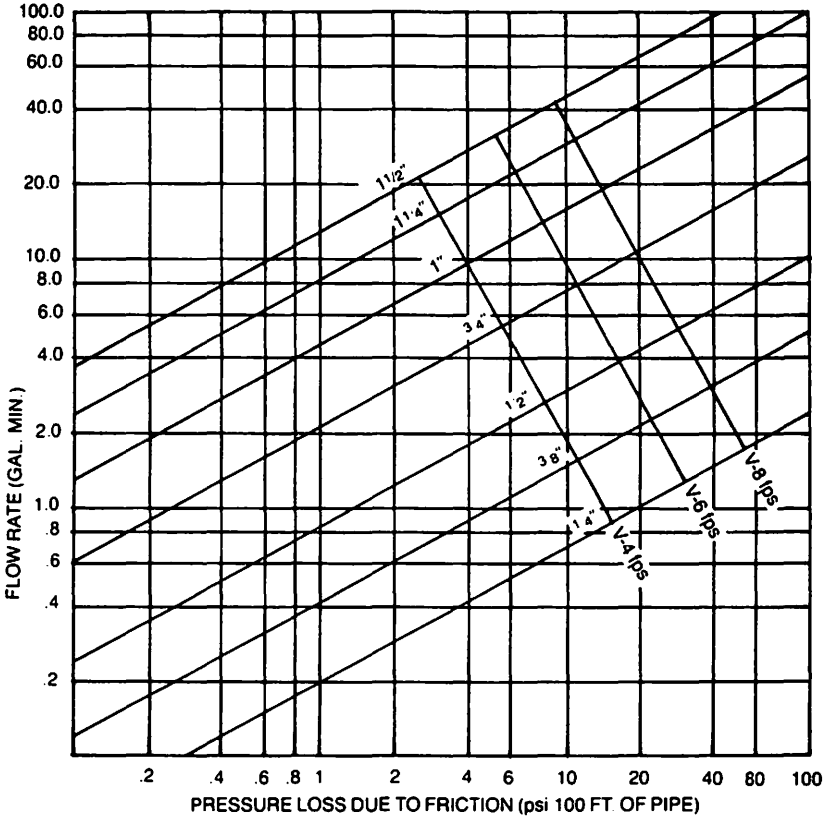


Figure No. E.3. (b)
PRESSURE LOSS (FRICTION) AS A FUNCTION OF FLOW-RATE MATERIAL: COPPER WATER TUBE—TYPE L, ASTM B 88

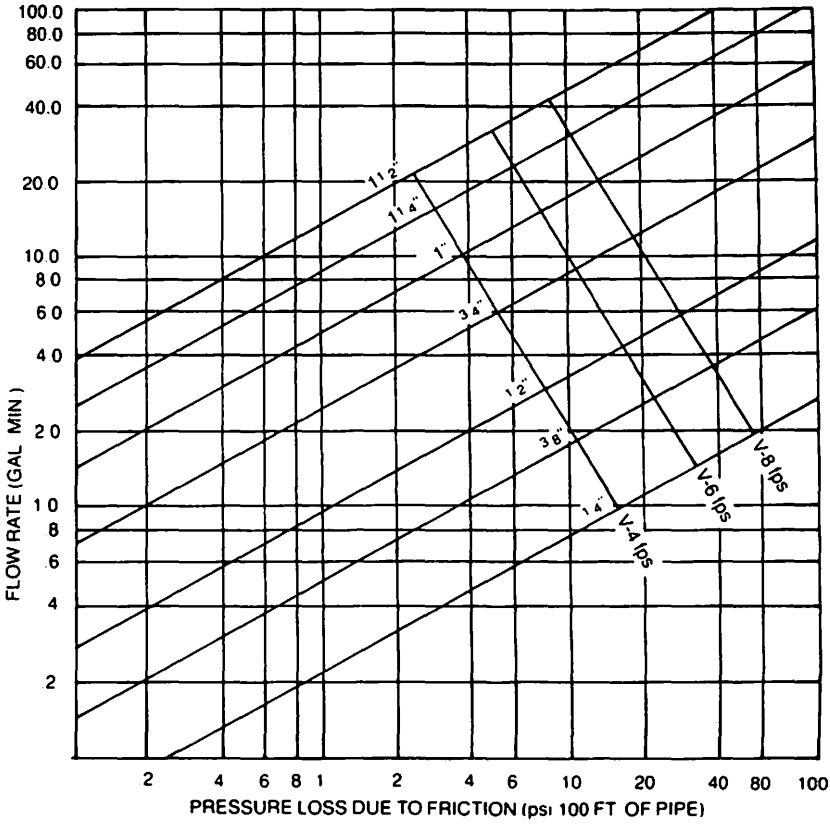


Figure No. E.3. (c)
PRESSURE LOSS (FRICTION) AS A FUNCTION OF FLOW-RATE MATERIAL: COPPER WATER TUBE—TYPE M, ASTM B 88

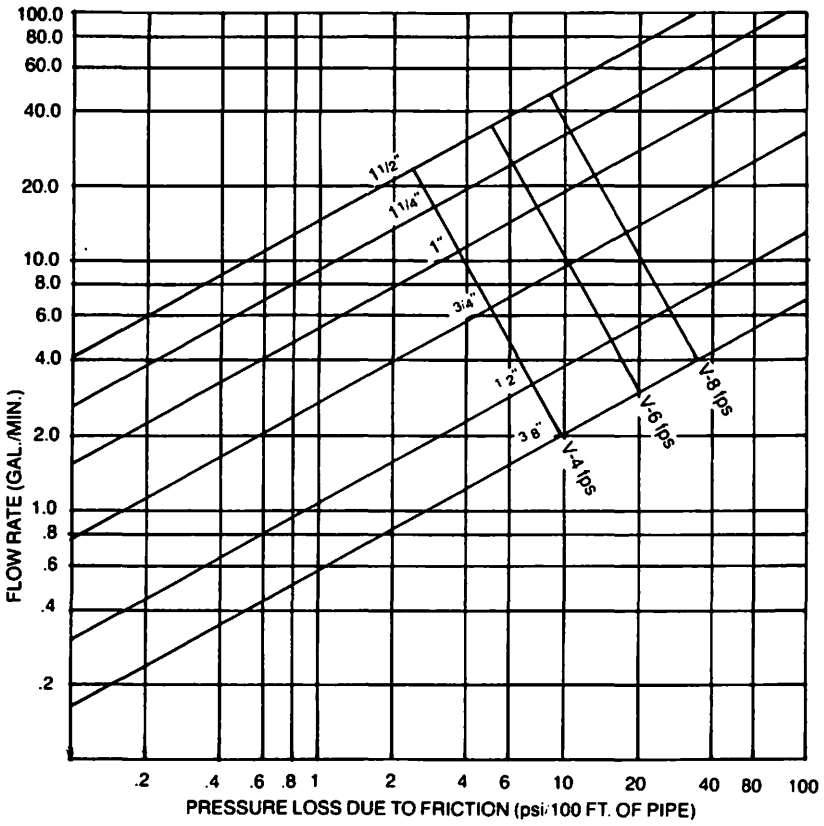


Figure No. E.3. (d)
PRESSURE LOSS (FRICTION) AS A FUNCTION OF FLOW-RATE MATERIAL: STEEL STANDARD WEIGHT PIPE ASTM A 120/A 53

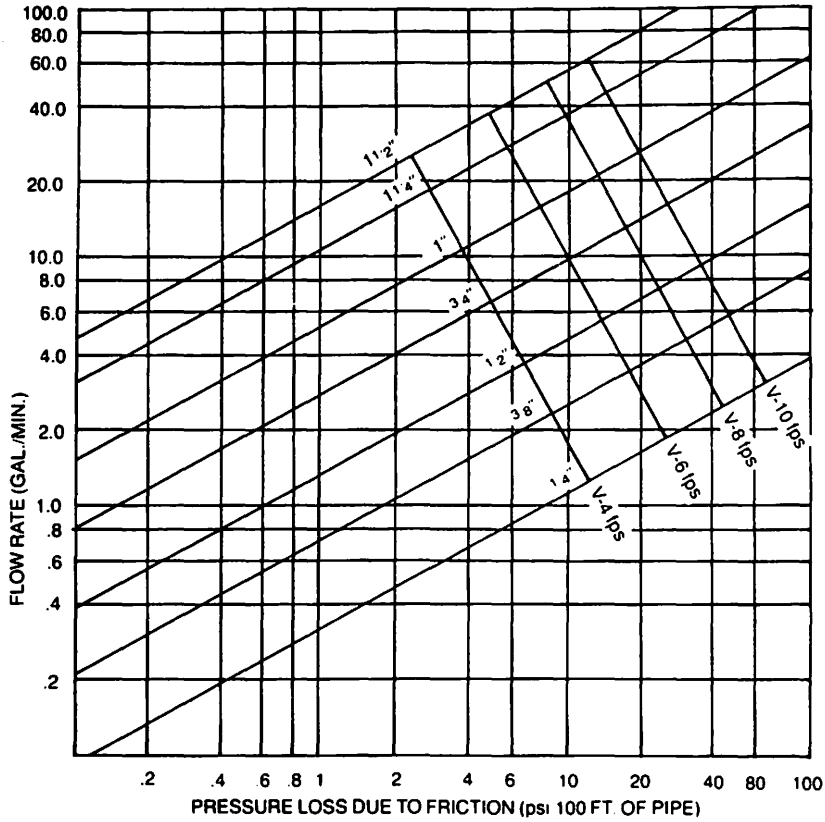


Figure No. E.3. (e)
PRESSURE LOSS (FRICTION) AS A FUNCTION OF FLOW-RATE MATERIAL: CPVC PIPE, SCHEDULE 40, ASTM F 441 OR PE PIPE, SCHEDULE 40, ASTM D 2447

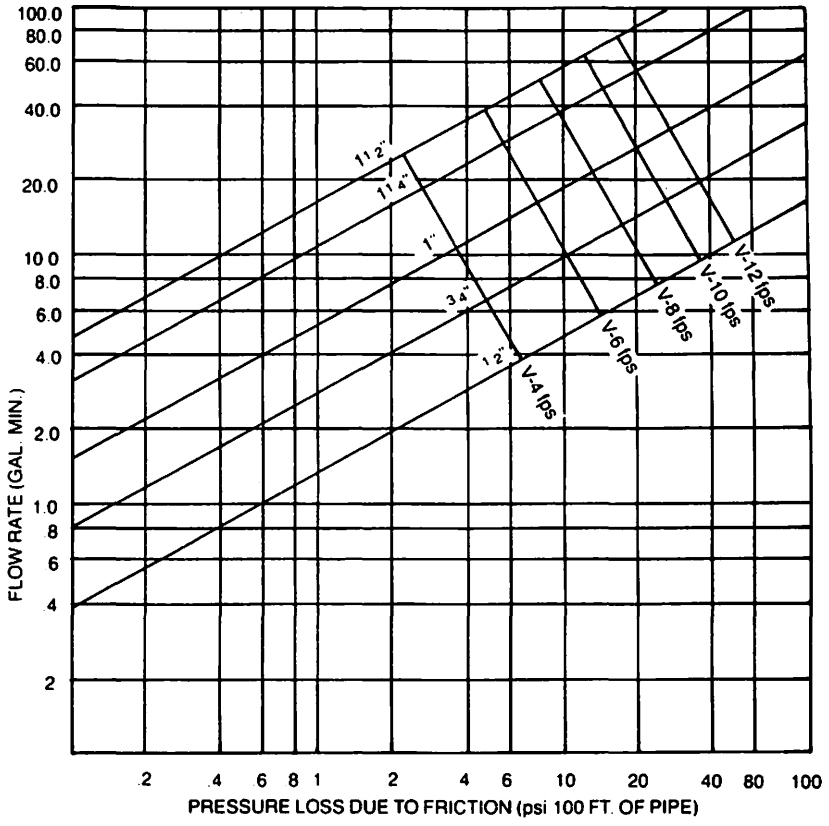


Figure No. E.3. (f)
PRESSURE LOSS (FRICTION) AS A FUNCTION OF FLOW-RATE MATERIAL: POLYBUTYLENE TUBING, SDR-11, ASTM D 3309 OR CPVC TUBING, SDR-11, ASTM D 2846

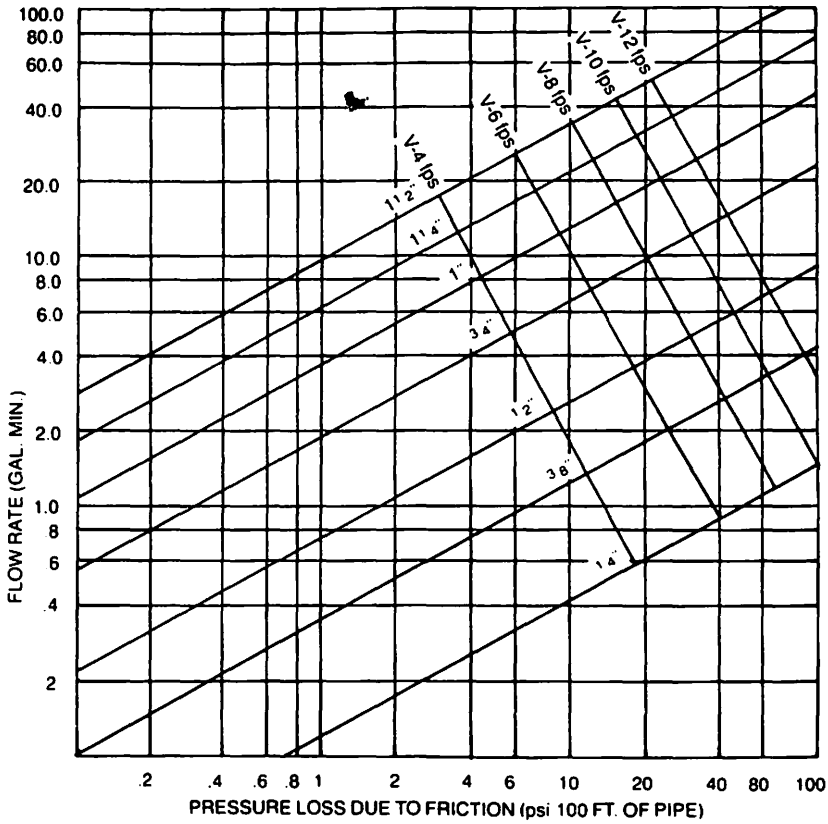


FIGURE NO. E-4
WATER PIPE SIZING CHART

Fixture Unit Table for Determining Water Pipe and Meter Sizes for Flush Tank Systems

Meter and Street Service	Building Supply & Branches	Maximum Allowable Length in Feet					
		40	60	80	100	150	200
Pressure Range–30 to 45 psi							
3/4"	1/2" **	6	5	4	4	3	2
3/4"	3/4"	18	16	14	12	9	6
3/4"	1"	29	25	23	21	17	15
1"	1"	36	31	27	25	20	17
1"	1 1/4"	54	47	42	38	32	28
1 1/2"	1 1/4"	90	68	57	48	38	32
1 1/2"	1 1/2"	151	124	105	91	70	57
2"	1 1/2"	210	162	132	110	80	64
1 1/2"	2"	220	205	190	176	155	138
2"	2"	372	329	292	265	217	185
2"	2 1/2"	445	418	390	370	330	300
Pressure Range–46 to 60 psi							
3/4"	1/2" **	9	8	7	6	5	4
3/4"	3/4"	27	23	19	17	14	11
3/4"	1"	44	40	36	33	28	23
1"	1"	60	47	41	36	30	25
1"	1 1/4"	102	87	76	67	52	44
1 1/2"	1 1/4"	168	130	106	89	66	52
1 1/2"	1 1/2"	270	225	193	167	128	105
2"	1 1/2"	360	290	242	204	150	117
1 1/2"	2"	380	360	340	318	272	240
2"	2"	570	510	470	430	368	318
2"	2 1/2"	680	640	610	580	535	500
Pressure Range–Over 60 psi							
3/4"	1/2" **	11	9	8	7	6	5
3/4"	3/4"	34	28	24	22	17	13
3/4"	1"	63	53	47	42	35	30
1"	1"	87	66	55	48	38	32
1"	1 1/4"	140	126	108	96	74	62
1 1/2"	1 1/4"	237	183	150	127	93	74
1 1/2"	1 1/2"	366	311	273	240	186	154
2"	1 1/2"	490	395	333	275	220	170
1 1/2"	2"	*380	*380	*380	*380	370	335
2"	2"	*690	670	610	560	478	420
2"	2 1/2"	*690	*690	*690	*690	*690	650

*Maximum Allowable Load on Meter
**Building Supply–3/4" minimum

Appendix F
BARRIERS FOR SWIMMING POOLS, SPAS AND HOT TUBS

Section F-101 Application

The provisions of this chapter shall control the design of barriers for residential swimming pools, spas and hot tubs. These design controls are intended to provide protection against potential drownings and near-drownings by restricting access to swimming pools, spas and hot tubs.

Section F-102 Definitions

For the purposes of these requirements, the terms used shall be defined as follows and as set forth in Section R-1 15.

Above-ground/on-ground pool: See definition of swimming pool.

Barrier: A fence, a wall, a building wall or a combination thereof which completely surrounds the swimming pool and obstructs access to the swimming pool.

Hot tub: See definition of swimming pool.

In-ground pool: See definition of swimming pool.

Residential: That which is situated on the premises of a detached one-or two-family dwelling or a one-family townhouse not more than three stories in height.

Spa, nonportable: See definition of swimming pool.

Spa, portable: A nonpermanent structure intended for recreational bathing, in which all controls, water-heating and water-circulating equipment are an integral part of the product and which is cord-connected (not permanently electrically wired).

Swimming pool: Any structure intended for swimming or recreational bathing that contains water over 24 inches deep. This includes in-ground, above-ground and on-ground swimming pools, hot tubs and spas.

Swimming pool, indoor: A swimming pool which is totally contained within a structure and surrounded on all four sides by walls of said structure.

Swimming pool, outdoor: Any swimming pool which is not an indoor pool.

Section F-103 Requirements

F-103.1 Outdoor swimming pool: An outdoor swimming pool, including an in-ground, above-ground or on-ground pool, hot tub or spa shall be provided with a barrier which shall comply with the following:

1. The top of the barrier shall be at least 48 inches above grade measured on the side of the barrier which faces away from the swimming pool. The maximum vertical clearance between grade and the bottom of the barrier shall be 2 inches measured on the side of the barrier which faces away from the swimming pool. Where the

top of the pool structure is above grade, such as an above-ground pool, the barrier may be at ground level, such as the pool structure, or mounted on top of the pool structure. Where the barrier is mounted on top of the pool structure, the maximum vertical clearance between the top of the pool structure and the bottom of the barrier shall be 4 inches.

2. Openings in the barrier shall not allow passage of a 4-inch diameter sphere.
3. Solid barriers which do not have openings, such as a masonry or stone wall, shall not contain indentations or protrusions except for normal construction tolerances and tooled masonry joints.
4. Where the barrier is composed of horizontal and vertical members and the distance between the tops of the horizontal members is less than 45 inches, the horizontal members shall be located on the swimming pool side of the fence. Spacing between vertical members shall not exceed 1 3/4 inches in width. Where there are decorative cutouts within vertical members, spacing within the cutouts shall not exceed 1 3/4 inches in width.
5. Where the barrier is composed of horizontal and vertical members and the distance between the tops of the horizontal members is 45 inches or more, spacing between vertical members shall not exceed 4 inches. Where there are decorative cutouts within vertical members, spacing within the cutouts shall not exceed 1 3/4 inches in width.
6. Maximum mesh size for chain link fences shall be a 1 1/4-inch square unless the fence is provided with slats fastened at the top or the bottom which reduce the openings to not more than 1 3/4 inches.
7. Where the barrier is composed of diagonal members, such as a lattice fence, the maximum opening formed by the diagonal members shall not be more than 1 3/4 inches.
8. Access gates shall comply with the requirements of Section F103.1, Items I through 7, and shall be equipped to accommodate a locking device. Pedestrian access gates shall open outward away from the pool and shall be self-closing and have a self-latching device. Gates other than pedestrian access gates shall have a self-latching device. Where the release mechanism of the self-latching device is located less than 54 inches from the bottom of the gate, the release mechanism and openings shall comply with the following:
   a. The release mechanism shall be located on the pool side of the gate at least 3 inches below the top of the gate; and
   b. The gate and barrier shall have no opening greater than l/2 inch within 18 inches of the release mechanism.
9. Where a wall of a dwelling serves as part of the barrier one of the following conditions shall be met:
   a. The pool shall be equipped with a powered safety cover in compliance with ASTM ES13-89; or

b. All doors with direct access to the pool through that wall shall be equipped with an alarm which produces an audible warning when the door and its screen, if present, are opened. The alarm shall sound continuously for a minimum of 30 seconds immediately after the door is opened and be capable of being heard throughout the house during normal household activities. The alarm shall automatically reset under all conditions. The alarm system shall be equipped with a manual means, such a touchpad or switch, to temporarily deactivate the alarm for a single opening. Such deactivation shall last for not more than 15 seconds. The deactivation switch(es) shall be located at least 54 inches above the threshold of the door; or

c. Other means of protection, such as self-closing doors with self-latching devices, which are approved by the governing body, shall be acceptable so long as the degree of protection afforded is not less than the protection afforded by (a) or (b) described above.

10. Where an above-ground pool structure is used as a barrier or where the barrier is mounted on top of the pool structure, and the means of access is a ladder or steps, then:

a. The ladder or steps shall be capable of being secured, locked or removed to prevent access; or

b. The ladder or steps shall be surrounded by a barrier which meets the requirements of Section F- 103.1, Items 1 through 9. When the ladder or steps are secured, locked or removed, any opening created shall not allow the passage of a 4-inch diameter sphere.

F-103.2 Indoor swimming pool: All walls surrounding an indoor swimming pool shall comply with Section F-103.1, Item 9.

F-103.3 Prohibited locations: Barriers shall be located so as to prohibit permanent structures, equipment or similar objects from being used to climb the barriers.

Section F-104 Exemptions

A portable spa with a safety cover which complies with ASTM ES13 entitled "Emergency Standard Performance Specification for Safety Covers and Labeling Requirements for All Covers for Swimming Pools, Spas, and Hot Tubs," 1989 edition, shall be exempt from the provisions of this chapter. Swimming pools, hot tubs and nonportable spas with safety covers shall not be exempt from the provisions of this chapter.

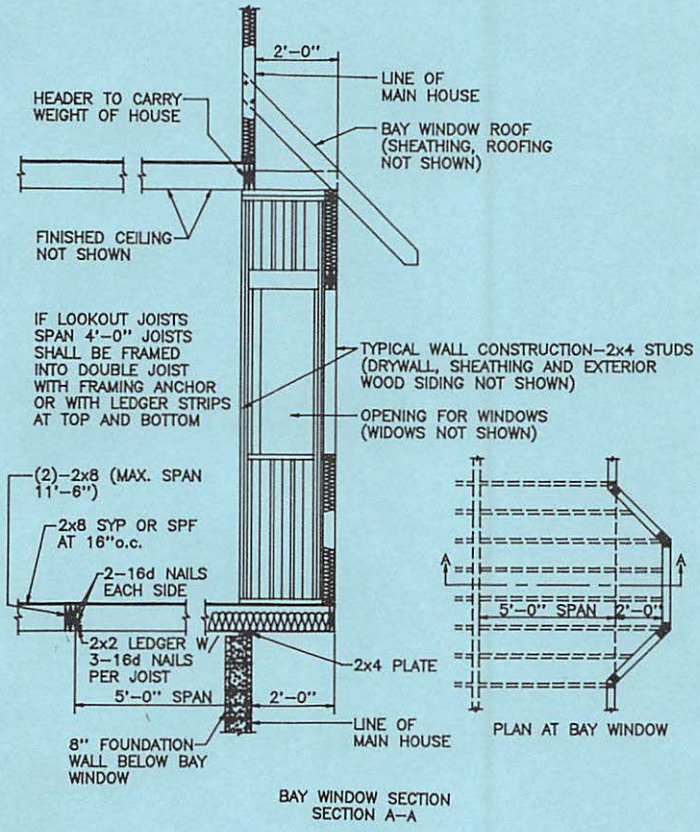
APPENDIX G
CANTILEVER FLOOR SECTIONS

G-1 SECOND FLOOR SECTIONS:

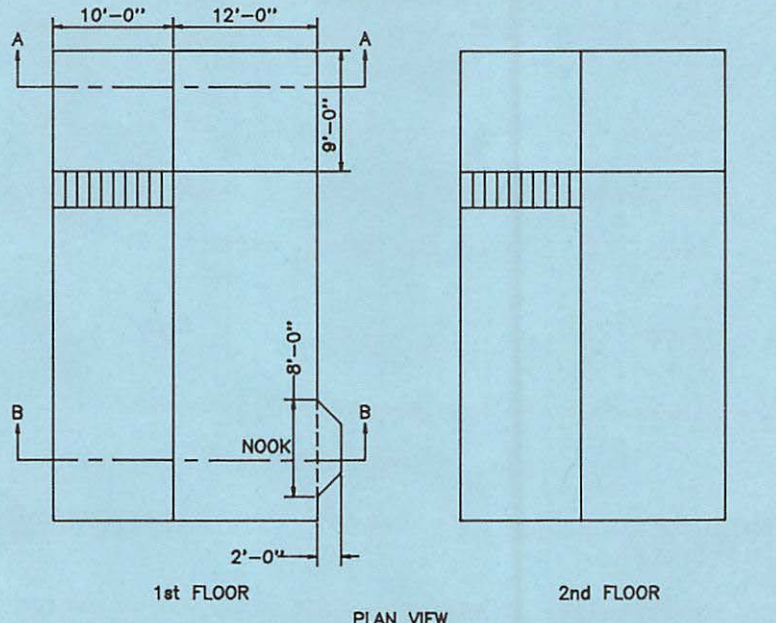
Where second story is framed out over the wall below and the second floor joists run parallel to the supporting wall, the supporting members of the overhang shall carry back at least 30 inches and frame into doubled floor joists. The maximum projection of the overhanging shall be 15 inches. Where framing 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



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 Roof load = 390#/1ft

$$\text{Nook roof load} = \frac{\text{nook span}}{2} \times \text{roof load (live + dead)} + \frac{\text{nook span}}{2} \times \text{ceiling dead load} =$$

$$= \frac{2}{2} \times 30 + \frac{2}{2} \times 10 = 40\#/1\text{ft} \qquad \text{Nook} = 40\#/1\text{ft}$$

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)

BOLT SPACING

1/2" ø BOLTS @ 2'-0" o.c.
MIN STEEL EDGE CLEARANCE 1 1/2"

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.

Table No. H-2 (Continued)

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.

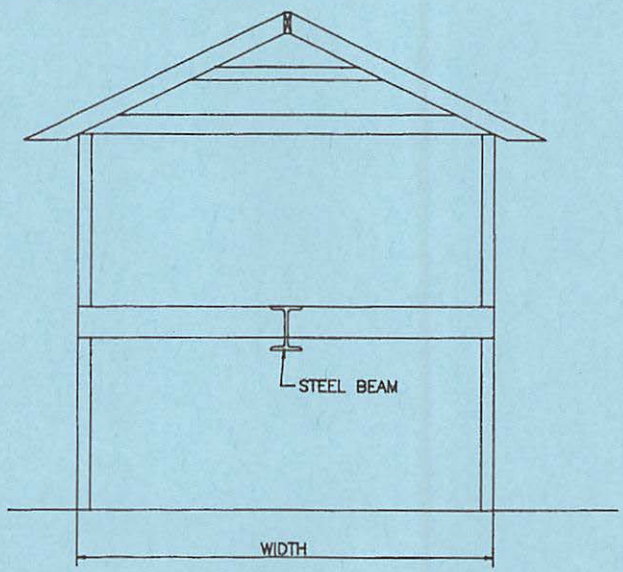
APPENDIX I

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
22	W8 X 31 W10 X 22 W12 X 19	4	W8 X 35 W10 X 22 W12 X 19	4	W8 X 35 W10 X 22 W12 X 19	4	W8 X 40 W10 X 26 W12 X 19	4	W8 X 40 W10 X 26 W12 X 22	4
24	W8 X 40 W10 X 26 W12 X 22	4	W8 X 48 W10 X 30 W12 X 22	4	W8 X 48 W10 X 30 W12 X 22	4	W8 X 48 W10 X 30 W12 X 26	5	W8 X 48 W10 X 39 W12 X 26	5
26	W14 X 22 W10 X 39 W12 X 26	4	W14 X 22 W10 X 39 W12 X 26	4	W14 X 26 W10 X 39 W12 X 26	5	W14 X 26 W10 X 39 W12 X 26	5	W14 X 26 W10 X 45 W12 X 30	5
28	W14 X 26 W10 X 45 W12 X 30	4	W14 X 26 W10 X 45 W12 X 30	4	W14 X 26 W10 X 45 W12 X 30	5	W14 X 30 W10 X 49 W12 X 35	5	W14 X 30 W10 X 54 W12 X 35	5

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. 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 R-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	0.61
Interior Finish	1/2" Drywall 5/8" Drywall (Other)	0.45 0.56	
Mineral Fiber or loose fill or cellulose	R-19 Batts R-22 Batts R-30 Batts R-38 Batts (Other)	19.00 22.00 30.00 38.00	
Sheathing on Inside of Rafters	1" Expanded Polystyrene Foam 1" Extruded Polystyrene Foam 1" Polyurethane 1" Polyisocyanurate (Other)	3.80 5.00 7.20 7.20	
Outside Air Film	(to be included for all situations)	0.17	0.17
Total R-Value Between Framing of Ceiling (Must be 31 or More)			

Trade-off calculations (E-2501.7) must be attached for cathedral ceilings of less than R-31

PRESCRIPTIVE COMPLIANCE FOR FLOOR

COMPONENT	PRODUCTS	R-VALUE BETWEEN FRAMING	TO BE USED
Inside Air Film	(to be included for all situations)	0.61	0.61
Mineral Fiber	R-19 batts	19.00	
flooring	(sub-floor + finished floor value)		
Outside Air Film	(to be included for all situations)	0.17	0.17
Total R-Value Between Framing of Floor (Must be 20 or More)			

SLAB-ON-GRADE must have R-5 perimeter insulation extending 24" (total) down and underneath but at least to the frost line.

PRESCRIPTIVE COMPLIANCE FOR GLASS DOOR & WINDOW UNITS

% OPENINGS	WINDOW TYPE USED	AREA OF OPENINGS
Up to 1%	Single Glazed	
Up to 23%	Single Glazed & Storm or Double Glazed	
> 23% < 33%	Double Glazed with Low-Emissivity Glass	
33% or more	Double Glazed with Low-E & Argon Gas	

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	0.68
Interior Finish	1/2" Drywall	0.45	
	5/8" Drywall	0.56	
	Interior Paneling	0.25	
	(other)		
Mineral Fiber	R-11 Batts	11.00	
w/ Vapor	R-13 Batts	13.00	
Retarder	R-15 Batts	15.00	
	R-19 Batts (compressed to 5 1/2")	18.00	
	R-21 Batts	21.00	
Loose Fil	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	
	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	0.17
Total R-Value Between Framing of Opaque Wall (Must be 16 or More) or complies with Section E-2502 Exception 1 2 3			

COMPONENTS USED AT STRUCTURAL SHEATHING

COMPONENT	PRODUCTS	R-VALUE BETWEEN FRAMING	TO BE USED
Inside air film	(to be included for all situations)	0.68	0.68
Interior Finish			
Insulation			
Sheathing			
Exterior Finish			
Outside Air Film	(to be included for all situations)	0.17	0.17
Total R-Value Between Framing at Structural Sheathing (Must be 16 or More)			

Indicate products to be used and use R-Value from above. Trade-off calculations (E-2501.7) may be used for assemblies less than R-16 and attached to this worksheet.

APPENDIX K
Recommended Construction Practice for Slabs 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	W1.4 X W1.4
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.

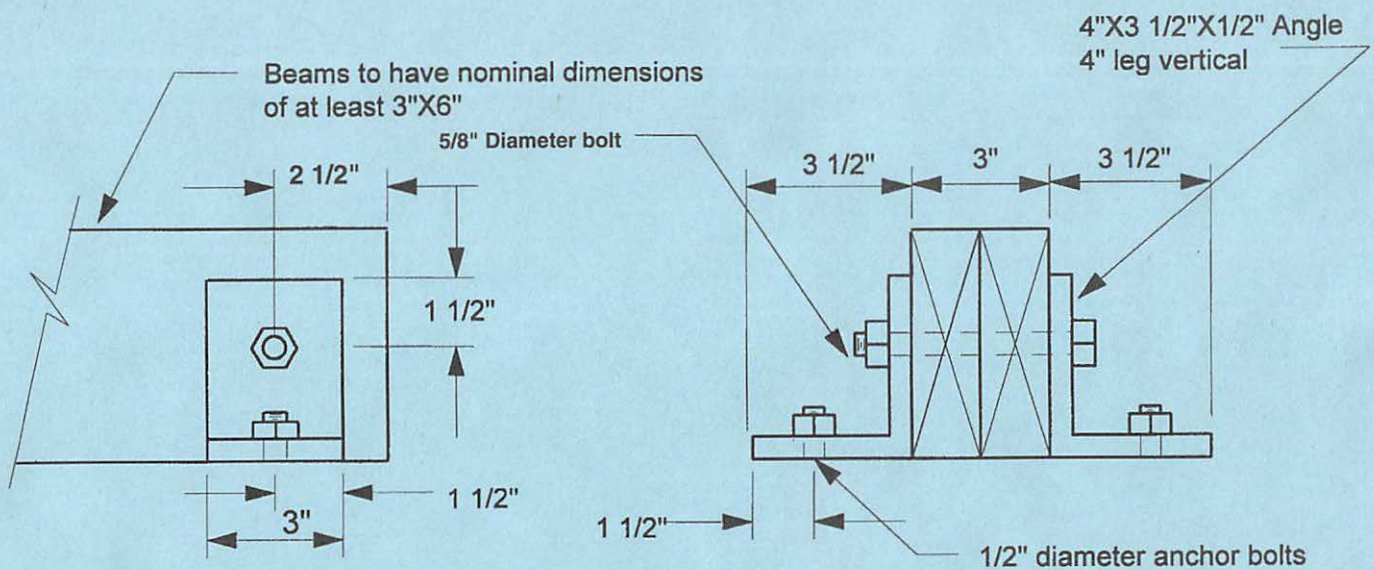
APPENDIX L

Table No. L-1
Girder Connection to Piers

velocity (mph)	Girder Span		
	4'-0"	6'-0"	8'-0"
100	L1	L2	L2
110	L2	L2	DESIGN

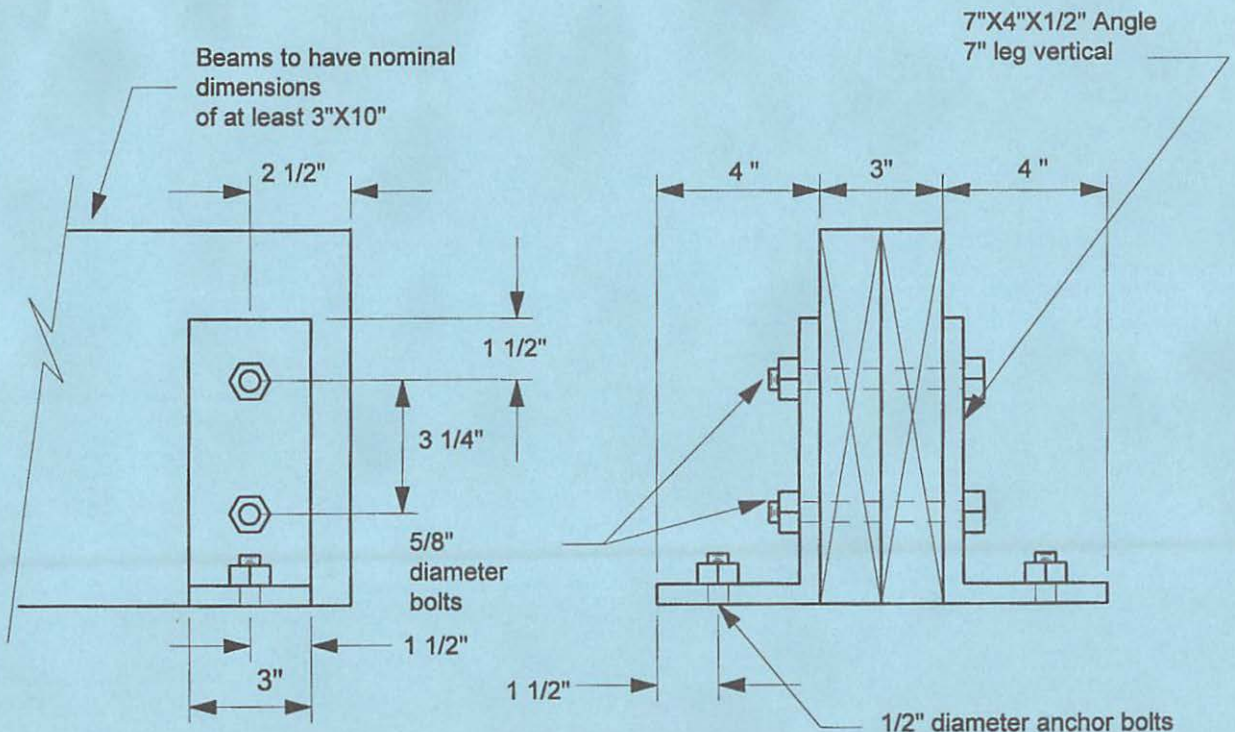
This table is valid for Southern Pine and Spruce Pine Fir but not less dense woods.

Connections L1 and L2 are possible anchors connecting wood beams to pier and curtain wall construction. These connections are shown in Figures L-1 and L-2, respectively..



SINGLE BOLT THRU WOOD BEAMS

FIGURE L-1
CONNECTION L-1



TWO BOLTS THRU WOOD BEAM
FIGURE L-2
CONNECTION L-2

Appendix N
FOAM PLASTIC DIAGRAMS

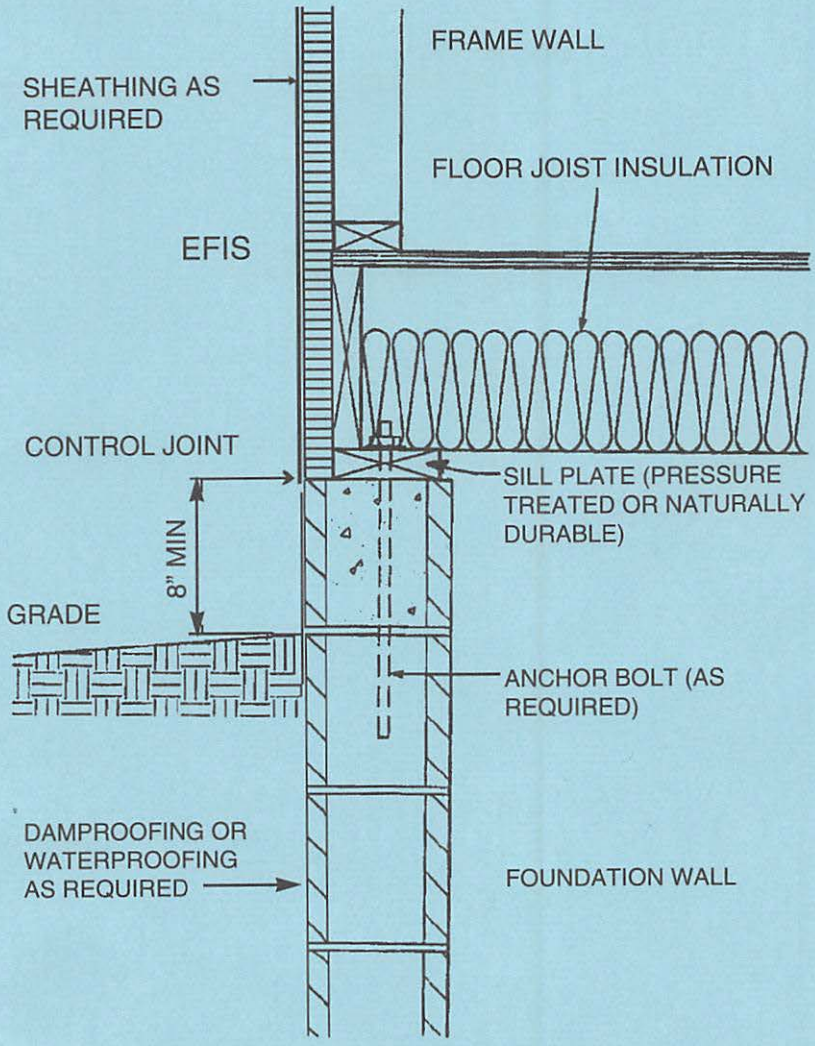


FIGURE N-1

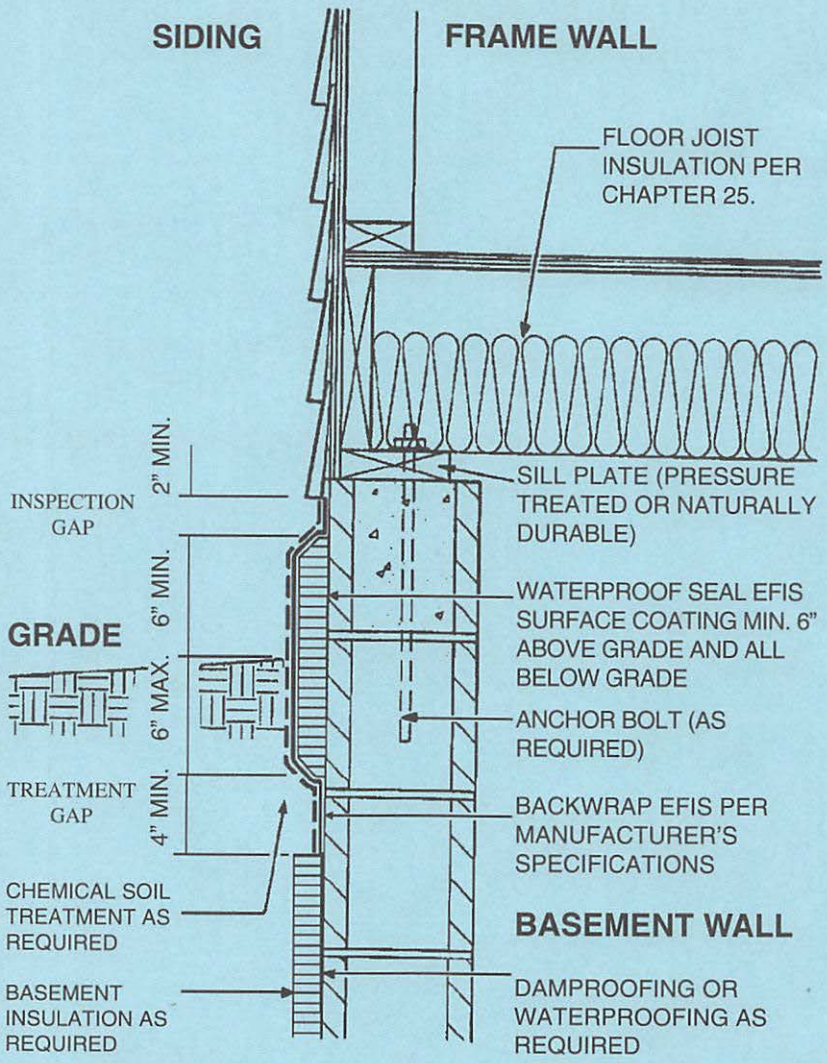
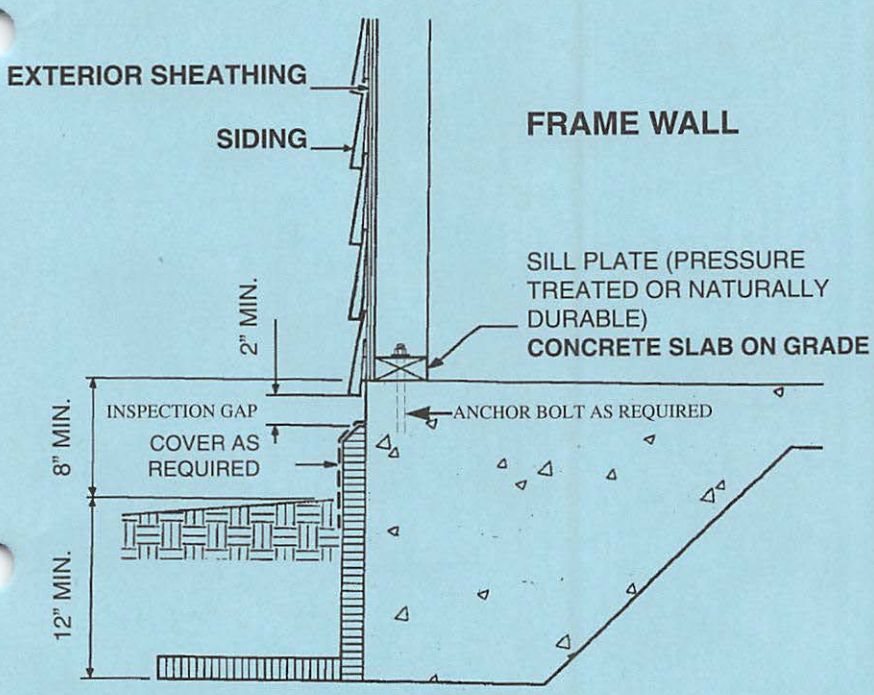

SIDING
FRAME WALL
FLOOR JOIST INSULATION PER CHAPTER 25.
2" MIN.
INSPECTION GAP
6" MIN.
SILL PLATE (PRESSURE TREATED OR NATURALLY DURABLE)
WATERPROOF SEAL EFIS SURFACE COATING MIN. 6" ABOVE GRADE AND ALL BELOW GRADE
GRADE
6" MAX.
ANCHOR BOLT (AS REQUIRED)
TREATMENT GAP
4" MIN.
BACKWRAP EFIS PER MANUFACTURER'S SPECIFICATIONS
CHEMICAL SOIL TREATMENT AS REQUIRED
BASEMENT WALL
BASEMENT INSULATION AS REQUIRED
DAMPROOFING OR WATERPROOFING AS REQUIRED

FIGURE N-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 N-3

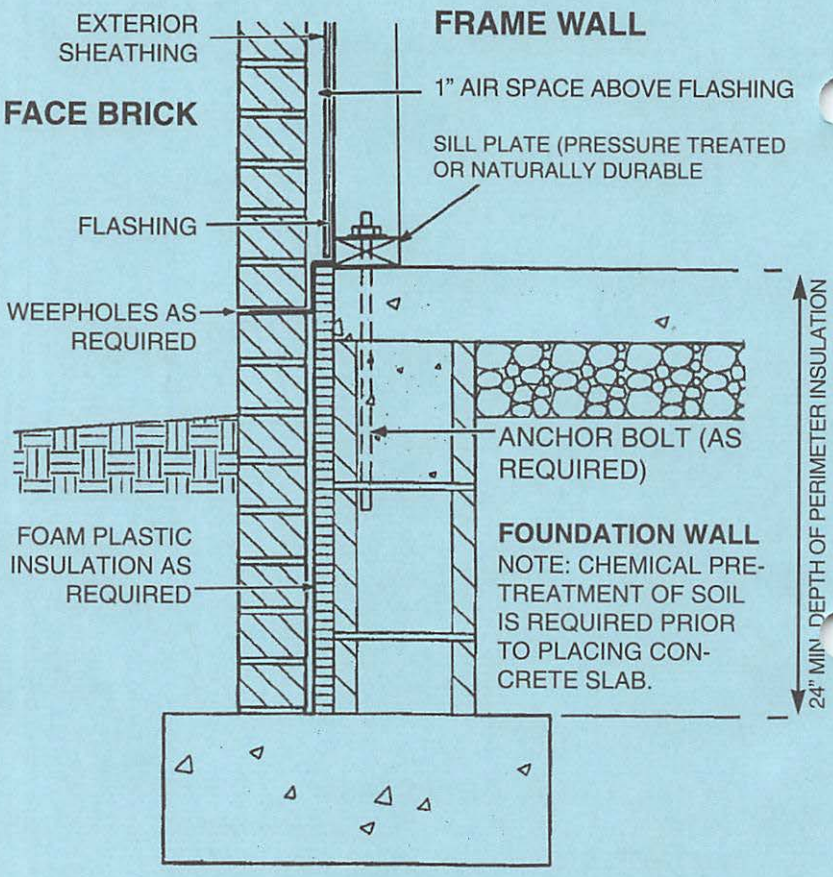

EXTERIOR SHEATHING
FRAME WALL
1" AIR SPACE ABOVE FLASHING
FACE BRICK
SILL PLATE (PRESSURE TREATED OR NATURALLY DURABLE
FLASHING
WEEPHOLES AS REQUIRED
ANCHOR BOLT (AS REQUIRED)
FOAM PLASTIC INSULATION AS REQUIRED
FOUNDATION WALL
NOTE: CHEMICAL PRE-TREATMENT OF SOIL IS REQUIRED PRIOR TO PLACING CON-CRETE SLAB.
24" MIN. DEPTH OF PERIMETER INSULATION

FIGURE N-4

A

R